From The Chief Editor's Desk

Dear Readers,

I am extremely happy to present you the 4th edition of Agriculture Today Year Book 2011. The huge response received for the earlier Year Books has been the driving force behind this latest edition of the Year Book. I thank all the readers for their support and encouragement. With the love of our readers, 'Agriculture Today' has become a pioneer in raising the voices of Indian farmers and all stakeholders in agriculture. Today, the magazine is effectively influencing policies related to agriculture and agribusiness.

Like the earlier editions, Year Book 2011 also contains a number of informative articles contributed by the most eminent persons in Indian agriculture. These articles try to present the agriculture scenario of India in a holistic perspective. I am sure that the balanced combination of data, analysis and information will be of great interest to our readers.

With all my heart, I thank the eminent writers for their valuable contribution for the Year Book 2011. Without their timely contributions, this Year Book could not have been possible. I hope that the Year Book will serve as a useful guide and reference material to all those related to the agriculture sector, including government officials, policy makers, scientists, agribusiness companies, NGOs, institutions, agri researchers, professionals, planners etc. Despite our best efforts, I realize that there is still scope for further improvement and we shall do better in the next edition in 2012. I request all the esteemed readers to lend their valuable support by sending in comments and suggestions.

I take the opportunity to express our gratitude to Prof. MS Swaminathan, Chairman and all the members of the organizing committee of the Agriculture Leadership Summit 2011 for their valuable guidance. I am also thankful to my colleagues specifically Ms. Dinchengfa Boruah, Abdul Rehman and Ashima Colvin for their untiring efforts in compiling and editing the Agriculture Year Book 2011.

With best wishes
M.J Khan

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Factory:
Plot No. 242/P, GIDC, Panoli,
Dist - Bharuch - 394116,
Tel: (+91)-2646-645843, Fax: 272255

"To forget how to dig the earth and tend the soil is to forget ourselves"

-Mahatma Gandhi

"I know of no pursuit in which more real and important services can be rendered to any country than by improving its agriculture, its breed of useful animals, and other branches of a husbandman's cares."

-George Washington

"Cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to their country and wedded to its liberty and interests by the most lasting bands"

-Thomas Jefferson

"Farming looks mighty easy when your plow is a pencil, and you're a thousand miles from the corn field."

-Dwight D. Eisenhower

"When tillage begins, other arts follow. The farmers, therefore, are the founders of human civilization."

-Daniel Webster

"The experience of ages has shown that a man who works on the land is purer, nobler, higher, and more moral... Agriculture should be at the basis of everything. That's my idea."

-Nikolai Gogol

"The discovery of agriculture was the first big step toward a civilized life."

-Arthur Keith

MajorConcerns

Agriculture:
Challenges and Opportunities

Dr. S. K. Nanda, IAS

Agricultural scenario in the country presents a lot of challenges and opportunities. The challenges are mainly due to factors of water or irrigation facilities availability and the market forces which are operating outside the production field. The storage facilities are a factor for sustainability of crops and also the gamble of monsoon, more particularly, the timely precipitation. Opportunities are namely exports both of fresh and processed vegetables other than castor seed oil and production of cereal crops for food security beyond self-consumption. These opportunities can be scaled up and linked up to new facilities, namely, air cargo complexes, establishment of good laboratory for quality inspection of agricultural products and adoption of hi-tech farming and advance techniques. In the recent past even space technology has been used for multi spectral images to reveal data of the relative levels of silt, sand, calcium and clay and the GPS technology is being used in agriculture to measure field acreage more precisely for information of farmers.

In days to come, water is going to be the most deficient factor and its economic use and optimum utilization has to be a matter of strategy through field leveling, formation of watershed using micro irrigation system including deploying systems for timely watering in requisite quantity so as to salvage the rest of water in rest of the season to nurture the future plants. The Government of India has taken up various schemes under different Ministries namely MGNREGA, RKVY, NABARD assistance and also group schemes for irrigation for the benefit of farmers for supplying water and moisture. But the most key element that is required is to have a totalistic plan of the produce and crop that has to be taken up and the need for water emerging out of this crop pattern. No doubt, the mixed cropping and double cropping have been activated to double benefits at single time but the need for water or moisture has to be adequately planned since mono crop phenomenon over a long period of time has been giving more problems than solutions to the farmers in his field.

Agriculture growth rate of the country is not merely to be seen as a statistical entity but has to be understood as an element factoring the food and nutritional security that has to enable inclusive growth of the farmers. It is an admitted fact that an area which is producing sugarcane, cotton and oil seeds will contribute to GDP more compared to other crops and the growth rate of that area in terms of agriculture will be double digit compared to an area which is producing cereals, food crops and vegetables. But these crops have got a direct impact on the food and nutritional security than the GDP impact or growth rate dimension. We have to keep agriculture sometimes away from the statistical jugglery of growth rate but link it up with factors of optimum utilization of water mechanism, productivity out of soil and give the benefit of mixed or double cropping to address the needs of self-sufficiency and income returns for better livelihood. If this strategy becomes the under pinning element for agriculture, we can have a balanced agricultural growth rather than entering the rat race for monetary returns alone leading to market crashes and unproductive results at the end of the day. We have also crops that are sustainable

which means they would be able to subsist or survive on surface water or conserved water than through digging of ground water and with help of minimum use of water through technology. We should be having those seed varieties again that can give us more productivity in shortest possible time and such a phenomenon can encourage the demoralized farmers to take up more of agriculture instead of looking at agriculture in terms of money terms or seasonal returns alone.

We do not have statistics on a real time basis to demonstrate how much of land have been lost every day for non-agricultural purposes on account of promised huge money returns like in housing estates, establishing of malls and commercial complexes and other utility institutions.

Sooner or later there has to be a law that has to restrict formation of industrial zones or non-agricultural compartments in agricultural rich zones and simultaneously there has to be earmarking of zones or lands based on classification of soil, clay, water and the nutrients. All those lands which are suitable for agriculture and the capture areas for agricultural output should not have threats of any other use when it comes to agricultural growth. For the last few years, we have almost touched more than 90MT wheat production and in years to come the productivity of wheat in non-wheat states are gradually increasing than the traditional wheat states. The same would be true of rice and the success of rice cultivation in northern states is also an eye opener. The productivity of rice and wheat has been improving on an average in every area though there are certain states which are falling short of the productivity benchmark of the best performing states. We need not have to compete always with such states on these matters but need to have a close look at cultivation of the other millets which also contribute to the source of food like cereal sources in our homes. We must try to step up its production to reduce the mono dependence which in turn also reduces the mono cultivation of the same species leading to lot of many complications as years go by. The same is true of local oil seeds which are consumed by the local people but not marketed to fetch incomes and such local oil seeds like in Niger seeds should be retained not only as a part of bio-diversity but as a part of our strategic food security plan so that they are locally produced, consumed and sold. Ideally, a village can be rich if it is self-sufficient i.e. if produce of the village is consumed locally and distributed sub-regionally other than being sold outside the village. This is better than to have trading goods which are manufactured outside and transported to the places of consumption leading to inflated costs that lowers down the purchase power of the people. One cannot dispute the money power returns of cotton or oil seed crops but it has to be grown with necessary food crops so that the soil nutrient is maintained and human nutrients are guaranteed.

Of late growing trees as a crop has been one of the trends that have been noticed in areas where agricultural capitalism is growing. In areas of Tamilnadu, some parts of Karnataka and Haryana and in two to three districts of Gujarat, growing trees as a crop which fetches income in form of a capital return at the end of five years has become more rewarding. It has not only restored the soil richness and nutrient of the soil but has also facilitated agriculture through a symbiotic relation of tree cropping that enhances the productivity, water retention and soil quality. In the districts of Anand and Nadiad, it is a common saying that Patel farmers have an Income Schedule consisting of one third income from dairy, one third from tree crop and the remaining from main crops, both cash and food varieties. Such a tree crop is either cultivated on a plot size or it is planted on the periphery of the agricultural field consisting of species that give a timber value in the timber market. The cultivation of tubers roots and herbs is becoming another rewarding activity. To promote cultivation of such species and to introduce health enabling agents that are cheap and have potency, Medicinal Plants Board as well as of the MOEF have started flagship programmes like cultivation of “Dashmool” in the hilly track of India. Even the bamboo mission which encourages the plantation of bamboo have the intended impact of giving fixed and promised income returns apart from protecting the quality aspects of the soil and contributing to the medical merchandise in the alternative health segment.

As far as Gujarat is concerned, the cultivation of the total cash crop and total oil seeds has overtaken the

total cultivation of Kharif and Rabi crops. But if India has to attain nutritional security, it is also very essential that locally produced vegetables and fiber crops are locally marketed and are made available other than forming a part of the chain for the national market. There has been a continuous growth in the productivity of the cereal crops in the state of Gujarat compared to the national productivity average for rice, bajra, cotton, sugarcane and tobacco. However much more need to be done in case of crops like maize and wheat. The new pulse policy by which pulses would be grown under an incentive policy would definitely give a thrust to the nutritional security. It has been noticed that in the tribal belts, the farmers are taking up maize crops with pulses like tuvar, moong, cowpea and udid. In similar way mixed cropping pattern is becoming a common phenomenon in arid and semi-arid areas of north Gujarat which contributes about 16% of total exports in the agricultural sector covering derivatives, castor, sesame, marine products and fruits and vegetables. The Government of India's Exim Policy that focuses agro export zones for commodities like groundnut, castor, banana, potatoes would definitely provide high returns and give them the access to export and strengthen the capacity of farmers to go for export quality products and take a deep interest in the technology and core areas of agriculture.

No doubt today, hi-tech agriculture has been professed and practiced to incomes of farmers but simultaneously we cannot miss out the gap that has been noticed in use of bio-fertilizers & pesticides and practice of green manuring. The soil health cards and the Krishi Mela are two interventions that have been added to inform the farmers about the soil health status and bring them near to scientists to know about the cultivation issues so as to achieve capacity building. However, there is still a need for better management of water through simple interventions for ground water management and surface water dispersal. The tissue culture for high quality production in fruits like water melon, jambu and for plants like Jojoba, Ratanjyot, White musli and Brahmi have to be upscaled and replicated for making agriculture income more rewarding and sustainable. The use of implements and innovative methods for cultivation and the demonstration of crop-wise and field-wise practices have to be a regular feature to keep farmers updated and engaged through visual and audio channels. They need to be also kept continuously informed about vermin-culture, bio-energy potential of agricultural waste and the market information about food processing industry with stories of successful farmers to emulate their experiences and enrich themselves for continuously remaining on the marching foot and take a great leap forward.

We need to produce more food not for money alone but for healthy and financially sustainable farmer homes and in this process we should be able to reach food security and combat against all factors to catch up with the gaps. We do not need subsidies to make agricultural growth but we need Rs 50,000 crores worth waste in agriculture to be saved by giving linkages of transport, storage and processing. We do not need urbanization in a manner to destroy good agricultural fields but need fertile agricultural areas encircling the urban towns to feed the urban population. We do not need to depend on major oil seeds crops alone but encourage other local oilseeds to be strengthened and we also need technology to empower the tissue culture for productivity of fruits and vegetables which would address the excess of carbon in soil to its logical conclusion to adapt to climate change phenomenon. We do not want genetically modified crops to dominate but disseminate about our markets to farmers, create store houses and preserve bio-diversity of different crops and vegetables for maintaining the old balance so that we do not get stumped on the back foot. We need a balanced, pragmatic, holistic and technologically sustainable model to see that we thrive and live to produce big, eat well and make that the centre of our economy in every inclusive manner.

Principal Secretary, Forests & Environment Department, Government of Gujarat

Economic Independence of Farmers for Sustainable Growth

The latest round of the global economic crisis is capitalism saving itself by placing unprecedented burdens on the poor and needy. Agriculture sector, world over, has experienced a phenomenal growth since the mid-twentieth century. The growth, driven by Green Revolution technology, has made a significant dent on aggregate supply of food grains, ensuring food security to the growing population. The next stage of agricultural growth however, faces a serious challenge in terms of sustainability of the resources & economic independence of the farmers rather than political independence. It is high time we integrate Livestock & Agriculture sector for better sustainability of farming community to address the national food security needs. Education of rural masses for adopting new techniques will play a significant role in entire process of livelihood generation of farming community.

*M J Saxena**

*Anup Kalra***

Introduction:

"Agriculture is the backbone of the Indian Economy"- said Mahatma Gandhi five decades ago. Even today, as we enter the new millennium, the situation is still the same, with almost the entire economy being sustained by agriculture, which is the main stake of the villages. Not only the economy, but also every one of us looks up to agriculture for our sustenance too.

Significance of Agriculture:

Although agriculture contributes only 21% of India's GDP, its importance in the country's economic, social, and political fabric goes well beyond this indicator. The rural areas are still home to some 72 percent of the India's 1.2 billion people, a large number of whom are poor. Most of the rural poor depend on rain-fed agriculture and fragile forests for their livelihoods.

The sharp rise in food grain production during India's Green Revolution of the 1970s enabled the country to achieve self-sufficiency in food grains and stave off the threat of famine. Agricultural intensification in the 1970s to 1980s saw an increased demand for rural labour that raised rural wages and, together with declining food prices, reduced rural poverty.

Sustained, although much slower, agricultural growth in the 1990s, reduced rural poverty to 26.3 percent by 1999-2000. Since then, however, the slowdown in agricultural growth has become a major cause for concern. India's rice yields are one-third of China's and about half of those in Vietnam and Indonesia. With the exception of sugarcane, potato and tea, the same is true for most other agricultural commodities.

Indian livestock sector has show better promise (growth of 4-5%) than the agriculture sector (growth of -1

to 1%). This in a way has helped the rural farming community. The key point to be observed here is that our majority of the ruminants are reared under suboptimal conditions, as the small livestock holders hold around 70% of our country's livestock.

Concerns

It is only relatively recent phenomenon that large-scale forest areas, grazing lands and waste lands have been converted into croplands to support the rising population, which has caused ecological imbalance and atmospheric pollution. With no further scope for expansion of agricultural land, efforts have been made to enhance the production of food grains using high-yielding variety of seeds, fertilizers and irrigation along with advanced farm equipments. This has led to serious concerns.

Soil fertility: A continuous fall in soil fertility is a major problem in many parts of India.

Water: Irrigation is the biggest consumer of fresh water, and fertilizer and pesticides contaminate both surface and groundwater.

Pollution: Pesticides are hazardous to human health as well as to the local ecology. Incorrect handling, storage and use of pesticides lead to health and pollution problems.

Agriculture cannot be sustainable unless it is economically viable over the long term. All this would mean less food, more hunger, higher inflation and unsustainable farming.

The Resultant

The recent double recession and inflation indicate that farmers may be politically independent but not in economic terms. The recent global economy saw 250 companies listed on the London a steep loss of their Stock Exchange values. The turbulence in the global markets saw more than $2.5 trillion wiped off from investors' wealth. The sensex in India lost over Rs 4 lakh crore in recent trading sessions. Recently, the news broke out of the unprecedented downgrading of US sovereign long-term credit rating by Standard & Poor's from `AAA' to AA'. The simultaneous sovereign credit crisis in the Euro zone has seen the virtual insolvency of Greece, Ireland and Portugal, which had to be bailed out by huge packages. The crisis is now threatening Spain and Italy. The economic rating of the terrorism is on increase, the power centers are falling apart because of public unrest and hunger. Is this what we called development or independence?

Possible Solutions:

Export vs. local orientation: Governments tend to view export-oriented production systems as more important than those that supply domestic demands. This is misguided. Focusing on exports alone involves hidden costs: in transport, in assuring local food security, etc. Policies should treat domestic demand and in particular food security (either by farmers producing food for themselves, or by selling produce for cash they can use to buy food) as equally important to the visible trade balance.

Debt: The Green Revolution raised India's grain output significantly, but a vast number of small-scale farmers ran into a debt trap as they took out loans to raise their production, and then found they could not pay the money back. About 40,000 were so desperate that they committed suicide. We need to relook into rural finance, which is today governed by landlords, who in turn dictate the price of the produce.

Risk: Concentrating on specific commodities seems to promise high economic returns. But market production implies certain risks: markets change quickly, and international agricultural prices are dropping. Cheap foreign food may sweep into the national market, leaving Indian farmers without a market. As a World Trade Organization signatory, the Indian government is under pressure to deregulate and open its economy to the world market so cannot protect its farmers behind tariff walls.

Indigenous knowledge: Sustainable agricultural practices often rely on traditional knowhow and local innovation. Local people have a wealth of knowledge about their environment, crops and livestock. They keep locally adapted breeds and crop varieties. They have social structures that manage and conserve common resources, help people in need, and maintain the social fabric. Rather than ignoring or replacing this knowledge, sustainable agricultural development seeks to build on it and enrich it with appropriate information from outside. This should be examined on scientific platform for its application

India – Policies for Agriculture

The Indian government's policies have always emphasized food grain

self-sufficiency, which has not necessarily coincided with agricultural sustainability. The growth of agricultural production and productivity, which had risen significantly during 1970s and 1980s, declined during 1990s. These slowdowns have worsened since 2000, both overall agricultural production and food grains production have shown negative growth rates in 2000-01 to 2002-03 period. Decline in the growth rates of agricultural production and productivity is a serious issue considering the questions of food security, livelihood, and environment. As such, a critical examination of our reserves in Food Corporation godowns & their storage conditions need to be reexamined. If release of the part of the buffer stock can be helpful in containing inflation needs to be looked. This examination must be framed not only by India's ongoing need to ensure food self-sufficiency but also by the consequences of access to international markets.

Integration of Agriculture & Livestock:

Food: Our current challenge for its security & safety

In this **mission, Livestock is also expected to jointly play an important role**. Livestock plays an important role in our lives. Apart from providing livelihood to the people in the rural & semi urban areas, they form a vital link for the food security. They provide us milk, meat which is essential source of protein & energy. Moreover, agriculture income may come to farmer three to four times in a year where as the income from milk is on daily basis.

Feed: To help the bioconverter for producing food

In livestock farming, it becomes very important for us to feed our livestock with proper balanced feed. The basic principle of GIGO applies here. If you feed them right, they will remain healthy & more productive during their lifespan. As a matter of fact in our country our farmers mostly complain of less milk production & percentage of fat in the milk, but, often they do not realize that to produce, animals have to reproduce and for which feed is the most vital link.

Fodders: Nutritionally enriched green feed for Animal health

Fodder is important part of Livestock feeding & can never be under estimated. The fodders are rich in Omega 3 Fatty acid which is essential for maintaining a healthy heart, flexible joints, healthy growth and strong bones and teeth. Another constituent of importance is Conjugated Linoleic acid (CLA), which is believed to boost immune function and reduce the growth of tumors.

In our country we do not get the green fodder round the year which affects the health of the animals & the quality of the milk which they produce.

Hydroponics: A novel initiative for green Feed:

The word hydroponics has been derived from the Greek word where 'Hydro' means water and 'Ponic' means working, i.e. water working. Plants require 3 things to flourish- water, nutrients & sunlight. Hydroponics is a straightforward way of providing all these nutrients without the need of soil under controlled environment conditions to optimize the growth of plants. It is referred as feed because when compared to conventional fodder, protein content is about three times higher and energy values are about double in Hydroponics feed.

Completely natural: An important factor about growing green feed in Ayurvet's hydroponics machine is that it is a completely natural product. Therefore, there are no pesticides or fungicides used that could alternatively contaminate the milk or meat that are being produced.

Fuel: For our daily domestic & community needs

Energy is a necessary concomitant of human existence. Although many sources of energy exist in nature, it is coal, electricity and fossil oil which have been commercially exploited for many useful purposes. This century has witnessed the phenomenal growth of various industries based on these energy sources. Today, energy crisis has mainly emerged from the fear that the boons of fossil oil may turn into a bane as the disappearance of fossil oil would compel the habits and practices of living of the society to change. That is the crisis and that is the compulsion for searching alternate sources of energy.

Bio-Gas as one of the Alternate Renewable Sources of Energy: It has useful hydro-carbon with combustible qualities as that of other hydrocarbons. Though its calorific value is not high as some products of fossil oil and other energy sources, it

can meet some needs of household and farms.

It is estimated that alternative sources of energy like bio-gas plants, wind mills etc. may reduce the dependence on conventional sources of energy by about 20% by the turn of the century. Presently, the cooking medium in rural areas consist of burning dung cake, fire-wood and to some extent kerosene where it is available easily. The installation of bio-gas plants would directly replace the use of above three and in saving them, following gains would be made:

- Nearly 30% of available dung which is burnt and wasted would be recovered as bio-gas plants conserve the dung while producing bio-gas.
- The dung after digestion in gas plant preserves more of NPK in the dung solids and cellulose which otherwise gets lost if heaped in the open.
- Rural people would gradually stop felling trees. Tree felling bas been identified as one of the major causes of soil erosion and worsening flood situation.
- The most important social benefit would be that the dung being digested in the digester, there would be no open heap of dung to attract flies, insects and infections. The slurry from digesters can be transported to the farm for application in the soil, thus keeping the environment clean for inhabitation.

Fertilizer: For enriching the soil & its recharge

The government's recent decision on deregulation of the chemical fertilizer is indicative that it is not possible for the government to foot the subsidy bill. As a matter of fact, the use of synthetic fertilizer is reducing the soil fertility & affecting the food production, said a joint study by Non profit Green Peace & West Bengals'Visva Bharti University. The data quoted that in 1960 there was a 25 kg increase in grain production with each kg increase of fertilizer. In early 1990s this came down to 19 & late 1990s it was at 8kg. One of the report further mentions that micro nutrients of the soil are lost with over use of nitrogen fertilizer, urea. The fertilizer subsidy is now at Rs.1, 20000 crore against Rs.60 crore in 1976-77. Another study states that if these subsidies are gradually phased out in next 5 years, India will be able to save Rs.12, 000 billion. Biogas can be effectively promoted by using some these saving in our country. This would help in gradual shift to organic nitrogen fertilization of the soil.

Conclusion

For us in India, it is important to draw the correct lessons.

Given the global financial turbulence, India must not be foolhardy to rush into `Gen Next' financial reforms. In the first place, India should protect itself from the devastating effects of the global meltdown and learn from our traditional systems

The Government of India should further enhance priority on reducing poverty by raising agricultural productivity. However, bold action from policymakers will be required to shift away from the existing subsidy-based regime that is no longer sustainable, to build a solid foundation for a highly productive, internationally competitive, and diversified agricultural sector.

It is high time that we look at the farmers' economic independence rather than talking about political independence. One available good option would be to integrate the initiatives of Food, Feed, Fodder, Fuel and Fertilizer (5F) for inclusive growth of the farmers and bring prosperity to our country. This will help us in achieving National Food Security mission & also help in bringing back the soil fertility & improved crop production. This may not happen overnight, but then there is always a possibility to begin at some point.

References: on Request

**** M.J. Saxena: Managing Director Ayurvet Limited Delhi***
***** Dr. Anup Kalra: CEO (ARF) Ayurvet Limited, Delhi***
www.ayurvet.com
For feedback or additional information on this article please mail to mjsaxena@ayurvet.com; akalra@ayurvet.com

International Specter of Food Imperialism for India

Ajay Jakhar

Former Indian Prime Minister, the late Lal Bahadur Shastri was compelled to declare that all Indians should fast once a week so that another might get a meal. Most people in India today were not born then and most of the adult population would have forgotten those harsh times. Food insecurity stalks the country again and there are genuine fears that the country is entering a phase of food imperialism as in the earlier times of colonial imperialism. Indeed, if India does not act now; the choice will be between food imperialism and technology imperialism.

The Food and Agriculture Organization (FAO) calculates that food-deficit countries will be forced to spend 30 per cent more on importing food, valued at $1.3 trillion. The FAO also estimates that since 2004, world food prices on average have soared by an unprecedented 240 per cent. In January 2011, a price index compiled by the FAO that tracks 55 food commodities for export hit its highest level since tracking began in 1990. Countries not dependent on food imports are less affected by global volatility. Still, food prices are expected to rise 2% to 3% even in the United States in 2011.

To bring home the point, I draw on the information and analysis provided in a remarkable two-part article, Getting used to life without food, published in Financial Sense by F. William Engdahl. It connects the current state of affairs with the emergence of food as a commodity for speculative transactions by large banks and hedge funds. It points the finger at the forces and interest groups that have artificially created a scarcity of nutritious food in a multidimensional global phenomenon that begins with the ability to "manipulate the price of essential foods worldwide at will", almost irrespective of the physical supply and demand for grains.

China is attempting to feed 21% of the world's population with 7% of the world's arable land & India is attempting to feed 17% of the world's population with a mere 2% of the world's arable land. It is tough task to fulfill. A right thinking nation, that believes that it will conquer the 21st century should not have to make such a choice but to avoid that unpleasant option, India would have to invest in agriculture research & development (ARD) as its top priority. Or else it may find itself be forced to accept what is given to it on prices and terms it cannot afford or like.

Food price manipulation on a global scale is little understood. Till the mid-1970s grain crisis, there was no single "world price" for grain, the benchmark for the price of all foods and food products. Henry Kissinger, former Secretary of State, helped to achieve a 200 per cent jump in grain price, triggered off by the USA signing a three-year contract with the Soviet Union that had a failed harvest. There were global crop failures around that time and USA sold the entire U.S. grain stocks to the Soviet Union! Expectedly, an explosive price rise followed and the American press called it the "Great Grain Robbery".

There is another truth to be borne in mind, that there is enough food to feed the global population despite the specter of food insecurity. The surplus is available to those who control those excess arable lands, that is not available to other countries like India. Mahatma Gandhi said, 'There is enough for everyone's needs but not enough for everyone's greed'. The current population trend indicates growing numbers till 2050, when population and, hopefully, demand will stabilize. We may be self-sufficient today, but that is changing and we need to prepare. There has been a "predictably rapid rise in starvation, hunger and malnutrition in poorer populations around the world".

Almost all cultures have stored stocks of a grain harvest since times immemorial for the rainy day. After World War II, there was Gen-

eral Agreement on Tariffs and Trade (GATT) to push free trade among major industrial nations, especially the European Community. Agriculture was, however, kept off the table at the insistence of the Europeans (especially the French), "who regarded the political defense of Europe's Common Agriculture Policy (CAP) and European agriculture protections as non-negotiable". In the 1980s, courtesy Margaret Thatcher and Ronald Reagan, the free market views of Milton Friedman gained credence with the leading European power circles. The European Union finally agreed in 1993 to the GATT Uruguay Round, requiring a major reduction of national agriculture protection. Central to the Uruguay Round deal was agreement on one major change: national grain reserves as a government responsibility were to be ended".

What has changed is that we are not just threatened by nations but face a far greater threat from private conglomerates, more powerful than most nations of the world. The ownership structure is so complex that it is impossible to pinpoint any one person as the owner. Control is ever more important than ownership. They have the power to bend nations to their liking. The 1993 GATT agreement was to be implemented by the World Trade Organization that could enforce sanctions against violators as 'free trade' in agriculture products became "an agreed priority of the world's major trading nations!" Thus grain reserves came to be managed by the 'free market,' by private companies. USA took the lead by passing the 1996 Farm Bill and eliminated its grain reserves and the E.U. followed suit.

Save for China and India, few countries cling on to a strategic security policy of nationally held grain reserves. Irrespective of the fact that India has been accused of poorly managing its reserves, India has built a national reserve to safeguard its interest. But times have changed & we should also improve our market intelligence to benefit from trading in international markets. India has also contributed to spike in prices of commodities by irrationally announcing imports & exports. It is akin to shooting one-self in the leg. In India, the government is at its wit's end trying to tame food inflation that has placed food out of the reach of vast sections of India's below the poverty line people. To the west, food insecurity is an unknown phenomenon. It is not so in India and large parts of Africa and South Asia. What, however, is unknown is the impact that big finance may have had on arriving at this state of affairs.

With the grain reserves gone in the USA, E.U. and major OECD countries, private corporations worked to do away with the agricultural commodity derivatives regulation and permit speculative manipulations and clear the way for Wall Street to make a profit. In 1999, at the urging of major Wall Street banks such as Goldman Sachs, JP Morgan, Chase Manhattan and Citibank, the Clinton Administration made a law in 2000 called the Commodity Futures Modernization Act (CFTC) - the government body charged with supervising derivatives trade in exchanges such as the Chicago Board of Trade or NYMEX. CFTC proposed to deregulate trading in derivatives between major banks or financial institutions, including derivatives of agricultural commodities. The CFTC deregulation of commodity trading allowed speculators to take huge positions or bets on the future grain price with no need to take actual delivery of wheat or corn at the end. No longer was future price a form of hedging limited to knowledgeable active participants in the grain industry, whether farmers or millers or large grain end-users. Grain joined oil as a speculative commodity where prices could be manipulated. Now speculators neither produced nor took delivery of the corn or wheat they gambled with. In essence, the deregulation virtually did away with government supervision of derivatives trading and led to the 2007 financial collapse & also the recent explosion in grain prices. Earlier, in 1991, Goldman Sachs had

rolled out its own commodity index -The Goldman Sachs Commodity Index or GSCI - which eventually became the global benchmark for derivatives trading of all commodities, including food and oil. Barclays, Deutsche Bank, Pimco, JP Morgan Chase, AIG, Bear Stearns and Lehman Brothers entered with their own commodity index funds as high-risk commodity investing. The grain price bubble of 2007-2008 was put in perspective by Olivier de Schutter, a U. N. Special Rapporteur on the Right to Food: "a significant portion of the increases in price and volatility of essential food commodities can only be explained by the emergence of a speculative bubble". Money made out of commodities offset some of the losses on home mortgages! With the dot.com stock bubble in 2000, as major financial players began seeking alternatives, commodities and high-risk derivatives based on baskets of commodities became a major speculative investment for the first time. Between 2003 and 2008, the investment in various commodity index funds has risen from some $13 billion to $317 billion. Oil and grain speculation bubble in 2008 and commodity index funds have had food prices shoot through the roof. What is absolutely clear is that we need to be self-dependent and imported food is not an option. Is India willing to recognize this and does it have the political will to invest in initiatives that will not bear fruit in the immediate future? If we were to invest a billion dollars each year for 10 years in ARD & extension service, we could gain food security.

Imported food dependency is artificially created by huge multinationals. The cheap agribusiness imports often undercut the prices of locally grown crops, driving millions from their land into overcrowded cities in desperate search of jobs". Things changed with the passage of the Summers-Geithner Commodity Modernization Act of 2000 and the 'Enron Loophole' permitting exemption from government regulation. In 2006 Deutsche Bank asked for and was granted CFTC permission to be exempt from all trading limits. Others followed. For some two billion people in the world who spend more than half of their income on food, the effects have been horrifying. During the speculation-driven grain price explosion in 2008, more than a quarter billion people became what the U.N. terms 'food insecure', or a total of one billion human beings, a new record". This was a clear consequence of eliminating reserves & deregulating grain speculation.

Based on Indian experience of food shortages and world food aid, it is time that Indian policy makers were cautioned against the machinations of the global food powers and they learnt to protect Indian interests through focused investing in ARD, agriculture infrastructure, transferring the knowledge to the farmer, market access to make farming a profitable enterprise. It needs to be borne in mind that focused policies and appropriate investments will start yielding positive results after a decade and the country would need different breakthroughs for different agro-climatic zones. It is not an easy task given the recent record of government research output & outreach activities.

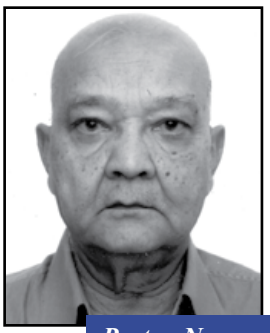
The global food price spike is also due to the fact that food has become just another commodity like oil or tin or silver whose scarcity and price could ultimately be controlled by a small group of powerful trading insiders. By end 2007, trading in food derivatives was fully deregulated and the USA's grain reserves had gone. There was nothing to prevent the food price rises. Four main factors that will wreak havoc & drive prices higher are weather, higher demand, smaller yields and crops diverted to biofuels in future. All these developments mixed with a cocktail of deregulated free commodity derivatives trading have created the ingredients for the worst potential food crisis in human history. Where does that leave India? The use of food as a lever in international politics/relations is hardly new. Not only did the USA profit from it, it had used food as an instrument in the cold war to drive weaker economies away from the Soviet Union. Former U. S. President, Lyndon Johnson, repeatedly interrupted food aid to India, during the terrible famine of 1965-66, in retaliation against New Delhi's criticisms of the U.S. war in Vietnam. In 1974, as a million people in Bangladesh perished in a famine, the U.S. cut off food aid because Bangladesh sold jute to Cuba. In 1982, when famine struck Ethiopia, the U.S. held up relief assistance because Addis Ababa was a Soviet ally.

Now the world is faced with another problem, the propagation of Bio Fuels. George Bush in the year 2007 introduced the '20 in 10' concept for cutting America's gasoline use by 20 per cent by 2010. Farmers and big agribusiness giants got subsidies to grow corn for fuel instead of food and, even today, ethanol producers in the USA get a subsidy of 51 cents per gallon of ethanol. E.U. came up with its "10 in 20" for 10 per cent of all road fuel in the E.U. to be biofuel by 2020. In 2011, 40 % of all U.S. arable land is being planted with corn to be burnt as biofuel. Strangely, India itself has given similar incentives to a sector that should not be allowed.

When Smt. Indira Gandhi became Prime Minister, she had said, "I do not want to beg for food again.' If we do not act now, that is what we will be doing in 10 years, if not earlier. Meanwhile, it is time for policymakers to read the writing on the wall because there is no insecurity more damning that food insecurity afflicting three quarters of a billion people.

Chairman, Bharat Krishak Samaj

Fertilizer Policy Flip-Flop Detrimental to Long Term Growth



Pratap Narayan

Fertilizer Policy flip-flop led to more than seven fold increase in subsidy from about Rs.13250 crores in 1999-2000 to Rs 95850 crores in 2008-09. Two major set backs were (i) increasing allocation of gas to the power sector, at the cost of the fertilizer sector since late 80s, and (ii) adverse changes in pricing parameters with a view to somehow reduce subsidy without tackling basic factors responsible for its increase, thus rendering the industry unattractive for fresh investment.

World over, wherever gas is available, entire ammonia and urea production is based on gas. This is particularly true in major ammonia/urea exporting nations in the Middle East and CIS. Even in the USA, for priority for gas allocation (determined on a 10-point scale), fertilizer was at second position compared to ninth rank for power. Heating was the only industry ranked ahead of fertilizer. Even at the ninth position, gas utilization in power generation was restricted to satisfying peak-load requirements and not for generating power for base load. Besides there was a clearly laid down convention that, in the event of any shortage in gas supplies, the reduction would be affected in the reverse order. Thus the power sector would be the second sector to face supply cut with the fertilizer industry to be the last but one. Two previously urea exporting countries, Japan and South Korea, learnt to their peril where fertilizer production was based on naphtha and, in wake of rising feedstock costs in70s, the two were priced out in the international market and had to cut back urea production drastically.

It is a well recognized fact that the most optimum use of gas, a rich resource of hydrocarbons, is for petrochemical and fertilizer industry. This is primarily because these sectors not only harness the energy component associated with gas, but also utilize the 'chemical value' in the form of carbon and hydrogen. The power sector uses gas merely as a source of energy, where the chemical components are burnt and lost. This was precisely why, soon after gas was discovered in Bombay High, two Committees in 70s and early 80s headed by doyens of oil industry/energy, Lovraj Kumar and Satish Chandran, were formed to chart out the most optimum utilization of gas. Their recommendation was unanimous - gas should be first allocated to the fertilizer sector and any allocations to power sector should be considered only thereafter. Based on these recommendations, two world scale urea plants at Thal and Hazira were set up. When gas supplies were augmented, the HBJ pipeline was set up to transport gas from Hazira (starting landfall point), to two urea plants at Bijaipur and Jagdishpur (terminating point), while also supplying gas to four other urea plants along the route at Kota, Aonla, Babrala and Shahjahanpur. This resulted in a major jump in urea capacity resulting in self sufficiency, eliminating shortages and dependence on costlier imports that had plagued the Indian agriculture sector.

In India, unfortunately, the success of this policy became its own enemy and, in the late 80s and 90s, increasing allocation of gas was made to power and other industries at the cost of fertilizer industry. The urea plants that were based on gas were not only asked to change over steam and captive power generation to costlier fuel oil but even the feedstock requirements were not fully met, thus necessitating these units to supplement with costlier naphtha. This switch away from gas was done on two spurious arguments that (i) while urea can be imported, power cannot and (ii) if we can import cheap urea, there was no need to produce it

domestically at higher cost. This ignored two basic facts: one, that while for power generation alternatives of hydro power or even of coal/fuel oil based thermal power were available, these were not efficient or cost effective for urea production, and two, that with increasing self sufficiency in India and China, imports were negligible leading to excess supply and dumping price in the international market.

During the last few years, with stagnation in domestic availability, when higher import of urea was resorted to, the country paid a much higher price to industry in other countries leading to their exploitative profits while entailing an unsustainable subsidy burden on the Government of India. During 2008-09, the average CFR cost of imported urea was about US$ 530/MT against an indigenous urea cost of about US$ 250/MT from gas based plants. This is despite Indian companies paying significantly higher price of gas as compared to exporting countries. For example, the gas price in Middle East exporting countries is less than US$ 1/MBTU, while in India it was US$ 3/MBTU under APM/JV, US$ 7.5/MBTU from LNG, and US$ 6.5/MBTU from RIL/Private producers. If adequate gas had been made available for expansion of capacity, eliminating imports, nearly Rs 8000 crores in GOI subsidy would have been saved. Further, if only adequate gas had been made available for switch over of the remaining plants based on significantly higher cost Furnace Oil and Naphtha, additional about Rs 3600 crores would have been saved in GOI subsidy. Apart from the cost aspects, there is also the issue of energy conservation in the present scenario of acute shortage in the country. Even from this point of view, gas based plants are the most efficient. The consumption of energy per tonne of urea produced is the lowest in gas based plants at 5.96 G Cal, rising to 7.22 and 8.21 G Cal in respect of naphtha and fuel oil based plants respectively.

Fortunately, in recent years, the top most priority in allocation of gas for the fertilizer sector has been restored and it is hoped that this would be maintained as it has generated interest in not only conversion of naphtha and fuel based plants to gas but also in addition of capacity by the industry.

On the fertilizer pricing policy front, in the wake of oil crisis in the 70s, the Government faced the dilemma of reduced consumption while fixing cost based price and rendering indigenous industry unviable while reducing price to level affordable by farmers. This was resolved on implementation of High Power Marathe Committee recommendations in late 70s. While MRP could be fixed by Government at a price affordable by farmers, the industry was protected through the Retention Price Scheme under which the resultant loss suffered by the industry as compared to its reasonable cost of production and distribution was reimbursed by the Government based on monthly dispatches. Routing of the subsidy through the industry was considered administratively convenient and cost effective in view of lack of infrastructure for distribution of small amounts to over 115 million farmers spread over more than 6 lakh villages. Fair implementation of this system for over two decades led to sharp growth in consumption and production of plant nutrients and foodgrains. Production of N and P increased from about 1.9 and 0.5 million tonnes (MMT) in 1976-77 to about 10.7 and 3.8 MMT respectively in 1999-2000. The total nutrient consumption increased from 3.4 MMT to 18.1 MMT and the production of foodgrains increased from 111 MMT to 210 MMT during the same period. Import of urea was virtually eliminated.

However, here again, it led to complacency and resultant adverse changes in industry pricing policy.

Implicit in the scheme was that increase in production and consumption would itself increase subsidy to control which it was necessary to adjust farmer price suitably in line with increasing production cost due to commissioning of new plants entailing higher investment, sharp depreciation of rupee and increase in the cost of main inputs-indigenous as well as imported. Inability to do so, partly due to socio-economic condition of majority of resource poor farmers and partly due to political compulsions, led to sharp increase in subsidy from Rs 375 crores in 1981-82 to Rs 4800 crores in 1991-92. Instead of appreciating that subsidy

is the difference between the price fixed by Government and reasonable cost of production and distribution, also fixed by Government and influenced by increasing cost of main inputs and services supplied mainly by Government agencies (oil/gas companies and Railways) or imported over which industry had no control, ad-hoc decisions were taken.

Thus, in August 1992, based on recommendation of JPC, sudden decontrol of phosphatic and potassic fertilizers was announced removing subsidy and reducing urea price by 10%, a sure prescription for skewed consumption of nutrients. However, even this was short lived and within a few days it was announced that a subsidy of Rs 1000/MT of DAP and MOP and proportionate amounts on NP/NPK products will be given directly to the farmers by State Governments. The States had again to depend on the industry to reduce prices as determined by them and claim subsidy. This inevitably led to distortions as the States had neither the expertise nor inclination to ensure reasonable industry pricing and make timely payment. This, besides adverse affect on the industry's viability, also led to reduced consumption of P and K from 3.321 MMT and 1.361 MMT in 1991-92 to 2.669 MMT and 0.909 MMT in 1993-94 respectively. With GOI deciding in 1996 and 1997 to significantly increase concession, fixing reasonable prices and pay subsidy directly to industry, there was revival and increase in consumption of P and K to 6.506 MMT and 3.313 MMT respectively during 2008-09.

In respect of Nitrogenous fertilizers also, several adverse features have been introduced like progressively increasing capacity utilization norm, tightening consumption norms mopping up the benefit of improved efficiency even with retrospective effect, grouping of the plants based on feedstock and vintage with the ostensible objective of introducing common pricing in a highly heterogenous industry with respect to capital cost and landed cost of feedstock and other inputs and then legislating payment either on normative cost or actual cost whichever is lower.

This has rendered the industry totally unattractive; there has been no investment in a new plant for almost a decade except in minor de-bottleneck and revamp. While production of N and P remained stagnant, continuous increase in consumption has increased our dependence on import. Against no import of urea and 0.86 MMT of DAP in 2000-01, during 2008-09, Urea and DAP import rose to staggering 5.67 MMT and 6.19 MMT respectively. All this tightening of the industry pricing parameters had been done, in the name of reforms, with the sole objective of somehow reducing/containing subsidy. Yet it has not succeeded because the basic factors responsible for increase in subsidy have not been tackled, namely holding farmer price at the same level as in March 2002 for nearly 8 years and galloping increase in the cost of inputs/services since then. The new pricing policy for Urea, which was due from 1-4-2010, has yet to see the light of the day and NPS III, with all its adverse features, has been extended until further orders.

Another measure taken by the Government during 2008-09 and 2009-10 was the issue of Fertilizer Bonds in lieu of cash subsidy disbursal, which led to serious liquidity problem for the industry as they had to pay for raw materials and services in cash. To maintain production, therefore, the Bonds had to be sold at a heavy discount leading to further adverse impact on industry's viability.

In respect of phosphate and potash, the Nutrient Based Subsidy (NBS) introduced last year was a step in the right direction under which, at the beginning of the year, the Government notified the subsidy payable on each nutrient and the industry was free to fix the farmer price. In order to increase consumption of Sulphur to overcome its increasing deficiency in soil, this secondary nutrient was also covered under NBS. This led to increasing formulation of products suited to specific soil-crop based requirements. However, even this has come under strain during the current year because of initial announcement about unrealistic level of subsidy in the face of rising cost of imported raw materials and intermediates besides the finished products and the recent decision to mop up the benefit during last financial year of any lower cost inventory of products carried forward from the previous year.

There is currently also talk of introducing NBS on Urea as also direct transfer of subsidy to the farmers leaving the industry free to fix the price for the products. Both these steps will be welcome by the industry provided the same are implemented in the correct spirit and the industry is deregulated. Unfortunately, the problem is that the Government has been, for the last over one decade, ignoring the basic objective of the subsidy scheme, namely to make available fertilizers to resource poor farmers at affordable price and, at the same time, ensure the health and growth of the industry to avoid exploitation in the international market by resorting to heavy imports.

In the interest of the projected growth of agricultural production, for which fertilizer security is a pre requisite, it is important that a long term and conducive fertilizer policy is formulated without any further loss of time and implemented in its true spirit.

Ex DG, FAI

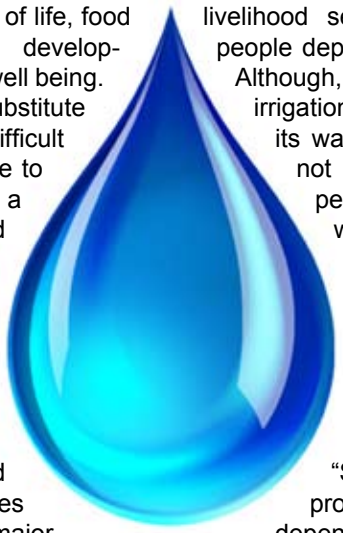
Improving Water Use Efficiency in Agriculture

*H.S. Gupta**

*T.B.S. Rajput***

1. Introduction

Water is prime requirement for all aspects of life. It is imperative to make certain that adequate supplies of water of good quality are maintained for all the needs of entire population while preserving the hydrological and biological functions of ecosystems. Innovative technologies including the improvements in the indigenous technologies, are needed to fully utilize limited water resources and to safeguard these resources against pollution. Water is essential for sustaining all forms of life, food production, economic development, and for general well being. It is impossible to substitute for most of its uses, difficult to de-pollute, expensive to transport, and it is truly a unique gift to mankind from nature. Water is also one of the most manageable of the natural resources as it is capable of diversion, transport, storage, and recycling. The surface water and groundwater resources of the country play a major role in agriculture, hydropower generation, livestock production, industrial activities, forestry, fisheries, navigation, recreational activities, etc. According to National Water Policy (MoWR, 2002) in the planning and operation of systems, water allocation priorities should be broadly categorized as: (i) drinking water, (ii) irrigation, (iii) hydropower, (iv) ecology, (v) agro-industries and non-agricultural industries, and (vi) navigation.



The country gets about 400 million hectare-metres (mha-m) of precipitation annually, which is augmented by 20 mham contributed by rivers flowing in from the neighboring countries. Net evapo-transpiration losses are nearly 200 mha-m. About 135 mha-m is available on the surface and the remaining recharges groundwater. Water is a critical input for sustainability of agriculture, which consumes more than 80 per cent of available water resource. With increasing demand from other sectors, availability of water to agriculture is going to decline. This calls for efficient utilization of water to safe guard the livelihood security of 600-million people dependent on agriculture. Although, India has the largest irrigation system in the world, its water use efficiency has not been more than 40 per cent. If it continues, water crisis would lead to reduced production and productivity, which would affect the quality of life of the people.

The Agenda 21 of the Conference says: "Sustainability of food production increasingly depends on sound and efficient water use and conservation practices consisting primarily of irrigation development and management with respect to agriculture, livestock water supply, inland fisheries and agro forestry. Achieving food security is a high priority in many countries including India, and agriculture must not only provide food for rising population, but also save water for other uses. The challenge is to develop and supply water saving technology and management methods and, through capacity building enable farming communities to adopt new approaches in irrigated agriculture (Water Resources Development in India, 2010)".

Many land and water problems of significant importance now confront our irrigated agriculture. Large quantities of water pumped from groundwater or diverted from streams are lost by seepage and evaporation from tanks, canals, distributaries and field channels. Improperly designed field irrigation systems and uncontrolled water application methods are resulting into huge losses of water through seepage and deep percolation. In many cases not only the loss of water is concerned but also the damage it creates by way of water logging and accumulation of harmful salts. Sustainable use and management of water resources and effective conservation practices are the issues of prime importance to be looked upon for sustainable development of country. Moreover, the develop-

ment techniques for management of the resources should be technically sound, economically viable, socially acceptable and replicable, and environmentally sustainable.

2. Rainfall variability

The long-term average annual rainfall for the country is 1160 mm, which is the highest anywhere in the world for a country of comparable size (Lal, 2001). The annual rainfall in India however fluctuates widely. The highest rainfall in India of about 11,690 mm is recorded at Mousinram near Cherrapunji in Meghalaya in the northeast. In this region, rainfall as much as 1040 mm is recorded in a day. At the other extreme are places like Jaisalmer, in the west, which receives barely 150 mm of rain. Though the average rainfall is adequate, nearly three-quarters of the rain pours down in less than 120 days, from June to September. As much as 21% of the area of the country receives less than 750 mm of rain annually while 15% receives rainfall in excess of 1500 mm. Precipitation generally exceeds 1000 mm in areas to the east of Longitude 780 E. It reaches nearly to 2500 mm along almost the entire west coast and over most of Assam and sub-Himalayan West Bengal. Large areas of peninsular India receive rainfall less than 600 mm. Annual rainfall of less than 500 mm is experienced in western Rajasthan and adjoining parts of Gujarat, Haryana and Punjab. Rainfall is equally low in the interior of the Deccan plateau, east of the Sahyadris. A third area of low precipitation is around Leh in Kashmir. The rest of the country receives moderate rainfall. Snowfall is restricted to the Himalayan region.

In India, as stated earlier, rainfall is highly seasonal. All of it is received in less than 150 hrs of actual rainfall; half of it descends in no more than 20 to 30 hrs of heavy spells. As a consequence of this behaviour, runoff is a typical feature of monsoonal India. After making deductions for soil storage and immediate evaporation, 30 to 40 per cent of the total rain is available as runoff. If not harvested, runoff represents a loss of useful rainfall to the area of its incidence.

3. Water resources

Although India occupies only 3.29 million sq. km geographical area, which forms 2.4% of the world's land area, it supports over 15% of the world's population. India supports about 1/6th of world population, 1/50th of world's land and 1/25th of world's water resources [The Institution of Engineers (India), 2003]. The total utilizable water resources of the country are assessed as 1086 cubic km. India receives annual precipitation of about 4000 cubic km, including snowfall. Rainfall in India is dependent on the south-west and north-east monsoons, on shallow cyclonic depressions and disturbances and on local storms. Most of it takes place under the influence of south-west monsoon between June and September except in Tamil Nadu, where it is under the influence of north-east monsoon during October and November. India is gifted with a river system comprising more than 20 major rivers with several tributaries. Many of these rivers are perennial and some of these are seasonal. The rivers like Ganges, Brahmaputra and Indus originate from the Himalayas and carry water throughout the year. The snow and ice melt of the Himalayas and the base flow contribute the flows during the lean season. Lal (2001) mentioned that more than 50% of water resources of India are located in various tributaries of these river systems. Average water yield per unit area of the Himalayan rivers is almost double that of the south peninsular rivers system, indicating the importance of snow and glacier melt contribution from the high mountains.

Apart from the water available in the various rivers of the country, the groundwater is also an important source of water for drinking, irrigation, industrial uses, etc. It accounts for about 80% of domestic water requirement and more than 45% of the total irrigation in the country. As per the international norms, if per-capita water availability is less than 1700 cubic metre per year then the country is categorized as water stressed and if it is less than 1000 cubic metre per capita per year then the country is classified as water scarce. In India per capita surface water availability in the years 1991 and 2001 were 2309 and 1902 cubic metre and these are projected to reduce to 1401 and 1191 cubic metre by the years 2025 and 2050, respectively. Hence, there is a need for proper planning, development and management of the greatest assets of the country, viz. water and land resources for raising the standards of living of the millions of people, particularly in the rural areas.

4. Water requirement of different sectors

Keeping in view the level of consumption, losses in storage and transport, seed requirement, and

Table 1. Annual water requirement for different uses (in cubic km) (MoWR, 1999)

Use	Year 1997-98	Year 2010			Year 2025			Year 2050		
		Low	High	%	Low	High	%	Low	High	%
Surface Water										
Irrigation	318	330	339	48	325	366	43	375	463	39
Domestic	17	23	24	3	30	36	5	48	65	6
Industries	21	26	26	4	47	47	6	57	57	5
Power	7	14	15	2	25	26	3	50	56	5
Inland navigation		7	7	1	10	10	1	15	15	1
Environment-Ecology		5	5	1	10	10	1	20	20	2
Evaporation Losses	36	42	42	6	50	50	6	76	76	6
Total	**399**	**447**	**458**	**65**	**497**	**545**	**65**	**641**	**752**	**64**
Groundwater										
Irrigation	206	213	218	31	236	245	29	253	344	29
Domestic	13	19	19	2	25	26	3	42	46	4
Industries	9	11	11	1	20	20	2	24	24	2
Power	2	4	4	1	6	7	1	13	14	1
Total	**230**	**247**	**252**	**35**	**287**	**298**	**35**	**332**	**428**	**36**
Total water use										
Irrigation	524	543	557	78	561	611	72	628	807	68
Domestic	30	42	43	6	55	62	7	90	111	9
Industries	30	37	37	5	67	67	8	81	81	7
Power	9	18	19	3	31	33	4	63	70	6
Inland navigation	0	7	7	1	10	10	1	15	15	1
Environment-Ecology	0	5	5	1	10	10	1	20	20	2
Evaporation losses	36	42	42	6	50	50	6	76	76	7
Total	**629**	**694**	**710**	**100**	**784**	**843**	**100**	**973**	**1180**	**100**

buffer stock, the projected food-grain and feed demand for 2025 would be 320 million tonnes (high-demand scenario) and 308 million tonnes (low-demand scenario). The requirement of food grains for the year 2050 would be 494 million tonnes (high-demand scenario) and 420 million tonnes (low -demand scenario). Table 1 provides details of the population of India and per capita water availability as well as utilizable surface water for some of the years from 1951 to 2050 (projected). The availability of water in India shows wide spatial and temporal variations. Also, there are very large inter annual variations. Hence, the general situation of availability of per capita availability is much more alarming than what is depicted by the average figures.

The irrigated area in the country was only 22.6 million hectare (Mha) in 1950–51. Since the food production was much below the requirement of the country, due attention was paid for expansion of irrigation. The ultimate irrigation potential of India has been estimated as 140 Mha. Out of this, 76 Mha would come from surface water and 64 Mha from groundwater sources. The quantum of water used for irrigation by the last century was of the order of 300 cubic km of surface water and 128 cubic km of groundwater, total 428 cubic km. The estimates indicate that by the year 2025, the water requirement for irrigation would be 561 cubic km for low-demand scenario and 611 cubic km for high-demand scenario. These requirements are likely to further increase to 628 cubic km for low-demand scenario and 807 cubic km for high-demand scenario by 2050.

5. Development and Management of Water

1. Groundwater management
2. Conjunctive use of surface and ground water
3. Rainwater harvesting
4. Watershed management
5. Water quality conservation and environment restoration
6. Recycle and reuse of water

5.1 Groundwater management

Groundwater irrigation has played a major role in achieving food security in India and supplying potable water to millions in the country, besides supplying water for industrial use. It is a much dependable water source when compared with surface water. About 50% of the total irrigated area is dependent upon groundwater (CWC, 2000) and about 60% of irrigated food production comes

from groundwater-irrigated land (Shah et al, 2000). At a global level, the groundwater situation in India is comfortable. But at a micro level, there are regions where groundwater is mostly untapped and also there are regions where groundwater has been overexploited. This has caused water table rise over some regions and its considerable decline at other regions, resulting in reduction in discharge, saline water encroachment, arsenic and fluoride contamination, drying of springs and shallow aquifers, increased cost of groundwater lifting, and even local subsidence at some places. It has been reported that declining water level could reduce India's crop harvest by 25% or more (Seckler et al, 1998). On the other hand, absence of conjunctive use of surface and ground water in the canal command areas has created problems of water logging and salinity.

Artificial recharge to increase ground water

It is not possible to enhance precipitation, but is possible to reduce water losses in the form of evaporation and runoff of surface water, and to increase the availability of renewable supplies by various artificial recharge methods. There is no single method of recharge, which can be used universally. Huge sums are spent annually for obtaining more and more ground water. Much emphasis is needed for efficient development and use of groundwater potential.

The traditional village ponds, which have been filled up in most of the villages, used to act as storage tanks for the cattle drinking and were the natural means for augmenting recharge to ground water. These ponds need to be rehabilitated and made usable for storage and to recharge ground water.

5.2 Conjunctive use of surface and groundwater

Ground water resource is an important component of total water resource. The first rule for ground water exploitation is not to exceed its recharge for its long-term sustainable use. Ground water may be used alone and in conjunction with available surface water. Since ground water needs to be pumped for application on the surface. The same pumping unit may be used to develop some extra pressure so as to adopt pressurized irrigation water application methods. Besides offering a good control on its application, pressurized irrigation methods do attempt to achieve higher efficiencies and in turn higher productivity of water. Thus, the optimal conjunctive use of the region's surface and groundwater resources would help in minimizing the problems of waterlogging and groundwater mining.

5.3 Rainwater harvesting

Rainwater harvesting is the process to capture and store rainfall for its efficient utilization and conservation to control its runoff, evaporation and seepage. Some of the benefits of rainwater harvesting are:

- It increases water availability
- It checks the declining water table
- It is environment friendly
- It improves the quality of groundwater through dilution, mainly of fluoride, nitrate, and salinity,
- It prevents soil erosion and flooding, especially in the urban areas.

Even in ancient days, people were familiar with the methods of conservation of rainwater and had practiced them with success. Different methods of rainwater harvesting were developed to suit the geographical and meteorological conditions of the region in various parts of the country. Traditional rainwater harvesting, which is still prevalent in rural areas, is done by using surface storage bodies like lakes, ponds, irrigation tanks, temple tanks, etc. For example, Kul (diversion channels) irrigation system which carries water from glaciers to villages is practised in the Spiti area of Himachal Pradesh. In the arid regions of Rajasthan, rainwater harvesting structures locally known as Kund (a covered underground tank), are constructed near the house or a village to tackle drinking water problem. In Meghalaya, Bamboo Rainwater Harvesting for tapping of stream and spring water through bamboo pipes to irrigate plantations is widely prevalent. The system is so perfected that about 18–20 litres of water entering the bamboo pipe system per minute is transported over several hundred meters.

There is a need to recharge aquifers and conserve rainwater through water harvesting structures. In urban areas, rainwater will have to be harvested using rooftops and open spaces. Harvesting rainwater not only reduces the possibility of flooding, but also decreases the community's dependence on groundwater for

domestic uses. Apart from bridging the demand–supply gap, recharging improves the quality of groundwater, raises the water table in wells/bore-wells and prevents flooding and choking of drains. One can also save energy to pump groundwater as water table rises. These days rainwater harvesting is being taken up on a massive scale in many states in India. Substantial benefits of rainwater harvesting exist in urban areas as water demand has already outstripped supply in most of the cities. Different ways of harvesting water include:

- Capturing run-off from rooftops;
- Capturing run-off from local catchments;
- Capturing seasonal flood water from local streams; and
- Conserving water through watershed management.

Apart from increasing the availability of water, local water harvesting systems developed by local communities and households can reduce the pressure on the state to provide all the financial resources needed for water supply. Also, involving people will give them a sense of ownership and reduce the burden on government funds.

The principle of rainwater harvesting is to conserve rainwater where it falls according to local needs and geophysical conditions. Nevertheless, there are limits beyond which in-situ rainwater conservation cannot be stretched. Also, the value of soil-stored water is fixed up to a point i.e., from field capacity to wilting point. Therefore, if prolonged dry conditions prevail and the crop is exposed to moisture levels below the wilting point, the only way to sustain the withering crop would be irrigation. Apparently, runoff capturing and its recycling as irrigation hold key to stable and sustainable development of rain fed agriculture. People across various agro-ecological regions have come up with indigenous water harvesting structures, unique in mode and displaying basic engineering skills. These indigenous structures have been grouped together, based on geomorphic controls and climatic variables (Table 2).

Table 3. Potential rainwater storage through small-scale water harvesting structures

Rainfall zone, (mm)	Geographical area, (Mha)	Harvestable runoff through water harvesting structure, (Mha-m)
100-500	52.07	0.78
500-750	40.26	1.51
750-1000	65.86	4.03
1000-2500	137.24	14.61
>2500	32.57	3.26
Total		23.99

Table 2. Indigenous water harvesting systems

Agro-ecological regions	Water harvesting structures
Hill Areas	Water was diverted with the help of simple engineering structures into artificial channels to carry it to agricultural fields. Known as Kuhls or Kuls.
Arid and Semi-arid areas	Rivers and seasonal streams were tapped and channels were directed into storage structures, viz., Zing in Ladakh, keres in Karnataka and Ahar in Bihar.
Cold and Arid Ladakh	In Ladakh, which depends on snow-melt for water, it is collected during the evenings in small reservoirs for use the following morning.
Eastern Himalayas	In Nagaland and Arunachal Pradesh villagers divert a channel through the cattle shed in order to harvest nutrients for agricultural fields.
Northeastern Hills	Bamboo network is used as pipeline to direct water to a convenient spot for collection as drinking water.
Meghalaya	In Meghalaya a bamboo drip system is in vague for ages.
Tamil Nadu	In Tamil Nadu a big stream is often diverted to feed a chain of 25 to 30 tanks in a sequence called system tanks.
Western and Central India	In MP water is collected in a tank (bandhis) to moisten the soil. In this traditional 'haveli' system where water is stored in the field itself, crop is taken on residual soil moisture.
Arid Kutch	In Kutch, the Maldhari nomads collect sweet water for drinking from well in tanks called virda
Arid Rajasthan	In Jodhpur wells and step wells (Baoris), which are actually wells in the tank bottom, provide drinking water even in summers.

In areas where there are no other sources of water and it is termed as rain fed, harvesting maximum rainwater is the key for survival. Starting from field bunding to nalla plugging, gully plugging, de-silting of existing tanks, creation of additional storage reservoirs etc. need to be explored and implemented for exploiting the full potential of rain water harvesting. The estimated potentials of small-scale water harvesting structures in different rainfall zones are given in Table 3.

The requirement of water harvesting is increasing day by day due to the scanty availability of water resources, lack of sufficient rainfall dis-

tribution, depletion of over exploited ground water. The country loses 50-60% of the rainwater resulting in acute soil moisture deficit. To increase the storage capacity by reducing the percolation and evaporation losses during the runoff, vegetation management, mechanical treatment like compaction, reducing soil permeability by chemical treatments etc, improves the efficiency of travel time. Any or all of the following measures may be adopted for conserving soil and water, depending upon the local field situations.

1. Bunding
2. Submergence bundhis
3. Trenching
4. Bench terracing
5. Zing terracing
6. Vegetative barriers
7. Grassed waterways

According to Shah (1996), rainfall harvesting offers tremendous scope to augment water availability in India. In his calculations, increasing irrigation efficiency by 20%, adds 20 Mham to India's water pool; in contrast, tapping 20% more of the rainfall gives India 80 Mham additional water resources. Undoubtedly, if hitherto sidestepping of dry land areas by famous green revolution has to be converted into a revisit, warlike effort is necessary to close the gap between rainwater availability and runoff as surface flow.

5.4 Watershed management

Watershed is the unit of management in Integrated Water Resources Management (IWRM) where surface water and groundwater are inextricably linked and related to land use and management. Watershed management aims to establish a workable and efficient framework for the integrated use, regulation and development of land and water resources in a watershed for socio-economic growth. Local communities play a central role in the planning, implementation and funding of activities within participatory watershed development programmes. In these initiatives, people use their traditional knowledge, available resources, imagination and creativity to develop watershed and implement community-centered programme.

Currently, many programmes, campaigns and projects are underway in different parts of India to spread mass awareness and mobilize the general population in managing water resources. The efforts of villagers are visible in the form of rising water table and regenerated forests in some parts of country. Undoubtedly, coordinated watershed development programmes need to be encouraged and awareness about benefits of these programmes must be created among the people.

5.5 Recycle and reuse of water

Another way through which we can improve freshwater availability is by recycle and reuse of water. It is said that in the city of Frankfurt, Germany, every drop of water is recycled eight times. Use of water of lesser quality, such as reclaimed wastewater, for cooling and fire fighting is an attractive option for large and complex industries to reduce their water costs, increase production and decrease the consumption of energy. This conserves better quality waters for potable uses. Currently, recycling of water is not practiced on a large scale in India and there is considerable scope and incentive to use this alternative.

5.6 Demand management for irrigation

Simple techniques can be used to reduce the demand for water. The underlying principle is that only part of the rainfall or plants take up irrigation water, the rest percolates into the deep groundwater, or is lost by evaporation from the surface. Therefore, by improving the efficiency of water use, and by reducing its loss due to evaporation, we can reduce water demand. There are numerous methods to reduce such losses and to improve soil moisture. Some of them are listed below.

Mulching, i.e., the application of organic or inorganic material such as plant debris, compost, etc., slows down the surface run-off, improves the soil moisture, reduces evaporation losses and improves soil fertility.

Soil covered by crops slows down run-off and minimizes evaporation losses. Hence, fields should not be left bare for long periods of time.

Ploughing helps to move the soil around. As a consequence, it retains more water thereby reducing evaporation.

Shelter belts of trees and bushes along the edge of agricultural fields slow down the wind speed and reduce evaporation and erosion.

Planting of trees, grass, and bushes breaks the force of rain and helps rainwater penetrate the soil.

Fog and dew contain substantial amounts of water that can be used directly by adapted plant species. Artificial surfaces such as netting-surfaced traps or polyethylene sheets can be exposed to fog and dew. The resulting water can be used for crops.

Contour farming is adopted in hilly areas and in lowland areas for paddy fields. Farmers recognize the efficiency of contour-based systems for conserving soil and water.

Salt-resistant varieties of crops have also been developed recently. Because these grow in saline areas, overall agricultural productivity is increased without making additional demands on freshwater sources. Thus, this is a good water conservation strategy.

Table 4. Time required and suitability of different levelling techniques

Method	Per day area Leveled, ha	Leveling accuracy, cm	Area (ha)
Animal	0.08	+/- 4-5 cm	0-0.25
Hand tractor	0.12	+/- 4-5 cm	0-0.25
Blade	0.5-1.0	+/- 4-5 cm	0-0.5
Bucket	0.5-1.0	+/- 4-5 cm	>0.1
Laser	up to 2 ha	+/- 1cm	>0.1

Transfer of water from surplus areas to deficit areas by inter-linking water systems through canals, etc.

Desalination technologies such as distillation, electro-dialysis and reverse osmosis are available.

Use of efficient watering systems such as drip irrigation and sprinklers will reduce the water consumption by plants.

5.7 Efficient Utilization of Irrigation Water

Available water resource needs to be utilized efficiently for its sustainable use. There can be three basic types of village water resources including, harvested rain water, well/ tube well water or canal water supplies. All the three resources need to be conserved/ utilized efficiently so as to let the beneficiary area sustain usual activities of the village concerning water including, drinking, house hold uses and irrigation or any other. Water resource utilization for sustainable use under all three different types of resource situations need to be handled differently. The major management strategies for efficient utilization of irrigation water may be as follows:

1. Land preparation for efficient use of irrigation and rain water
2. Field rectangulation
3. Optimal alignment of conveyance network
4. Lining for minimizing conveyance losses
5. Raised bed planting systems
6. Appropriate Farm Irrigation Structures
7. Selection of optimal balance of crops
8. Matching crop needs with expected water supplies
9. Use of modern water application methods
10. Equitable distribution of irrigation water
11. Promotion of PIM

5.7.1 Land preparation for efficient use of irrigation and rain water

Modern intensive agriculture depends heavily on timeliness of the farming operation for enhanced crop yields and profits. Short turn around time and excessive tillage has often been attributed as the main reason for late planting of wheat. High crop yields depend on seedling emergence, better crop stand and early crop vigour. Smoothness of land surface meets the twin objectives of achieving a better crop stand, saving irrigation water and improving the input use efficiencies of costly chemical fertilizer nutrients.

In India, mostly the irrigation is practiced through surface application methods. As most of the fields are not properly levelled, low irrigation efficiency is a common consequence. Precision land levelling is expected to enhance water use efficiency and consequently harness higher water productivity. Conventional surface irrigation practices in unlevelled bunded units normally result in over irrigation (Corey and Clyma, 1973). This results in excessive loss of irrigation water as deep percolation, which in tune reduces the application efficiency up to 25 % (Sattar et al., 2003). Precision land levelling helps in controlling the emergence of salt affected patches, increase cultivable land area up to 2-3 %, increases cropping intensity and crop productivity (Khan, 1986), improves crop establishment, reduces weed problem (Rickman, 2002), saves irrigation water (Jat et al, 2003; Khattak et al., 1981; Ali et al., 1975).

Precision land levelling thus has tremendous potential for water saving, increasing crop yield, enhancing input use efficiency and long term sustainability of the resource base in intensively cultivated areas. The process of declining soil and crop productivity and degradation of the ecosystem as experienced in major cropping systems can be reversed by adoption of precision land levelling technology.

All farming operations right from land preparation to seeding require an optimal soil moisture condition. Seedbed preparation, seed placement and germination also require uniform soil moisture condition. But, undulated land results in non-uniform soil moisture on different point of fields which hampers these operations and normally delays seedbed preparation, seed placement, germination. Different land levelling techniques are suitable under different conditions (Table 4).

Capacity depends on size, residue, shape, moisture, soil type, soil condition and the skill of the operator

Laser controlled precision land levelling helps in-

- Improving crop establishment
- Improving uniformity of crop maturity
- Approximately 2 to 3 % increase in cultivable area
- Has potential to increase water application efficiency by over 50 %
- About 40 % increase in cropping intensity
- Increase in yield of crops (wheat 15 %, sugarcane 42%, rice 61% & cotton 66 %)
- Control in emergence of salt affected patches in the soil
- Approximately 35-45 % saving in irrigation water
- Reduces weed problems and improves weed control efficiency

5.7.2 Field rectangulation

Fragmented land holdings with irregular field boundaries are a common feature of the canal command areas in the country. Scattered fields

with irregular boundaries increase greatly the energy requirements in farming operations. They also require longer lengths of watercourses to convey water to different fields. They are often unsuitable to modern methods of water applications, like border strips and furrows. Converting the existing land into rectangular plots and their consolidation on ownership basis through suitable exchange between different owners are desirable features of an efficient on-farm water management program. Rectangulation of fields would not only provide for efficient mechanization but would also result into smaller lengths of watercourses. Rectangulation of fields would also enable the use of more efficient water application methods like border strips and furrows besides minimizing lengths of watercourses.

5.7.3 Optimal alignment of conveyance network

The lack of well maintained media of conveyance of water from the outlet to property heads remains a major bottleneck in the efficient functioning of the canal irrigation systems in the country. In some of the canal command areas, the watercourses from the outlets run in a random manner without much consideration of the local topographical features. It has also been observed that for most of the fields the watercourses do not exist even. For successful operation of any water distribution system, watercourses should touch each holding with at least one delivery point. A significant part of available water at the outlet is lost while conveying it to the different fields, through seepage from watercourses. Since the seepage losses below a canal outlet are a direct function of the length of watercourse, minimization of the total length of watercourses is essential. A properly designed water distribution system makes irrigation easy and efficient. Efficient structures will save labour, land and water. An on-farm irrigation water distribution system comprises several intricate hydraulic structures such as conveyance channels, check gates, distribution boxes, falls, turnouts and siphons etc.

5.7.4 Lining for minimizing conveyance losses

Watercourses account for water losses in excess of 20 per cent. Regular maintenance is the first step in terms of its reduction. Lining is the obvious answer but is expensive. Maintenance however, is the key for reduction in conveyance water losses in watercourses. Based on the available funds, appropriate criteria are available to decide for lining of different reaches of the watercourse for effectively minimizing the conveyance losses.

Seepage losses in the field watercourses are the single major cause of inequity in water distribution among different beneficiaries, even in those canal command areas where rotational water distribution system is in vogue To achieve equity in water distribution and to save more than 20 per cent of the amount of water diverted from the canal system to different fields, lining of field watercourses becomes an obvious solution. For handling the discharges normally available at the field level, pre-cast concrete channel sections do become most suitable owing to their low-cost, effectiveness in seepage control and other operating advantages.

5.7.5 Appropriate Farm Irrigation Structures

A properly designed water distribution system makes irrigation easy and efficient. Good irrigation structures are an essential part of an efficient irrigation layout. Efficient structures will save labour, land and water. An on-farm irrigation water distribution system comprises several intricate hydraulic structures such as conveyance channels, check gates, distribution boxes, falls, cutlets and siphons etc. Complexities of their design and construction give rise to bottlenecks in the in-budget on-time completion of distribution network with sound workmanship. Several similar problems may be overcome by the use of the pre-cast concrete structures. The greatest advantage is the convenience of transporting a large assortment of these structures of remote and /or scattered areas often with different access and of their rapid installation with the help of only a few unskilled labourers.

5.7.6 Raised bed planting systems

This system of crop establishment is a modification of the ridge-furrow system in which the ridges have been replaced by flat beds. Crops are cultivated on the raised beds while the furrows are used for irrigation (Tomer et. al., 2002). Fertilizers can be placed on the raised beds. The width of the raised beds will depend on the crops to be grown. This crop establishment technique has many advantages as it improves both water and nutrient use efficiency, requires lower seed rates and the furrows act as drainage channels in case heavy rainfall preventing temporary water logging. Appropriate farm machinery is now available commercially for raised bed cultivation.

5.7.7 Selection of optimal balance of crops

Mono-cropping or a mono- cropping pattern (like rice-wheat) is not good in long run as far as soil fertility, productivity and cost of production areas are concerned. A balanced

Table 5. Comparative irrigation efficiencies under different method of irrigation

Irrigation efficiencies	Irrigation efficiencies (%)		
	Flood irrigation	Sprinkler irrigation	Drip irrigation
Conveyance	40-50 (canal) 60-70 (well)	100	100
Application	60-70	70-80	90
Overall	30-35	50-60	80-90

Source : Sivanappan and Padmakumari, 1980

mix of food crops, cash crops, vegetables, fruits and flowers should be ensured to increase productivity of land and water according to the soils compatibility.

5.7.8 Matching crop needs with expected water supplies

Mismatch between available water supplies and crop water requirements both, in terms of quantity and timing are a major cause of low water use efficiency particularly in canal command areas. Models can play a useful role in developing practical recommendations for optimizing crop production under different canal water supply patterns. The applicability of FAO CROPWAT model has been established for determining optimal sowing schedule of crops in a crop calendar such that the actual crop water needs match with the probable amounts and timings of irrigation water availability. CROPWAT thus can be used as a powerful tool to simulate different crop water need scenarios under different planting dates and thus enable the user to select most optimal sowing dates of crops to realize high yields and water use efficiencies by matching the probable canal water supplies with crop needs.

5.7.9 Use of modern water application methods

Most surface irrigation methods result in very poor water application efficiency, only within the range of 30 to 35 per cent (Table 5). Among the surface irrigation methods, furrow method of water application is most efficient. Application of surge flow concepts in design and adoption of furrow irrigation system makes it more efficient. Highest water application efficiency is achieved through drip and sprinkler irrigation methods, up to 90 % and above. Pressurized methods of water application may be adopted wherever possible.

Micro irrigation, which has application efficiency of more than 90 per cent has emerged as a viable option and has received the attention of the Government for its promotion. It is proposed to cover 3 Mha in X Plan and 14 Mha in XI Plan having participatory approach through Micro irrigation. Sprinkler systems are effective and efficient way of water application to field crops. These provide enough control on water application. Proper design of the system also ensures high water application and distribution efficiencies. Micro irrigation systems include drip irrigation, micro sprinklers, mini sprayers, foggers, misters and bubbler systems. These systems are designed to irrigate only a part of the land area matching with the plant root zone. Micro irrigation systems achieve very high water use efficiency as well as nutrient use efficiency as these permit application of water-soluble nutrients along with irrigation water. These systems attempt to maintain favourable soil moisture levels all the time and thus ensures enhancement of quantity as well as quality of the produce. These systems are very suitable for water application in fruit and vegetable crops. Government of India has been partly supporting the expenses of the farmers on the purchase of these systems with a clear objective of achieving high water use efficiency (Table 6).

Table 6. Increase in yield and water savings in drip irrigation as compared to surface irrigation

Crop	Increase in yields, %	Water saving, %	Crop	Increase in yields, %	Water saving, %
Tomato	25-50	40-60	Kinnow	30-50	20-30
Okra	25-40	20-30	Ber	15-20	20-30
Potato	20-30	40-50	Guava	40-50	20-25
Cabbage	30-40	50-60	Mulberry	10-20	20-30
Brinjal	20-30	40-60	Lemon	30-40	25-30
Cauliflower	60-80	30-40	Pomegranate	20-40	20-30
Mango	60-70	30-40			

The problem of lesser water availability at the tail end of the canal owing to excess withdrawals on head reaches/ inadequate canal supplies has come to be known as classic tail-enders problem. Number of alternatives has been tried in different canal command areas but without much success. Micro irrigation offers a workable solution to the problem. The modus operandi will be simple; storing water in specially created tanks/ ponds as and when water is available and the apply this water through drip/ sprinkler systems to tail end beneficiaries irrespective of canal operation schedule.

5.7.10 Equitable distribution of irrigation water

In all irrigation schemes, the management of available water below the outlet is of vital importance and has long been neglected. Equitable distribution of water to the field and adoption of proper water application methods have great bearing on the benefits by way of returns per unit of irrigation water delivered to each hectare of land. The overall success of an irrigation project hinges around the management of water both above and below the outlet point. In the past, the irrigation engineers used to manage the irrigation supplies in the canals up to outlet point only. The management and distribution of water below the outlet was left to the beneficiary farmers. Experience has, however shown that many farmers, not knowing the implications of excessive water application to their fields, suffer by way of low production and also cause damage to their lands. They also deprive other farmers whose lands are situated in the tail reaches of the project, of their due share of irrigation supplies. Therefore, a need has been felt to ensure equitable, timely and efficient water utilization in the tertiary system below the outlet by organizing irrigation scheduling and coordinated water delivery plan.

Equity, as related to water deliv-

er, may be defined as the fair share of water to the users at different points in the system and is one of the main objectives of efficient irrigation management. In the day to day irrigation practice, the term equity is rather loosely used. What is usually meant is the allocation of water through time rationing according to the proportion of area held by the farmers in the outlet command. In the strict sense, it is proportional distribution of water and not equitable distribution of water.

Rotational water distribution system (or commonly known as WARABANDI) aims at distributing the available water equitably to all the beneficiaries. Socially it benefits the largest number of farmers in the command and economically this aims at the greatest overall production per unit of the available water, though not necessarily so per unit of land. In this system a farmer is at liberty to decide his own cropping pattern and water budget so long he can manage to remain within the constraints of his share. In a lean year the hardship is shared by all and not confined to those near the tail or to those who are otherwise less influential.

6. Virtual Water Transfer

By definition, virtual water is the water embedded in a product, i.e. the water consumed during its process of production. Virtual water refers to all sorts of production where water is used, e.g. it is not restricted to grain only. The production includes other inputs or investments like energy, labour, soil, market, etc. The concept emerged in the 1990s and receives more and more attention from people concerned with water management and in particular with water related to food production. The water requirements of food are by far the highest. It takes 2 to 4 litres per day to satisfy the drinking water needs of a human being and about 1000 times as much to produce the food (Renault, 2002). In this way, the concept of virtual water is important for food production and consumption. The importance of virtual water at global level is likely to increase as projections show that food trade will increase rapidly, i.e. doubling for cereals and tripling for meat between 1993 and 2020 (Rosegrant and Ringler, 1999). Therefore, the transfer of virtual water embedded in the food that is traded is becoming an important component of water management on global and regional level, particularly where water is scarce. India is a vast country with large spatial and temporal variations in availability of water resources. Hence, it is important that virtual water is properly assessed in terms of its value in space and time. It also needs to be analyzed how virtual water is considered at policy level on food trade, water management and agriculture.

7. People Participation and Capacity Building

For making the people of various sections of the society aware about the different issues of water resources management, a participatory approach may be adopted. Mass communication programmes may be launched using the modern communication means for educating the people about water conservation and efficient utilization of water. Capacity building should be perceived as the process whereby a community equips itself to become an active and well-informed partner in decision making. The process of capacity building must be aimed at both increasing access to water resources and changing the power relationships between the stakeholders. Capacity building is not only limited to officials and technicians but must also include the general awareness of the local population regarding their responsibilities in sustainable management of the water resources.

8. Conclusions

Ever increasing population in the country keeps exerting more and more pressure on our land and water resources to meet its growing food grain requirement and other demands. The projected food requirement in 2050 emphatically suggests a pronounced role for research, development and training in the water resources as well as agricultural sector. Some of the areas that need to be focussed upon are:

- Development of crops which require less water and can sustain on poor quality/saline water;
- Laser land levelling;
- Water harvesting through pond and bunding of fields;
- Modern irrigation techniques like sprinkler and drip should be promoted where water is scarce, and the topographic and soil conditions do not permit efficient irrigation by conventional methods.
- Water availability for crop production through life saving irrigation in rainfed areas;
- Augmenting water availability through:
  - Inter-basin and Intra-basin transfer of water;
  - Artificial recharge of ground water;
  - Recycling and reuse.
- Efficient use of irrigation water requires that water be applied to growing crops at appropriate times and in adequate amounts. Scheduling irrigation with limited water is a big challenge to agricultural scientists.
- Water use efficiency and fertilizer use efficiency always go hand in hand, therefore, increase in water use efficiency will automatically enhance nutrient use efficiency through water management.

Director, Indian Agricultural research Institute, New Delhi 110012
*****Project Director, Water Technology centre, IARI, New Delhi 110012***

Permanently Fallow- A New Cropping Pattern for Our Farmers?

Ashok C. Khosla

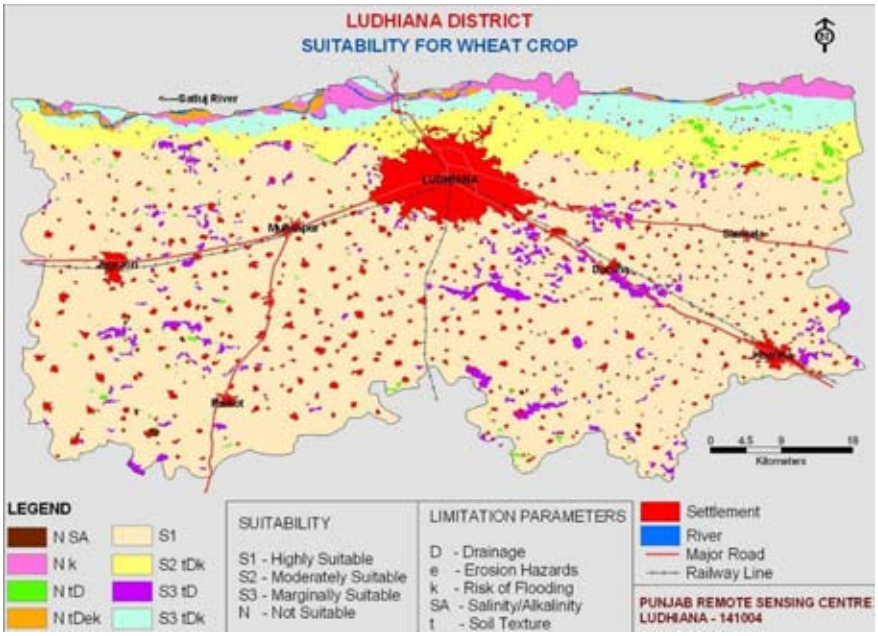
Agriculture resides deeply in the very DNA of our country, blessed as we are with fertile lands, nature's own bountiful systems that provide beneficial sunshine, cyclic rains and a vibrant bio-diversity. But this DNA is being increasingly exposed to forces seeking a rude mutation under which agriculture ends and human diversification takes over. Erstwhile lush farmlands are willingly allowed to be usurped to accommodate future non-agriculture use. This ominous exercise of choice made by land owners has deep ramifications and enormous future consequences.

Land is the most inelastic feature of our existence. Surrounded by people, by demands, by money and by man-made policies, we struggle to find some harmonious balance and some equality between population growth and consequent use of our land resources. A feature in this ongoing crush of humanity is that food is just but one item of demand on a user wish-list that gets longer and longer with each passing day, each year, successive generations. There are homes that need to be built, factories that need to produce, roads are needed to deliver, schools to educate, hospitals to heal. Each of these needs requires more and more land.

In many parts of the country, fertile farmlands are seen to continuously move away from agriculture, a new cropping diversification, a new form of land use. This diversification is permanent, inevitably irreversible. Replaced by concretes, gone forever is the productive layer of top-soil which has so painstakingly received careful dosage of nutrients each year to nourish our life-sustaining nature at work.

Are these just random instances, just a few odd acres here and there and which are almost insignificant given the large fabric of our farmlands? Or do they manifest some reactionary changes taking place and which, if allowed to remain ignored, even uncorrected, will pose serious challenges to our future food wellbeing? Both of these issues are examined in the context of Punjab, our agriculture show-piece state and which plays a critical role in our continuing food security.

In 2009, Government of Punjab



commissioned an Expert Study to develop a 20 year Vision Plan for its agricultural sector and recommend strategic directions & investments to manage agriculture in Punjab 2030. This study identified fundamentally critical areas, examined the issues encountered and developed future scenarios to identify and assess the farm canvas likely for Punjab 2030. Since Punjab has a small land area to begin with, the management of this vital natural resource was a key component within this study.

Briefly, 78% of Punjab's cropped area is deployed to grow alternating cereal crops, wheat and rice. The cropping intensity is over 1.9, a virtual double-decking of its farm production. Punjab vividly demonstrates the methods employed and outcomes received in government procurement of cereals for the Central Food Pool, by far the worlds largest such crop buy-back system. Essentially a contract farming mechanism, its key features are the close regulation of cost of inputs used for production and a 'support price', a thin gracious benefit given to farmers. This intent was soon overtaken by government's larger concerns over the rising treasury costs needed to meet 'social obligations' of supplying cereals to the needy. The mechanism of CACP as a real scientific basis for determination of MSP purchase was allowed to fall into chronic neglect, systematic abuse and hotbed of political interpretations.

Critically, a widening gap began to emerge between notional land use opportunity costs being estimated for MSP and the factual situation of rapidly escalating land values. A good indicator of a commercial equation for cereals is the theka price paid to rent farmlands annually to grow MSP crops. Over the past 6 years, average theka has increased from about Rs 18,000 per acre/year to Rs 32,000. This opportunity cost change alone equates to Rs 3 per kg of wheat and paddy taken in. Also during this same period, the capital value of farmland in Punjab has risen from Rs 20 lakhs per acre to over Rs 40 lakhs per acre.

Is the flight of farmland away from agriculture really happening and if so, to what extent? The Punjab study used the assistance of Satellite Remote Sensing pictorials to map known time changes and develop computer stimulations going into the future. The map below illustrates technological skills currently available for Ludhiana District as follows:

Based on computer aided guesstimates going into 2030, it was estimated that about 3% of Punjab's farmland will most likely shift away to some non-agricultural purpose. What does this mean to cereal production? In Punjab, a 3% reduction in farmland area actually equals to a 6% reduction in the gross cropped area. After factoring in yield lowering changes that are most likely to happen (physiological, agronomic, soil, climate), the production of wheat in Punjab 2030 was estimated to drop to 14.1 million tonnes, down 1.6 million tonnes from the 2008 production of 15.7 million tonnes.

Based on wheat MSP price tracked since 2000, the projected MSP for procurement of wheat in 2030 was estimated at about Rs 42 per kg. The monetary value of this shortfall of 1.6 million tonnes was thus believed to be about Rs 67,200 crores using 2030 prices.

In the case of paddy, the estimated shortfall was likely to be about 1.8 million tonnes. At the projected 2030 MSP of Rs 38 per kg, the value shortfall for lower paddy production was estimated at about Rs 68,400 crores.

The cumulative shortfall in 2030 output value of total cereal production on account of area loss plus yield slippage totals Rs 135,600 crores. This is almost equal in value terms to the entire State GDP generated in 2007-08.

Let us examine certain fundamentals involved with this alternate land use. Farmers are the absolute owners of the land. They are faced with really two very basic choices – economical necessity and economic necessity. Economical necessity dictates currently actionable use of the land to grow desired crops with the purpose of benefit. Economic necessity is a reaction to hitherto loss-making use of land, often a decision of last resort, a final solution.

We have an estimated 120 million farmer land-owners growing a vast variety of crops. Our Government actively supports this enormous diversity in several ways including subsidized fertilizer inputs, irrigation and market infrastructure. Added by a healthy confluence of human effort, we have secured adequacy in food security. Adequacy in nutritional security is perhaps not an unreachable dream. But in the journey travelled so far, the sad fact is that, increasingly our

farmers struggle each year in trying to make the sole agricultural occupation to become even a marginally paying proposition, somehow and anyhow enabling them to survive. Not surprisingly therefore, a staggering 35-40% of farmers polled recently expressed strong disfavour with having to continue with farming, both for themselves and certainly for their heirs. Seeking some form of exit away from farming is the new wish-list.

Agriculture is getting crowded out and increasingly reduced to becoming a deeper and even deeper non-paying proposition for farmland owners. Whilst people, demands, money and policies demonstrate flexibility to re-adjust amongst themselves, euphemistically described as inflationary response, there is really no adjustment that actually transfers to the farm origins. Five years ago, tomato farmers could stand to receive about 15% of the consumer rupee paid; cauliflower growers today get barely 9% of the retail price. And worse still, it is farmers alone who are squarely blamed for supply-side incompetence and retail price rise.

Each farmer carries on his/her shoulders the load of about 4.5 persons who depend on farm originated value chains for their livelihoods. However, many such beneficiaries are sheltered by policy umbrellas e.g. mandi APMCs, kirana Retail protection that enable them to swiftly capitalize on price adjustments to counter supply side shortcomings, whether true or artificial. All of this is without any hesitation and unchecked by any accountability, social or otherwise. The farmer alone remains isolated and disadvantaged. By the look of current will, our lengthy value chains will ensure there is a very definite lack of inclusion. For many downstream actors, agriculture in India is ruled by misinformation rather than information.

Economical necessity is epitomized by the yearly MSP fixed for cereal procurement. If there is anything truly backward in our agriculture, it is the gathering of reliable statistics for even the most fundamental of farming events – crop acres actually sown, crop harvests actually taken in, crop quality determination. What about reliable cost costing data – CACP itself is a long suffering victim to politics to arbitrariness? What about the studious recommendations of the Farmers Commission on C2 costs? Guesstimates have become the true culture in our agriculture; year after year we are fed figures of immediate comparatives for areas and yields and qualities and without any responsible co-relation ever with factual data.

This reality continues to be largely ignored by MSP Policy Administrators. Farmers perforce have to cultivate smaller and smaller parcels of land, the natural outcome of successive family inheritances happening. In this cycle, farm ownership and farm residency are often poles apart. Non-resident farmers are least concerned with good farming for proper income generation but energetically protect their fundamental rights to ownership seeing into the rising value of their farm lands. Graying of farmers all over the world is an inescapable fact. In Punjab, the flight of young talent now gives realism to a new equation, one that equates selling off 1 acre of farmland inheritance to secure a 4 year education and career in distant Australia.

Farmlands as assets are acquiring the dubious status of being stand-alone Non Performing Assets for output values actually generated and loans taken. Bank agricultural lending now carries the implied comfort of vastly appreciated land value as intrinsic collateral support instead of the real merits of returns securable from the purpose for which loans are given. Agriculture has the singular intrinsic opportunity to be directed as a self renewing asset. One-time cashing in conclusively ends this natural renewability forever. Yes, the resultant commercial activity will benefit future financial earnings but where will agriculture go to?

Importantly too, is there anybody who is even recording this change let alone engaging with issues in an attempt to manage it? Where is the solution and what needs to be done? Vital questions for our future, mostly remaining unanswered.

Management gurus teach you that acknowledging the existence of a problem is always the first step in finding solutions. So, should we ignore the real underlying problem of economical necessity being faced by farmers and remain unseeing to the economic necessity that is now gathering momentum? Should we not make attempts to create situations and circumstances that could discourage this permanent fallow as a cropping option for the future?

Certain scenarios identified for Punjab 2030 have showed a ray of hope by seeking to potentially limit the flight of farm land to about 2% instead of the projected 3%. But to do so will require more active mindsets that will address technology, value paid out, soil health and aided green diversification. Whether we choose to pursue these vigorously or not will have to stand the test of future accountability of our actions, interventions. Is this turnaround worth the financial effort likely to be expended? In the alternative scenario, wheat production in Punjab 2030 could increase to 17.9 million tonnes and paddy to 19.0 million tonnes. The net value change between the two scenarios in 2030 is a substantial Rs 323,000 crores. And, let us not overlook the fact that this is per year, each year and each successive year thereafter.

We are approaching a razor thin edge that differentiates economical from economic issues faced by the farmers. Let our goal for food security not be allowed to deteriorate into a basic fight-to-secure-affordable-food, a dire calamity for the millions and millions of our under-privileged.

Agribusiness Advisor

Agri-Biotech, Seed Innovation & Partnerships Key to Ensure National Food Security

India has a unique opportunity. Given the spirit of our entrepreneurial farmers, the scientific talent in our agriculture industry and universities, and the second-largest farming acres globally, if we can increase crop yields sustainably, we can achieve food security domestically and be a positive contributor to the world's agricultural needs. However, India itself is ranked among the lowest in human development index mainly owing to malnutrition, poor social infrastructure especially in areas of education and healthcare.

The World Bank, the Planning Commission, the National Council for Applied Economic Research (NCAER) have arrived at a broadly similar conclusion that 300 million to 400 million people in India live below the poverty.

Currently, India seems to be facing a situation similar to the 1960s, but with a difference. Then, the country did not have enough food supply due to which people suffered. Now there are food items in the market, but almost 70 per cent of the people find it hard to afford them. For 30 per cent population, it is impossible to buy any food with the limited money at their disposal. Between 1960 and 2010, real-term food scarcity has been a stark reality.

Between November and December last year, the prices of vegetables escalated by as much as 50 per cent. The major reason for the current food price inflation was unseasonal rains during the harvest of several foods crops including rice, wheat, onion and garlic. Imagine, just one crop failure or limited arrivals in a single season has disastrously thrown off track the country's food supply chain and made them inaccessible to the common man.

The spectre of climate change threatens agriculture, especially in developing countries where farming is dominated by small-scale farmers heavily relying on rainfall. Erratic weather also means continued challenges of pests across crops. Since there are indications that the tropics are slated for more catastrophic climatic changes - more floods, longer droughts, salinity of water because of sea water incursion - is this the beginning of an alarming situation that could emerge in the near future?

D Narain

It is the time for introspection. Let us not be a nation that is over-optimistic of meeting our challenges with

existing tools. The fundamental questions are - Is India's food policy for production and productivity increase, storage, distribution, pricing and food subsidy scheme appropriate and in the right direction for the future? Are we confident that our present approach to food production methods and the attitude towards newer technologies will ensure enough food for the present and future generations?

One of the key solutions to these challenges is agricultural innovation: produce more and conserve more, and thereby improve farmers' lives. Private players have been focusing on countering these adverse realities with technology, partnering with governments and farmers to improve farm productivity and food quality, thus tackling food scarcity.

Monsanto's worldwide three-point commitment to grow yields sustainably focuses on developing better seeds by helping farmers double yields, conserve resources like land, energy, fertilizer and water up to one-third per unit of output and improve farmers' socio-economic conditions. Our partnerships in India have already begun to demonstrate positive, impactful results in Rajasthan, Gujarat, Himachal Pradesh, amongst others. In key cotton-growing states like Maharashtra, Gujarat and Punjab, the cotton farming scenario has depicted radical change, thanks to Bt cotton.

The technology-induced turnaround has also been witnessed in Burkina Faso, Africa which falls at the bottom of the pyramid in terms of the overall development index. Commercial Bt cotton plantation has shown an unprecedented 14-fold year-to-year increase - from 8,500 hectares in 2008 to 115,000 the following year.

India needs technologically empowered flood and drought resistant, salinity tolerant, targeted pest-resistant food crops (rice, wheat, vegetables and fruits) to feed its people and livestock.

Imagine the potential for Indian farmers to replicate the Indian cotton success story on 88 per cent of its remaining crops to meet the world's needs. For this to happen, they need to have access to cutting-edge agriculture technologies, agronomic education and market linkages to help them remain globally competitive. We believe we can compete in the global market with agri-commodity powerhouses like Brazil and Argentina. We need to revive, modernize, and make agriculture accessible to markets and sustainable, to empower India to seek its rightful place on the global map. Decision-making on policies and technologies for food production and productivity increase is a collective effort.

By adopting available and new, emerging technologies, India with its scientific and technical capability has a huge opportunity to feed not only its millions, but the other millions starving in South Asia and Africa. Already 14 million farmers in 25 countries are raising biotech crops, both for food and fibre, in over 134 million hectares. The numbers are increasing.

We envision a prosperous India where inclusive growth means agriculture yield-led growth that improves farmers' lives and India as a global self-sufficient contributor in agriculture.

India Region Lead - Monsanto India

Sons of The Soil: The Least Privileged..!

Dinchengfa Boruah

Once, famous scientist and author Benjamin Franklin said, "There seem to be but three ways for a nation to acquire wealth. The first is by war, as the Romans did, in plundering their conquered neighbours. This is robbery. The second by commerce, which is generally cheating. The third by agriculture, the only honest way, wherein man receives a real increase of the seed thrown into the ground, in a kind of continual miracle, wrought by the hand of God in his favour, as a reward for his innocent life and his virtuous industry."

Out of the three options given by Franklin, the most possible and appropriate way for India to gain wealth seems to be 'agriculture'. But unfortunately in the present scenario, agriculture appears t be the most neglected and the least popular occupation. Today, in our country it is easier to get a car loan than a farm lone. Today's youth (even those who hail from a family that has been practicing agriculture for generations) find government jobs more attractive than that of working on farms. In fact, according to latest reports, people in the age group of 15-24 seem to prefer to pursue study rather than working on farms. The number of youth working on farms has declined by 14 million in the last decade (2001-2011).

Crop holiday..!!!

The farmers today who are unsatisfied with the agricultural scenario in the country often feel alienated and frustrated that lead to an occasional outburst of their anger. One such latest outburst by farmers against the step-motherly treatment to agriculture is the 'crop holiday' by the farmers of Andhra Pradesh. To teach a lession to the government's inflation busters, farmers in large number from the fertile east and west Godavari districts of Andhra Pradesh have decided not to cultivate paddy this season. The farmers have decided to keep their fields fallow rather than risk continued losses. They blamed the soaring input costs and low prices at which the government buys the produce behind their decision. "We were driven to such a tough decision because of rising costs and government indifference," says K. Nageswar Rao, a farmer leader from Vijayawada. Farmers of these areas believe that that farming is only helping the dealers of fertilizers, pesticides and middlemen to make money and not the farmers. So they have decided to protest. But their outburst is not a violent one. They have declared a 'crop holiday' as a way of protest in which they would keep their fields empty. A 'crop holiday' will mean that a large chunk of the 1300 quintals of seeds and Rs 120 crore worth of pesticides and fertilizers provided by the government for distribution at subsidized rates will not find any takers. The crop holiday is definitely going to affect the state's economy. The area is known as the Koonaseema belt, where over 11 lakh acres are irrigated by the Godavari waters. This makes it possible to raise multiple crops, including tobacco and sugarcane, in a year. The farmers' boycott could cover three to four lakh acres, according to govern-

ment figures. It is time that government takes initiatives before the 'crop holiday' spreads to other parts of the country and becomes an epidemic which will be extremely harmful to the country.

The ever widening gap:

The gap between the rich and the poor is increasing.

Some are living to eat, while others are struggling to eat enough to be able to live…

-Anna Hazare

And in India, the most downtrodden are the farmers that constitute about 75% of the country's population. According to the Arjun Sengupta report, the average monthly income per household from cultivation was Rs 1,578 a month for small farmers and Rs 8,321 for big farmers in 2003 whereas the average income of an Indian is more than Rs 3000 a month. Now, compare the occupation of agriculture with that of a government job: as mentioned in the Sengupta report, the lowest-paid government employee got the pay and perks exceeding Rs 10,000 a month. Available datas suggest, an average Indian farm family works 80 hours per week and earns $3000 a year. Whereas an average farm family in U.S works 80 hours per week (same as that of an Indian farm family), and earns $ 60,000 a year (20 times more than that of an Indian farm family). The question is what is the reason behind this huge gap? This revelation by World Trade Centre may give us a probable answer. As declared by WTO in 1990, there is a 'negative subsidy' imposed on Indian farmers by the government. Negative Subsidy refers to cases where the income received by the farmer by the sale of his produce is less than the income he would have received in a hypothetically free market where the government does not intervene in any manner. This makes us question, is the government of India neglecting the farmers? Recent cases of protests in various parts of the country against land acquisitions add fuel to this burning question. Anna Hazare who has been fighting for a Jan Lokpal bill has said, "After Lokpal, we will also have to fight for farmers' rights, bring a law that ensures permission of gram sabhas before land acquisition." It is necessary that a movement like the one for Jan Lokpal Bill is initiated for farmers' rights. It is necessary that voices are raised against the plight of millions of Indian farmers. According to reports, 2.5 lakh farmers across India committed suicide due to agriculture related problems in between years 1997-2009. Laws and acts to fight corruption are definitely needed in this country. No doubt an anti corruption agency will be helpful for farmers who are victims of corruption too. However there is an equal need for laws protecting farmers' rights. Age old Acts like Land Acquisition Act of 1894 needs to be amended before more POSCO and more Singur take place.

Policy reforms for a sustainable agriculture:

The average annual rate of growth in agriculture fell from more than 4 percent per year during 1992/93 to 1996/97 to less than 2 percent per year during the period 1997/98 to 2002/03, and it remains low. The agricultural sector seeks urgent reform without which it is impossible for India to achieve food security. For this, India needs to make some strategic choices. Here is a list of major areas that need reforms:

- Enhancing pro-poor rural and agricultural investments: Government's willingness to invest on agriculture is often not up to expectations. Private Banks often seem reluctant in providing loans to farmers. Thus, the first strategic decision must be to

raise the level of public investment in agriculture and in rural India. Research shows that investments in R&D have the highest impact on agricultural growth per million rupees invested. The rates of return to public investment in research have been as high as over 60 percent, and in extension, over 50 percent. Thus the government needs to invest more in agricultural research.

- Reforms to address the landless poor: According to the India Rural Development Report of 1992, 43% of the country's rural population was absolutely or near landless. Landless agricultural labour makes up almost half of those living below the poverty line in rural India. A majority of the economically and socially weaker sections of society, such as scheduled castes and tribes, dalits, adivasis and women, make up the majority of landless population working as labour. Special policies are welcome to uplift this section of the Indian society as they are often missed out in most of the schemes like the one in Land Acquisition Act of 1894.
- Fighting the water challenge. According to data given by International Water Management Institute (IWMI), One third of the world's population is already affected by water scarcity and another one third of world population will face absolute water scarcity by the year 2025. Water rights, combined with appropriate incentives, are essential for establishing rational water allocation because they provide users with the security to invest in water-saving technology and practices. Extensive schemes and programmes are necessary to promote technologies like Micro Irrigation.
- Reforming the trade and market policy: Trade liberalization in agriculture has the potential to bring rich dividends to developing countries, including India. India can harvest rich returns from trade liberalization, provided it also carries out large-scale reforms to streamline domestic markets and put in place the infrastructure and institutions to connect local markets with national and global markets. If we keep the 1991, the year of economic liberalization in India as a base, there seems to be a negative graph in the agriculture sector. According to the available data, agricultural production fell by 12.6% in 2003, one of the sharpest drops in independent India's history. Agricultural growth slowed from 4.69% in 1991 to 2.6% in 1997-1998 and to 1.1% in 2002-2003. This slowdown in agriculture is in contrast to the 6% growth rate of the Indian economy for almost the whole of the past decade. Farmer suicides were 12% of the total suicides in the country in 2000, the highest ever in independent India's history. An NSSO2 survey in 2005 found that 66% of all farm households own less than one hectare of land. It also found that 48.6% of all farmer households are in debt. During the time of economic liberalization, most farmers in India were already in a position of minimum security, with no education system, credit facilities, access to alternative employment, or efficient technology. Their only support was government subsidy and regulation. Liberalization policies came in and dismantled their only support structure. It halted the sharp reduction in rural poverty from 55% in the 1970s to 34% in the 1980s.

What appears from the above data is that the trade and market policy vis-à-vis agriculture definitely needs reform.

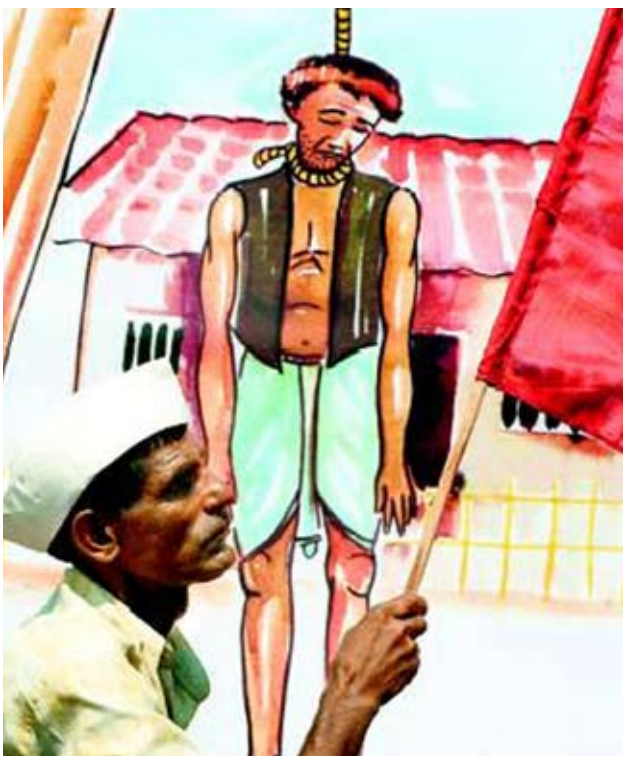
SUICIDE OF ONE FARMER EVERY 30 MINUTES!

According to reports more than 500 farmers have killed themselves in last 5 months in the Bundelkhand region of Uttar Pradesh.

Now, have a look at this shocking report on farmer suicides in India as given by the National Crime Records Bureau (NCRB)

- More than 216, 000 farmers have killed themselves since 1997
- In 2009 alone, the most recent year for which official figures are available, 17,638 farmers committed suicide—that's one farmer every 30 minutes.
- In 2009, 2,872 farmers committed suicide in Maharashtra, worst in the country.
- About 46 farmers commit suicide everyday in India.

If committing suicide is a crime, these farmers have to be regarded as criminals. But the broader question: what is the reason behind this crime? This is a major issue of concern especially for a country like In-



dia where about 70 % of the population depends on agriculture. Look at the contrast: Maharashtra is the home to 1 lakh millionaires but not to forget that it is also home to the maximum number of farmers' suicides in the country. This trend represents the trend of the nation where rich are getting richer and richer and the poor is getting poorer and poorer. The condition has worsened over the past year with 18 of the 28 states reporting more suicides. The steep rise in the farmer suicides graph is not limited to Maharashtra or a particular region of the country. The trend can be seen in eastern states like West Bengal, northern states like Punjab and southern states like Kerala too. Country's full fledged progress cannot be expected as long as this agrarian crisis continues.

Just blaming the government and putting the onus on it to fight the crisis is no solution. It is a collective responsibility of the government, the media and the public. Government needs to give its 100 % to help this major population of India. More funds, better infrastructure, education to farmer, subsidies and agriculture loans with minimum interests, new technologies, more agriculture colleges etc are the key areas that government needs to look into. However these steps have to be accompanied by a regular inspection mechanism. An inspection body probably will be a good move.

Media too has to play a crucial role in fighting the agrarian crisis. It is high time that media brings the plight of the farmers into limelight and proves itself to be the 4th estate of democracy. The irony is we can see Aishwarya Rai's pregnancy as a headline but not the plight of hundreds of thousands of farmers. As reported by P Sainath (rural affairs editor, The Hindu) when the agrarian crisis in Vidhrava district of Maharashtra came into light, there were 6 national media journalists covering this but at the same time 540 media persons were covering the Lakme Fashion Week. The irony as said by Sainath is that, the models on the ramp were showcasing cotton garments but the farmers who grew cotton were committing suicides. It is time that media takes the onus too and proves to be the voice of the mass. More films like 'Peepli Live' can play an important role in this regard.

Last but not the least, it is very important that the general public, the youth, the urban population understand this grave situation. Being blind and being ignorant about such crisis does not mean that the crisis does not exist. It is time that public awareness is created about such issues. Youth should realize the fact that for a better future of the country, solving the crisis is extremely necessary. The brain drain reveals the uncaring attitude of most of the youth today. It is time that schools, colleges and the media educate the youth about the crisis. For we believe, once the fire in the youth is lit, it can be a great asset in fighting India's poverty.

Expectations Galore:

As India's 12th five year plan is soon going to be submitted, expectations are high that the agricultural sector will get its due attention. According to reports, Planning commission is likely to strive to enact policies that will achieve around a 4 percent growth rate in farm produce. We hope that, the 12th five year plan is able to bring smiles on the faces of Indian farmers. As said by Saurabh Tripathi, a partner with Boston Consulting Group in his article in the Wall Street Journal, "Rural infrastructure, which serves 70 percent of the population, doesn't get the attention it deserves. As the Planning Commission sets out to draft the country's planned investments for the next five years, it is important to take note of this gap, and the innovative solutions needed to fill it."

Jai Jawan, Jai Kisan..!!!

Assistant Editor, Agriculture Today

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In Focus

Technology Led Horticultural Growth Need of the Hour

Dr. A.S. Sidhu, Dr. T.M. Gajanana** and Dr. M.R. Hegde***

India is the second largest producer of fruits and vegetables in the world. The horticulture sector has been the main stay of Indian agriculture with production of more than 216 MT of fruits and vegetables. The horticulture sector contributes to 28.6 per cent of the agricultural GDP from about 12 per cent of area and 37 per cent of total export earnings in agriculture. However, there is still a big gap between demand and supply due to rising demand and low productivity. With food security attained as a result of focused attention in the five year plans, nutritional security to the undernourished population is a priority. The per capita availability of vegetables and fruits is far below the recommended levels and the nutritional security can only be achieved by achieving quantum jump in productivity. Hence, it is imperative that there is a paradigm shift towards evolving technologies for enhancing productivity in horticultural crops through concerted efforts in research, development and extension.

CURRENT SCENARIO OF FRUITS AND VEGETABLES

Global scenario

With the GOI initiatives having started bearing fruits, India is now the second largest producer of fruit and vegetables contributing about 12.40 per cent and 13.30 per cent to the total world fruit and vegetable production, respectively. Among fruits, India ranks first in the production of mangoes (41%), banana (28%), papaya (30%). Among vegetables, India is the largest producer of peas (30%); second largest in brinjal (29%), cauliflower (29%), onion (18%) and cabbage (8%).

Dr. A.S. Sidhu

Indian Scenario

Horticulture, including plantation and spices crops, has been growing over the years. Horticulture comprising fruits, vegetables and flower crops constitute the major chunk of this sector accounting for more than 90 per cent. Further, the share of these has also been increasing over the years. Horticulture, with 14 per cent of the net cropped area, contributes about 28.6 per cent to the agricultural GDP and the share of fruits and vegetables in this is to the extent of 25 per cent. Fruits and vegetables also account for about 37 per cent of total agricultural export earnings.

Growth in production of fruits and vegetables in the last decade

In India, fruits are grown on an area of 6.45 million hectares with a production of 75.55 million tonnes. During the last decade (2001-2011), fruit production has increased at a compound growth rate of 6.86 per cent. The important fruits are mango,

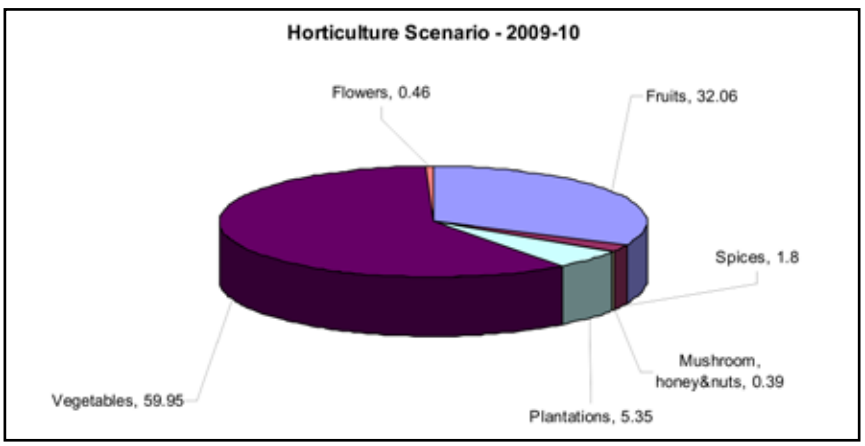


Table 1: Growth rates in Fruits, Vegetable, Flowers and Horticulture sector during the last ten (2001-11) years (%)

Crops	A	P	Y	Remarks
Fruits	6.00	6.86	0.81	Area led growth
Vegetables	3.78	6.08	2.21	A&Y led growth
F&V	4.70	6.34	1.57	Area led growth
Flowers	9.92	7.42		
	-	(64.49)*	-	
Horticulture	2.82	6.07	3.14	A&Y led growth

Cut flowers

citrus, banana, apple, litchi, guava, pomegranate and sapota. Vegetables are grown on an area of 81.99 million hectares with a production of 141.41 million tonnes. Vegetable production has registered a growth of 6.08 per cent during the last decade. The important vegetables grown are potato, brinjal, tomato, onion, okra, cauliflower, cabbage and green peas. Production of fruits and vegetables has increased from about 131.62 million tonnes in 2001-02 to 216.63 million tonnes in 2010-11 registering a growth of 6.34 per cent. During the last decade, horticulture sector as a whole has registered a growth of over 6 per cent, major contributions coming from fruits and vegetables [Table 1].

Growth in production of fruits and vegetables in the last five years

During the last five years (2006-07 to 2010-11), fruits and vegetables together registered a growth of 5.21 per cent in production, 2.96 per cent in area and 2.18 per cent in productivity. In case of fruits, production registered a growth 6.26 per cent which was mostly area led (4.17%) rather than productivity led (2.00%). In case of vegetables, production grew at 4.67 per cent with almost equal contribution from area (2.05%) and productivity (2.56%). Horticulture sector as a wholes registered a growth of 4.49 per cent which was the result of both area and yield growth [Table 2].

In the last five years, area under fruits increased from 5.5 million. hectares. to 6.45 mil. ha. registering a growth of 4.17 per cent. Production of fruits increased from 59.56 mil. tonnes to 75.22 mil. tonnes registering a growth of 6.26 per cent. Major fruits registering increase in area are papaya, litchi, banana, citrus and pomegranate. Significant contributors to increased production of fruits are banana, papaya, pomegranate, sapota, citrus, mango, guava, papaya and litchi. Production growth of fruits has been mainly area led as the productivity registered a growth of only 2 per cent. However, in the absence of data base on bearing and non-bearing orchards it would be difficult to generalize that the productivity of fruits is low and its growth is declining.

The area under vegetables increased from 7.58 mil. ha. to 8.2 mil. ha. with a growth rate of 2.05 and production of vegetables increased from 93.17 mil. tonnes to 141.41 mil. tonnes registering a growth of 4.67 per cent. Brinjal, okra and tomato contributed to the increased area under vegetables while onion, tomato, okra and brinjal showed greater increase in the production of vegetables. Productivity of vegetables increased at a rate of 2.56 per cent indicating thereby that production of vegetables has been the result of both area and yield increase in the last five years.

Table 2: Growth rates in Fruits, Vegetable, Flowers and Horticulture sector during the last five (2006-07 to 2010-11) years (%)

Crops	A	P	Y	Remarks
Fruits	4.17	6.26	2.00	Area led growth
Vegetables	2.05	4.67	2.56	A&Y led growth
F&V	2.96	5.21	2.18	A&Y led growth
Flowers	6.98	7.49 (18.57)*	-	
Horticulture	2.16	4.49	2.28	A&Y led growth

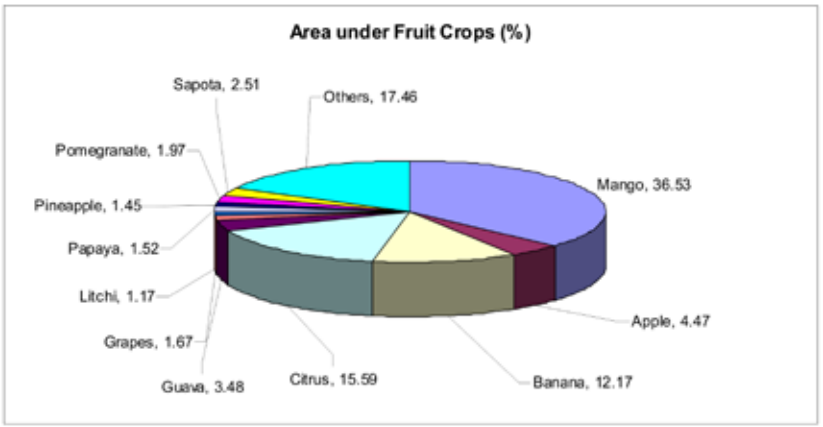
Cut flowers

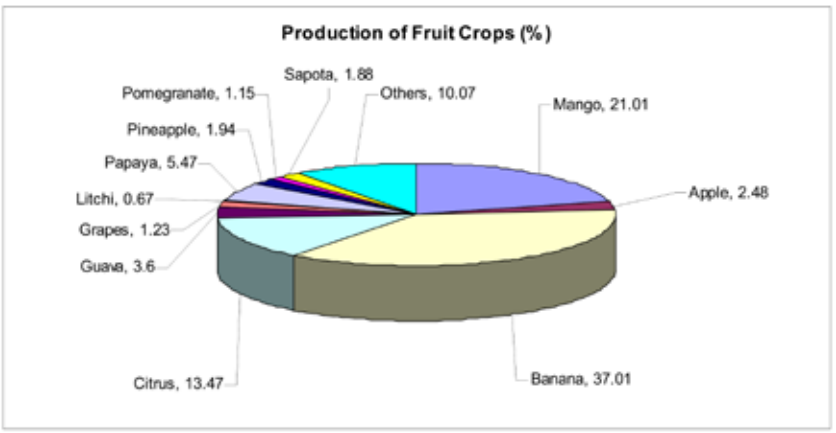
Share of different fruits and vegetables in area and production

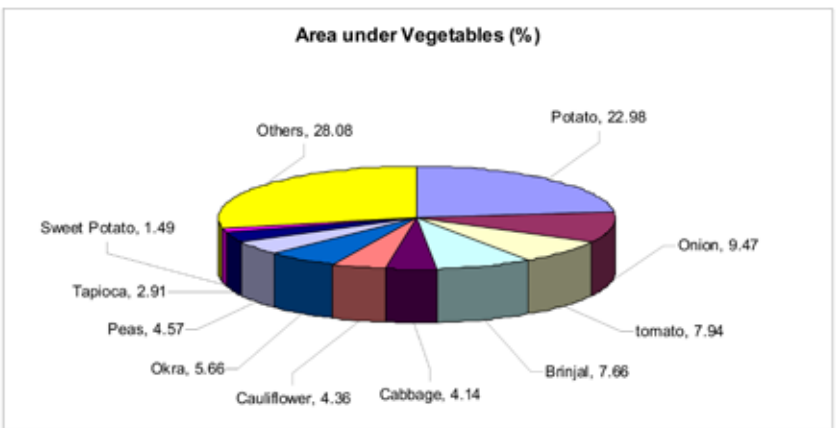
As can be seen from Fig.1-4, though area share of mango is the highest (37%), the production share is only 21 per cent. However, in case of banana, papaya, citrus and grapes production share is higher or at least equal to area share. This gives us an indication that productivity, especially in case of fruits- mango, is a matter of concern as there has been stagnation leading to area lead growth in production. In case of vegetables, while majority of vegetables had higher or almost equal share of area and production, due to lower productivity, okra and peas had a lower production share. This needs to be addressed at the earliest.

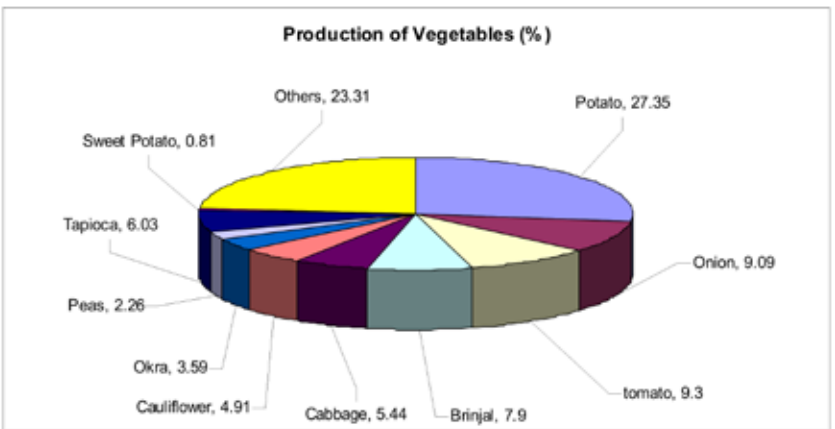
Supply and Demand for fruits and vegetables

With a production growth of 4.67 per cent in vegetables and 6.26 per cent in fruits the total production of fruits and vegetables available by 2016-17 would be 292.88 million tonnes with 184.08 mil. tonnes of vegetables and 109.39 million tonnes of fruits. Considering a population of 1409 millions by 2017 and the per capita dietary requirement of 400 g per day, the demand for fruits and vegetables would be 247 million tonnes. Export and seed requirements also to be met and hence the demand will be much higher than 247 million tonnes. With the present level of population growth, the annual domestic requirement of fruits and vegetables will be around 322 million tonnes by 2030 AD, which would have to be met with dwindling natural resources, particularly land, irrigation water and conventional energy sources, on the









facet of impending challenges such as climate change, shifting economic perspectives following trade liberalization, declining soil health and higher quality standards for environmental as well as for the produce and products safety. Therefore the research at IIHR would need further strengthening to support the horticultural advancement in these lines with a renewed outlook.

Major bottlenecks

Despite the research achievements and generous support for the developmental activities by the government of India, Indian horticulture is plagued by several constraints:

Low and declining productivity: One of the disquieting features of the Indian horticulture sector is the low and declining productivity of fruits and vegetables. Among fruits, with the exception of banana and papaya, the average productivity is much lower (11 t/ha) in India compared to many advanced fruit producing countries (21 t/ha in USA, Brazil). In case of vegetables, the productivity is 17 t/ha in the country which is much below the world productivity (33 t/ha – Spain). Low productivity levels decrease the profitability of farmers, especially the small and marginal growers.

Deteriorating production environment: Indian agriculture is predominantly small holders' agriculture as more than 82 per cent of the holdings are small and marginal. The contribution of agriculture in the GDP has declined from about 30 per cent during 1990-91 to about 15.7 per cent now. The average size of the landholding declined from 2.30 ha in 1970-71to 1.32 ha in 2000-01 with a concurrent increase in the absolute number of operational holdings from about 70 million to 121 million. The holding size for horticulture sector is no different, with the added constraint that it is mostly the marginal lands that is available for horticultural production. Moisture and salinity stress, poor soil fertility etc are characteristic features of such marginal lands to which horticulture has been extended recently and may continue in future also. Thus, while striving for increasing the productivity of small and fragmented arable land, it is also imperative to use the degraded and marginal lands as well as places

with abiotic stresses for extending the cultivation of horticultural crops. Even in good arable lands, the problems of land and water degradation are to be addressed to sustain productivity.

Post harvest loss and its impact on per capita availability: Despite phenomenal increase in the production of fruits and vegetables, the nutritional status of the population has not improved much, as the per capita availability of fruits and vegetables is still about 104 and 207 g/day respectively, far less than the recommended levels of 120 and 300 g/day respectively. A main reason for low per capita availability is the enormous losses of fruits and vegetables which are estimated to be 15 to 50 per cent that occur at different stages of handling, transport, storage, processing and distribution. India loses fruits worth Rs.12700 - 15876 crores (20-25% loss at average price of Rs.10,000/t) and vegetables worth Rs.12588 crores (20% loss at average price of Rs.5000/t), totaling to Rs.25289 –28464 crores annually.

Changing quality consciousness and global competition: As the consumers are becoming more quality conscious around the globe, improving the quality of horticultural produce is essential to make Indian horticulture globally competitive and to take advantage of the international trade liberalization. Quality is a very broad term including physical appearance, chemical composition with reference to taste and flavour as well as hygiene and health factors, especially pesticide residues and heavy metal contamination and its amelioration is essential for export promotion as well as import substitution.

Climate change and horticulture: Global temperature is predicted to increase gradually leading to more frequent hot extremes, floods, droughts, cyclones, and recession of glaciers. Dynamics of pests and diseases and pollination biology would be altered as a consequence resulting in greater instability in horticultural production and farmers' livelihood security.

Absence of market linkage and price stabilization: Absence of market infrastructure facilities for obtaining information on fluctuating prices poses a major threat for the horticultural producers in realizing higher returns. Effective and efficient market linkages, modalities of market regulation and price support are gaining utmost importance for making horticulture a profitable venture.

Technologies for mitigating the constraints

Indian Institute of Horticultural Research has been playing its role in mitigating the constraints of the horticultural sector. It is committed to harness the power of science in increasing productivity, enhancing input use efficiency, reducing cost and post-harvest losses, minimizing risks and improving quality of horticultural commodities through time tested conventional as well as advanced techniques and quality human resource development.

Crop improvement programmes aim at developing elite varieties or hybrids with resistance to multiple stresses through conventional breeding, pre-breeding and biotechnological tools. Functional genomics, marker-aided selection and gene stacking, and customized genetic engineering would be the thrust scientific tools for crop improvement. Biotechnology will be used to speed-up breeding and planting material supply especially where conventional efforts have shown low probability of research success in the past. Efficient farming systems, integrated crop management involving nutrient, water, pest and disease management along with canopy architecture modifications for proper light interception and utilization would be the key approach for developing crop production technologies. Scientific tools involving precision practices with the help of nano-technology, remote sensing, Geographic Information System and Global Positioning System would be well integrated to achieve this. Carbon sequestration stressing carbon credits from horticultural production system would be employed to address some of the environmental degradation issues and to improve soil health and its productivity. Potent and eco-friendly pesticide molecules would be identified for horticultural crop protection by studying their biodegradation and persistence patterns in horticultural produce especially those grown in polyhouse and in medicinal crops used for manufacture of neutraceuticals. Social science advancements are expected to compress supply chain and thereby reduce post harvest losses through linking production with markets by developing workable models while engineering would strive to address efficient management of energy and develop new machinery and equipment for processing and efficient horticultural operations that enhance quality and reduce human drudgery and production cost. Advanced information and communication technology would be employed for dissemi-

nation of knowledge and technologies, HRD activities as well as for developing risk-and-disaster management strategies, market intelligence and decision support systems.

Strategy and framework

In order to accomplish the vision and goals, a comprehensive approach with a shift in focus from supply-driven to demand-driven is required. Such an approach would culminate with enhanced productivity of horticultural Crops, Sustainable Technologies for Improving Soil, Seed Health Nutrient & Water Use Efficiency and Reduction of Drudgery, Systematization of Management Practices for Insect and Disease Management, Standardization of Varieties/Agro-techniques for Off-season cultivation, Strengthening Frontier Areas of Research for Enhancing Horticulture Production & Productivity, Safe utilization of Horticultural Crops through Best Post-Harvest Management and Commercialization of Technologies through Public-Private-Partnership Model, among many others. To accomplish the vision and the mission of IIHR, the following key areas would be given functional emphasis during the coming years to develop technologies which are socially compatible, politically feasible and ecologically sustainable and economically viable.

1. Enhancing horticultural production, productivity, quality and ultimately profitability of horticultural ventures and strengthening frontier areas of research for the same
2. Collection, conservation, evaluation and characterization of germplasm of horticultural crops and identification of new genes to achieve resilient horticulture
3. Developing new cultivars and technologies that can withstand biotic and abiotic pressures and have proofing against climate change while improving soil health as well as nutrient and water use efficiency
4. Systematization of insect and disease management through forecasting, surveillance and integrated control measures with more emphasis on environmental concerns
5. Standardization of techniques for off-season production, safe production and best post-harvest management which can result in horticultural produces and products rich in health nutrients and pharmaceutical principles
6. Enhancing the marketability of horticultural products through value addition, processing and waste utilization and mechanization
7. Mechanization for drudgery alleviation, precision horticulture and quality enhancement
8. Economic evaluation of production and marketing efficiencies, technology impact, returns to research investment and development of knowledge management systems in horticulture
9. Human resource development in frontier areas of horticultural science and effective transfer of technology programmes, including establishment of Technology Park and Business Processing Incubation Centre for capacity building, up scaling and commercialization.
10. Improve competitiveness through innovative approaches for Public-Private-Partnership and collaboration with national and international organizations in horticulture research and development as well as establishing linkages with various stakeholders in the horticultural production – supply chain.

Furthermore, in order to achieve the above said mission, the effective utilization of in-house human man-power, financial and infrastructure facilities are the needs of the hour. Also, capacity of the existing manpower needs to be strengthened by enriching their skills and providing latest state of the art facilities. Formulation of strategies for effective, centralized management practices to enhance efficiency and effectiveness of research resources is also need of the hour.

**** Director, Indian Institute of Horticultural Research, Bangalore***
***** Principal Scientist, Indian Institute of Horticultural Research, Bangalore***

Roadblocks in the Path of Indian Co-operatives

Co-operatives still continue to function in a traditional way with poor governance and management, poor resource mobilization, outside interference, dependence on government and lack of professionalization. Co-operatives are neither member-driven nor function professionally in a transparent manner with accountability to members. We cannot afford to see that these institutions wither away. Co-operatives need be member-driven; stakeholders should have a command over its affairs and activities. There is need for more transparency, more of interaction and confidence-building measures. Concentration of power in a few hands in a co-operative institution is a sure sign of its weakness and mismanagement. If co-operatives have to succeed and properly compete, innovations and new techniques have to be adopted, rather sooner than later.

Dr. Daman Prakash

It is now increasingly recognized that the co-operative system in India has the capacity and potentiality to neutralize the adverse effects emerging from the process of globalization. After economic liberalization under the new economic environment, co-operatives at all levels are making efforts to reorient their functions according to the market demands. The failure of the public sector in several cases is a worrisome trend. Privatization has also failed to make an impact in the rural areas. Therefore there is great hope on the co-operative sector. The paper examines the causes of slow progress and highlights the emerging role and challenges of the co-operative sector. In comparison to the step-motherly treatment of the past, co-operatives are now considered an important plank of development. The government is committed to co-operative development. Co-operatives have inherent advantages in tackling the problems of poverty alleviation, food security and employment generation. Co-operatives are also considered to have immense potential to deliver goods and services in areas where both the state and the private sector have failed.

Co-operatives in a vast country like India is of great significance because:

- It is an organization for the poor who wish to solve their problems collectively;
- It is managed democratically;
- It is an institution of mutual help and sharing;
- It softens the class conflicts and reduces the social cleavages;
- It reduces the bureaucratic evils and follies of political factions;
- It overcomes the constraints of agricultural development;
- It creates conducive environment for small and cottage industries.

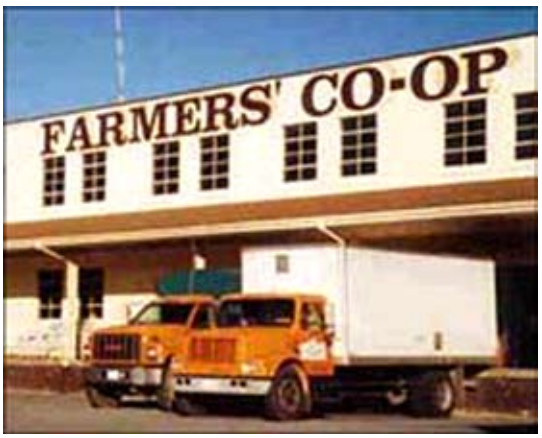
Slow Pace of Growth in Co-operatives

Despite its rapid growth, the overall progress of Co-operative Movement during the last 100 years is not very impressive. Some of the principal road-blocks have been the following:

[a] Government Interference: The Co-operative Movement in India was initiated in 1904 under the auspices of British government. Right from the beginning the government has adopted an attitude of patronizing the Movement. Co-operative institutions were treated as being a part and par-

cel of the government administrative set up. The government interference thus became an essential element in the working of these institutions. As a result, people's enthusiasm for the Movement did not grow. After attainment of Independence in 1947 some healthy changes in the attitude of the government did take place. It was not given proper importance that it deserved in any Five-Year Plan. Even today, quite often co-operative societies are imposed upon the people. Though this increases in the membership of co-operatives, the spirit of co-operation cannot flower fully. Neither it grew according to any plan nor did it become a people's Movement. It just grew very slowly and that too haphazardly. It turned out to be a State-driven institution.

[b] Mismanagement and Manipulation: The essence of the Co-operative Movement is that it gives the farmers the status of shareholders and assures them agricultural, educational and other facilities. Co-operative institutions are small institutions owned by a small number of members. A hugely large memberships turns out to be mismanaged unless some secure methods are employed to manage such co-operatives. Over the years, this truly democratic idea got corrupted and farmers with larger holdings grew more powerful thereby altering the power structure of the co-operatives. In the elections to the governing bodies money became such a powerful tool that the top posts of chairman and vice-chairman usually went to the richest farmers even though the majority of members were farmers with small or medium-sized holdings.



Co-operatives do not enjoy level-playing field vis-à-vis private retail chains in the country. It is well-known that business houses cannot be run on bureaucratic lines. Board members need to learn to take quick, appropriate and member-cum-customer friendly decisions. Traditional type of business of co-operatives must be conducted by competent and professionally-qualified personnel.

[c] Lack of Awareness: People are not well informed about the objectives of the movement, rules and regulations of co-operative institutions. Unfortunately, no special efforts have been made in this direction. People look upon these institutions as means for obtaining facilities and concessions from the government. Lack of education, dirty local politics, caste-ridden elections to the offices of co-operative societies, bureaucratic attitudes of the government officers at the lower rank are some of the hurdles in spreading the correct information about the Co-operative Movement and in educating the members about its true character and vital role in the society. It has been observed that a large number of members are not aware of the existence of byelaws, their rights and duties and the roles of office-bearers and management staff of the co-operative. Studies have shown that almost 90-92% of members of PACS in Uttar Pradesh have never seen copies of the byelaws of their own co-operatives.

[d] Inadequate Role of Promotional Institutions: To create awareness among co-operative members and general public, the promotional institutions like the National Co-operative Union of India and the State Co-operative Unions/Federations must take a stronger lead to implement member education programmes. Field studies have shown that the educational instructors and field projects are getting ineffective due to: [i] lack of programming for them; [ii] lack of funds; [iii] inadequate supply of support material; and, [iv] lack of trainers training programmes. At present NCUI's 40 field projects do not have any funds to carry out field activities, nor do they have any support material and work programmes. Also, much of the responsibility rests with the co-operatives themselves. They need to allocate some funds for

the education and orientation of their members. The scope of central-level Co-operative Education Fund needs to be revisited so that interested co-operative institutions and specialized agencies are able to generate training and educational materials.

[e] Restricted Coverage: The Co-operative Movement has also suffered on account of two important limitations on its working. One is that the size of these societies has been very small. Most of these societies are confined to a few members and their operations extended to only one or two villages. As a result, their resources remain limited, which make it impossible for them to expand their means and extend their areas of operations. Two, most of the societies have been single-purpose societies.

Such societies are unable to assess a total view of the persons seeking help, nor can they analyze and solve problems by themselves. The help these societies render thus cannot be adequate. By assessing the persons and the problems only from one angle, these societies neither help properly the person nor make an optimal use of their resources. Under these circumstances it has not been possible for these societies to make much progress.

[f] Functional Weakness: The Co-operative Movement has suffered from inadequacy of trained personnel. Lack of trained personnel has been caused by two major factors: [i] there has been a lack of appropriate institutions for training of personnel; [ii] due to unsatisfactory working of co-operative institutions, qualified and experienced personnel did not feel attracted or motivated. The functioning of the co-operative societies, too suffer from several weakness. Some of these are, not being careful of the need of credit-seekers or their repaying capacity at the time of granting loans, making no adequate provision for repayment of loans, unsatisfactory accounts keeping, factional politics in the management, lack of co-ordination among various divisions of the co-operative structure, too much dependence on outside sources of finance, lack of and untimely auditing and inspection. Thus there are several pitfalls. Poor infrastructure, lack of quality management, over-dependence on government, dormant membership, non-conduct of elections, lack of strong human resources policy, neglect of professionalism, etc. are the limiting factors. Indian co-operatives are also unable to evolve strong communication and public relations strategies which can promote the concept of co-operation among the masses.

[g] Misconceived Concentration of Power: Although co-operatives are democratic business institutions, yet the distribution and exercise of power at the Board level is a matter of concern. In general, the principal task of the Chairman of the Board is to conduct the meeting and assist in formulating logical business proposals and take appropriate decisions. The chief executive of the co-operative is given the task of implementation of such decisions. In many cases it has been found that the Chairman, due to self-interest, assumes both roles as leader of the organisation as well as that of the executor of the decisions taken. They become executives reducing the chief executive/managing director to execute the orders from the Chairman. Such a situation generates manipulation and serves self-interest. In a large number of small co-operatives, Chairmen are the bosses and the managers are mere clerks. To insulate the co-operative from such a situation, a careful study of byelaws is of great relevance where the rights and duties of chairmen and managers are clearly defined. It becomes necessary for co-operative enterprises to develop a proper chart of duties.

Conclusion

Neither private sector nor public sector shall promote social welfare. India requires meaningful reforms in the co-operative sector. Any sector to look after socio-economic development of a larger chunk of population should ensure: [a] Higher standard of living for the village people; [b] Production for mass consumption. Co-operatives should be considered an important plank of development. The co-operatives have inherent advantages in tackling the problems of poverty alleviation, food security and employment generation. Co-operatives have immense potential to deliver goods and services in areas where both the state and the private sector have failed. Member education programmes should not be mere philosophical or sermon-oriented activities rather they should have a proper blending of agriculture, human welfare and rural development subjects.

Consultant, IFFCO Foundation

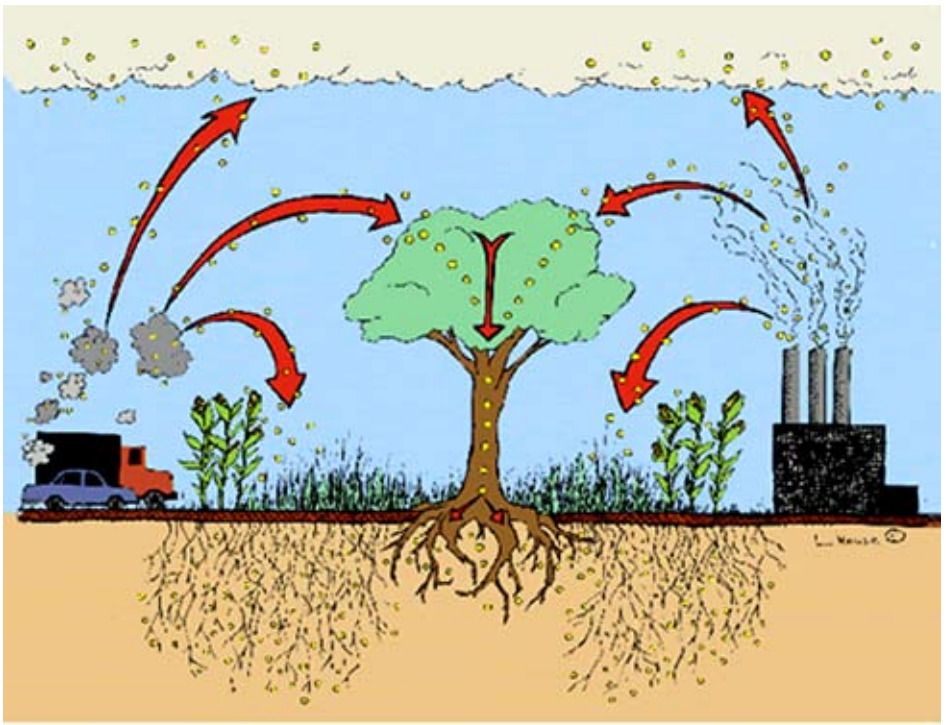
Soil Carbon Sequestering and Storing

A. Subba Rao and Pramod Jha*

Soil is the largest terrestrial carbon(C) pool, encompassing approximately two-thirds of the carbon in ecosystems. Also, mean residence time (MRT) of soil organic carbon pools have the slowest turnover rates in terrestrial ecosystems and thus carbon sequestration (Carbon sequestration is the long-term storage of carbon in oceans, soils, vegetation (especially forests), and geologic formations) in soils has the potential to mitigate raising concentration of CO_2 in the atmosphere. Soil C sequestration is the process whereby C is transferred from the atmosphere into soils. Furthermore, higher carbon stabilization in soil is benefitting the other ecosystem functioning like improvement in soil structure, water holding capacity, nutrient retention, buffering capacity and greater availability of substrates for soil organisms.

Organic matter is the vast array of carbon compounds in soil. Originally created by plants, microbes, and other organisms, these compounds play a variety of roles in nutrient, water, and biological cycles. For simplicity, organic matter can be divided into two major categories: stabilized organic matter which is highly decomposed and stable, and the active fraction which is being actively used and transformed by living plants, animals, and microbes. The amount of soil organic carbon (SOC) in soil depends on soil texture, climate, vegetation and historical and current land use/management. Soil texture affects SOC because of the stabilizing effect of clay on soil organic matter (SOM). Organic matter can be trapped in the very small spaces between clay particles making them inaccessible to micro-organisms and therefore slowing decomposition. In addition, clay offers chemical protection to organic matter through adsorption on clay surfaces, which again prevents organic matter from being decomposed by bacteria. Soils with high clay content therefore tend to have higher SOC than soils with low clay content under similar land use and climate conditions. Climate affects SOC amount as it is a major determinant of the rate of decomposition and therefore the turnover time of C in soils. In temperate grassland, high organic matter inputs combined with slow decomposition rates (determined by climate) lead to high SOC amounts, whereas in tropical areas, decomposition and the turnover of SOC tend to be faster, which result in poor buildup of soil organic matter (SOM).

Lal et al., (2004) computed carbon sequestration potential of Indian soils by assuming converting degraded soils to restorative land use and estimated a total potential of 39 to 49 (44 ± 5) teragrams carbon per year (Tg C/y). According to him, Indian soils have considerable potential of terrestrial/soil carbon sequestration. He estimated the soil organic carbon (SOC) pool of 21 Petagrams (Pg) to 30-cm depth and 63 Pg to 150-cm depth. The soil inorganic carbon (SIC) pool was estimated at 196 Pg to 1-m depth. The SOC concentration in most cultivated soils is less than 5 g/kg compared with 15 to 20 g/kg in uncultivated soils. Low SOC concentration in soil is attributed to plowing, removal of crop residue and other bio-solids, and mining of soil fertility. Accelerated soil erosion by water leads to emission of 6 Tg C/y. Important strategies of soil C sequestration include restoration of degraded soils, and adoption of recommended management practices (RMPs) of agricultural and forestry soils. Potential of soil C sequestration in India is estimated at 7 to 10 Tg C/y for restoration of degraded soils and ecosystems, 5 to 7 Tg C/y for erosion control, 6 to 7 Tg C/y for



Source: ERS/USDA

adoption of RMPs on agricultural soils, and 22 to26 Tg C/y for secondary carbonates.

Mechanisms for C stabilization in soils have received much interest recently due to their relevance in the global C cycle. The global soil organic carbon storage corresponds to 615 Gigatonnes (Gt) C in the top 0.2 m depth and 2344 Gt C at depths of up to 3 m, which is more than the combined C content of biomass and atmospheric CO2. It is the largest terrestrial C pool, encompassing approximately two-thirds of the C in ecosystems. Also, mean residence time of soil organic carbon pools have the slowest turnover rates in terrestrial ecosystems and thus C sequestration in soils has the potential to mitigate CO2 emission to the atmosphere. In 1992, the Kyoto Protocol on climate change demanded the fundamental understanding of the stabilization of carbon in soils.

What are C sink and source?

Soils are often C sinks, and sometimes C sources. A sink absorbs more C than it emits; a source emits more C than it absorbs.

Soil C sequestration and soil C storage

There is a difference between soil C sequestration and soil C storage. Soil C sequestration is the process whereby C is transferred from the atmosphere into soils. Soil C storage is the retention of sequestered C in the soil.

Soil carbon stock

The term soil C stock refers to the amount of C stored in the soil at any one time. Changes in stocks as a result of project activity are calculated as the difference between C stocks before and after that activity.

Soil carbon stabilization

Stabilization means the decrease in the potential loss of organic matter by microbial respiration, erosion or leaching (Sollins et al., 1996).

Soil carbon pools

The amount of organic carbon stored in soil results from the net balance between the rate of soil organic carbon inputs and rate of mineralization in each of the organic carbon pools described above. For soils to act as a sink, organic C needs to be stabilized in stable pools (Paustian et al., 1997). Process-based soil organic C (SOC) models are widely used for simulating, monitoring, and verifying soil C change. Ability of most of the SOC models to predict the carbon dynamics under long term studies depend upon the size of the soil carbon pools that are governed by first-order decay rates (Paustian, 1994; McGill, 1996; Basso et al., 2011). In majority of SOC models, SOC fractions are mainly divided into three main pools: active, slow, and resistant pool (van Veen et al., 1984; Parton et al., 1988). The active pool is assumed to be composed of microbial biomass and easily decomposable compounds (e.g., proteins and polysaccharides) from leaf litter and root-derived material with mean residence time (MRT) of few days to few years. The 'slow' or an intermediate pool consisting of structural plant residues and physically stabilized C, whose MRT varies from 10 to more than 100 years. The resistant or stable pool is considered to be composed of aliphatic compounds, often mineral stabilized, with MRT on the order of 1000 years (Trumbore 1997; Paul et al. 2001; von Lützow et al. 2006). The carbon model predictive capacity depends on estimates of these carbon pools. A particular challenge for regional model applications is to derive estimates of soil carbon pools. Lal (2004) computed the soil carbon pool of major soil orders of India by taking into account the data of Velayuthum et al., (2000) and Eswaran et al. (1993) and (1995). The organic carbon pool in soils of India and the world is presented in table 1 (adapted from Lal et al., 2004).

Table 1. Organic carbon pool in soils of India and the world is presented in table 1.

Soil order	India		World	
	0–30cm	0–150cm	0–25cm	0–100cm
	(Pg)	(Pg)	(Pg)	(Pg)
Alfisols	4.22	13.54	73	136
Andisols	–	–	38	69
Aridisols	7.67	20.3	57	110
Entisols	1.36	4.17	37	106
Histosols	–	–	26	390
Inceptisols	4.67	15.07	162	267
Mollisols	0.12	0.5	41	72
Oxisols	0.19	0.49	88	150
Spodosols	–	–	39	98
Ultisols	0.14	0.34	74	101
Vertisols	2.62	8.78	17	38
Total	20.99	63.19	652	1555

Strategies for soil carbon sequestration

One of the main options for greenhouse gas (GHG) reduction as identified by the IPCC is the sequestration of carbon in soils. Improving organic carbon content of terrestrial carbon pool by different agronomic measures like residue retention, application of organics, conservation of agriculture and reducing soil erosion have been documented by several authors. Lal (2004) broadly classify soil carbon sequestration strategy in two categories.

1. Land use change

a) Restoration of degraded lands- A

Table 1. SOC (%) content as affected by cropping system and residue addition at the end of three years of cropping

Cropping system	(-) residue	(+) residue
Continuous	0.64	1.51
Intercropping	1.06	1.45
Rotation	0.65	1.74

Source: Anyanzwa et al. (2010)

vast portion (120 m ha) of total geographical area of country is affected by various forms of land degradation. It offers an opportunity for storing carbon in soil by adoption of land restorative processes. The total potential of restoring degraded soils in India is 7 to 10 Tg C/y (Lal, 2004). Some of the important measures for land restoration and carbon sequestration strategies are green manuring, mulch farming/ conservation tillage, afforestation/ agroforestry, grazing management/ ley farming, integrated nutrient management/ manuring, diverse cropping systems etc.

b) Erosion control - Accelerated soil erosion depletes the SOC pool severely and rapidly. Soil conservation and water management, water harvesting and recycling, are important strategies of minimizing losses and restoring soil quality.

c) Retiring agriculturally marginal lands

2. Soil/vegetation management

a) Residue management

Incorporating plant residues is one means by which we can add organic matter to soil. Removal of crop residues from field is known to hasten SOC decline especially when coupled with conventional tillage (Mann et al. 2002). Incorporation of crop residues favours immobilization because of wide C/N ratio. However, long-term use (repeated additions) are known to improve organic C content (Table 1).

The extent of residue or crop cover left on the soil surface depends on the availability. In our country, there are great competing uses for crop residues as fuel or as thatching material or as feed. Therefore, crop residues are mostly disposed off from crop fields. In some situations, where they are available in abundance, crop residues are considered as waste material and disposed off by burning such as in the rice-wheat growing areas of north India.

b) Integrated nutrient management

Balanced application of inorganic fertilizer and organic amendments greatly influence the accumulation of organic matter in soil and also influence the soil physical environment. Soil organic carbon (SOC) was significantly influenced by the fertilizer and organic manure applied over 28 years of cropping (Hati et al., 2007). The results showed that the soil organic carbon (SOC) content in 100% NPK and 100% NPK + FYM treatments increased, respectively, by 22.5 and 56.3% over the initial level (1.14 kg m-2). Application of fertilizers in combination with manure resulted in greater accumulation and build up of SOC. This is because SOC is directly related to organic inputs.

c) Improved cropping systems

Principal mechanisms of SOC sequestration with Conservation tillage are increase in micro-aggregation and deep placement of SOC in the subsoil. Less tillage will influence the maintenance of C in un-decomposed residue and increase sequestered C in the soil. Incorporating plant residues is one means by which we can add organic matter to soil. Removal of crop residues from field is known to hasten SOC decline especially when coupled with conventional tillage (Manna et al. 2002). Crop rotations had significant influence on SOM content. Inclusion of legume in crop rotation resulted in build up of SOM. It is interesting to note that even in semi-arid areas where the cropping systems are mainly focused on water conservation, SOC improvements are noticed.

d) Pasture management

Biochar for soil carbon sequestration

The use of biochar as soil amendments is proposed as new approach for mitigating man induced climate change along with improving soil productivity. Biochar is a fine-grained, highly porous charcoal that helps soils retain nutrients and water. It is charcoal created by pyrolysis of biomass, and differs from charcoal only in the sense that its primary use is not for fuel, but for biosequestration or atmospheric carbon capture and storage. However, the use of biochar in agriculture is not a newer phenomenon. In primitive time farmers were using it for enhancing the production of agricultural crops. One such example is the slash and burn cultivation, which is still being practiced in some part of north-eastern India. Pre-Columbian Amazonian natives are believed to have used

Table 2. Terrestrial carbon management options (Adapted from Lal, R. 2008)

Management of terrestrial C pool	Sequestration of C in terrestrial pool
Reducing emissions	Sequestering emissions as SOC
Eliminating ploughing	Increasing humification efficiency
Conserving water and decreasing irrigation need	
Using integrated pest management to minimize the use of pesticides	Deep incorporation of SOC through establishing deep rooted
plants, promoting bioturbation and transfer of DOC into the ground water	
Biological nitrogen fixation to reduce fertilizer use	Sequestering emissions as SIC
offsetting emissions	Forming secondary carbonates through biogenic processes
Establishing biofuel plantations	Leaching of biocarbonates into the ground water
Biodigestion to produce CH4 gas	
Bio-diesel and bioethanol production	
Enhancing use efficiency	
Precision farming	
Fertilizer placement and formulations	
Drip, sub-irrigation or furrow irrigation	

biochar to enhance soil productivity and made it by smoldering agricultural waste. European settlers called it Terra Preta de Indio. Biochar can be used to hypothetically sequester carbon on centurial or even millennial time scales. In the natural carbon cycle, plant matter decomposes rapidly after the plant dies, which emits CO^2, the overall natural cycle is carbon neutral. Instead of allowing the plant matter to decompose, pyrolysis can be used to sequester some of the carbon in a much more stable form. Biochar thus removes circulating CO^2 from the atmosphere and stores it in virtually permanent soil carbon pools, making it a carbon-negative process. Some of the other measures outlined by Lal (2008) are mentioned in table 2.

Besides these measures, some important considerations for soil carbon sequestration are as follows.

1. It is important to take into consideration that each soil has a definite capacity of stabilizing soil carbon. Hence the difference of stabilization deficit could be the priority tool for selection or prioritization of land for soil carbon sequestration strategy.
2. The proportion of carbon stabilized would be greater in samples with larger carbon stabilization deficits and the relative stabilization efficiency would decrease as carbon input level increased. Therefore, the planners, policy makers and administrators should take into account of current status of soil carbon in stabilized pool and the capacity of soils to stabilize carbon. If a soil attains its upper limit of stabilized carbon pool, then further addition of organics may only lead to improvement in soil carbon in intermediate pool, which will be lost in due course of time.
3. In addition to increasing plant C inputs, strategies for enhancing soil C sequestration include reducing C turnover and increasing its residence time in soils (Jastrov et al., 2007). According to them two major mechanisms, (bio) chemical alteration and physicochemical protection, stabilize soil organic C (SOC) and thereby control its turnover. With physicochemical protection, biochemical attack of SOC is inhibited by organo-mineral interactions at molecular to millimeter scales. Stabilization of otherwise decomposable SOC can occur via sorption to mineral and organic soil surfaces, occlusion within aggregates, and deposition in pores or other locations inaccessible to decomposers and extracellular enzymes.
4. Soil structure is a master integrating variable that both controls and indicates the SOC stabilization status of a soil. One potential option for reducing SOC turnover and enhancing sequestration is to modify the soil physico-chemical environment to favour the activities of fungi. Specific practices that could accomplish this include manipulating the quality of plant C inputs, planting perennial species, minimizing tillage and other disturbances, maintaining a near-neutral soil pH and adequate amounts of exchangeable base cations (particularly calcium), ensuring adequate drainage, and minimizing erosion.
5. More research is needed, especially for the tropics, to more accurately capture the impact of region-specific interactions between climate, soil, and management of resources on C sequestration (Hutchinson et al. 2007). In this regard, simulation modeling of soil carbon dynamics will be of immense use for evaluating different cropping sequences for soil carbon buildup.

Director, Indian Institute of Soil Science

Research, Training, Extension and Education

Time for Restructuring Agriculture Regulatory Coordination

B. Yerram Raju

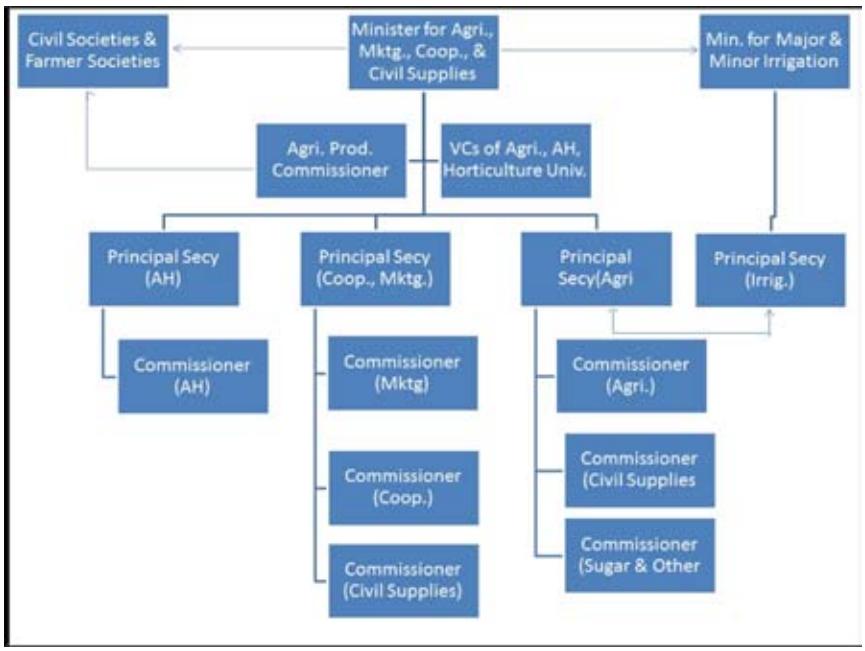
Lofty goals always keep the actions kicking. Andhra Pradesh hopes to post a 6.5 per cent growth in agriculture and the SGDP to leapfrog to 9.5 percent. By the end of the Twelfth Plan, production of 300mn tones of food is the hopeful target. The State needs such optimistic thinking and approach at this critical juncture. When one looks at the serpentine queues of the farmers for the seeds of any crop right at the sowing time, poor management of the farm sector stares at us. This is not the first year that the State has this predicament. In the marketing season, farmers bemoan of lack of space to store, and nobody to deliver the price for their season's hardship. We just witnessed in most market yards the paddy bags under sheets of water; not enough gunny bags to store; not even enough tarpaulins to store; no storage space in the existing godowns. Chilly farmers got their crop washed out in the untimely rains or burnt in well-designed cold storage warehouse disasters. The tenant farmers' rejoice at their right for institutional credit through the recently announced ordinance which hopefully results in the intended benefits – the only silver lining in this farm season, to site a good beginning. Why are all these happening for the last few decades? Why should farmers take to streets to fight for their basic production rights? Are there no remedies? Do these questions not beg of us to look at the fundamentals of administrative architecture of this most important sector on which 60 percent of the population still depends for their livelihood?

Unlike anywhere else in the world, farm and allied sectors are looked after by at least fourteen ministries and a host of organizations heavily bureaucratized: Ministry of Agriculture; Ministry of Animal Husbandry, Dairy Development, Fisheries; Ministry of Major and Medium Irrigation; Ministry of Cooperation; Ministry of Revenue, Relief and Rehabilitation; Ministry of Finance; Ministry of Food & Civil Supplies; Ministry of Marketing & Warehousing – at the State level and Ministry of Agriculture and Cooperation, Ministry of Food Processing; Ministry of Finance; Ministry of Forests & Environment; Ministry of Commerce and Trade; Ministry of Food and Civil Supplies at the Central Government level. There is State Planning Board and the Union Planning Commission at the helm to decide on many issues that concern all these ministries. Each Ministry has its regulatory strings to apply on the farmers because each is an empire unto itself and there is no coordination among them at the beginning of the agriculture season. Planning Commission long back seized to be a coordination agency. It is content with preparing grandiose plans and allocating limited resources through discussions at the National Development Council. Exigencies of politics predominate over economic necessities.

In Agrarian States like Andhra Pradesh, a beginning could be made in reorganizing the ministries and bringing the departments of agriculture, horticulture and allied activities like animal husbandry, fisheries, that deal with production, cooperation, marketing and civil supplies that deal with distribution under single Minister who should have full comprehension and empathy for the farmers. The organisational structure could be as follows:

This would mean that the number of ministries at the State level would be reduced to one from the existing four. There is a peer level relationship between the civil societies, farmers' associations on one side and the Minister for Irrigation on the other. Likewise, the APC would have a peer level relationship with the Vice Chan-

ORGANISATIONAL CHART OF THE STATE MINISTRY OF AGRICULTURE



cellors of the Agriculture Universities. At the beginning of the season, all the above functionaries would have a meeting with all the functionaries in the chart for a day or two. In this coordination meeting presided over by the Minister, Agriculture Production Commissioner who is of the rank of Additional Chief Secretary, is expected to be fully informed of all the links in the supply chain in production and value chain management in agriculture right up to the distribution end and would be in a position to format the decision making process depending upon the various issues that come up for discussion. The Minister can also invite the principal secretary (Energy) and Principal Secretary (Information Technology) for the half-yearly meetings to take into consideration the issues and facilitation that could come from them to the farmers during and off the season. Principal Secretary (Agriculture) should be the Member-secretary for this coordination panel. He would draft the minutes within the next twenty-four hours and arrange for issuance of appropriate instructions for all these line departments to follow implicitly and the concerned departmental heads would be squarely responsible for any and all lapses in implementing them. During the week that follows, the State Level Bankers' Committee should be convened to cause the financial arrangements to be put in place. This mechanism would expand the burden of implementation on those who are actually responsible. Transparency, Accountability and Governance would significantly improve.

Whenever the disasters occur, emergency meeting shall be held to take collective decision for coordinated implementation at the field level through the District Collectors. The Minister for Revenue would coordinate with the Minister for Agriculture in situations of natural calamities and other disasters.

AGRICULTURE BUDGET: These measures would make a significant departure from each department pulling in different directions making the farmers cry loud both at the beginning and end of the season. Further, the State like its immediate neighbour, Karnataka should put up Annual Agriculture Budget every year preceded by presentation of Agriculture Survey of the State done by the Agriculture, Animal Husbandry and Horticulture Universities. Agriculture Budget would specify the direction of expenditure into subsidies, distribution and revenues that come from marketing Cess and other sources and the deficit or surplus that it projects. The farmers would know by the end of February every year, what the State is up to.

The State would also have the pride of taking leadership once it ensures success of this model. The Rythu Chaitanya Yatras, Polam Badi, Atma, AIBP would automatically be integral to the whole effort and would be in a position to deliver results to the farmer. This would also help in reducing unnecessary expenditure in multiple delivery points in meaningless directions. Chief Minister Kiran Kumar Reddy, young and dynamic and sportive as he is, would be able to lap up electoral benefits from the largest voting constituency, viz., the farmers and could also win the hearts of the opposition. What matters, of course, is the courage to dispense with three Ministers!!

**** Economist and Member, Expert Committee of Cooperative Banking, Govt of AP. ,***
The views are personal.

Innovation, Partnerships & Progressive Policies: Imperative for A Transformed Agriculture Driven Growth in India

Sekhar Natarajan

Meet Chinthi Reddy, a young farmer who lives in Warangal, Andhra Pradesh and cultivates cotton seeds with Bt technologies on the five acres he owns. "Life has never been so good," he says looking at his tall standing cotton crop. Reddy has installed drip irrigation on his field at an investment of Rs. 70,000 and sent his son to the UK for MS studies in 2008. With his earning of Rs. 20,000 per acre on his cotton fields and savings of Rs. 7,500 per-acre in lesser pesticide use he has purchase more land for farming.

Reddy's story resonates with that of 60 lakh farmers who plant cotton with insect-protection technologies across India. More importantly, this is a story of the power of technology that led to the transformation of cotton farming in India since 2002. Across the large cotton growing states, Bt cotton technology seeds are improving the lives of Indian farmers by providing them with insecticide savings, higher yields, higher income, and helping them live lives of dignity.

Like Reddy, every Indian farmer growing any crop wants only three things: cutting edge technology seeds, higher yields, and a good price for his crop. That's exactly what India's Bt cotton revolution delivered for him, despite the challenges.

We have a unique opportunity. Given the spirit of our entrepreneurial farmers, the scientific talent in our agriculture industry and universities, and the second-largest farming acres globally, if we can increase crop yields sustainably, we can achieve food security domestically and be a positive contributor to helping meet the world's agricultural needs. However, India itself is ranked among the lowest in human development index mainly owing to malnutrition, poor social infrastructure especially in areas of education and healthcare.

The World Bank, the Planning Commission, the National Council for Applied Economic Research (NCAER) have arrived at a broadly similar conclusion that 300 million to 400 million people in India live below the poverty line – meaning they do not have enough to eat and to care for themselves. At the current prices and rate of inflation, it is anybody's guess what would be the number of India's poor.

Currently, we seem to be facing a situation similar to the 1960s, but with a difference. Then the country did not have enough food supply. People suffered. Now there are food items in the market, but almost 70 per cent of the people find it hard to afford them. For 30 per cent it is impossible to buy any food with the limited money at their disposal. Between 1960 and 2010 real-term food scarcity is a stark reality.

Between November and December last year, the prices of vegetables escalated by as much as 50 per cent. The major reason for the current food price inflation was unseasonal rains during the harvest of several food crops including rice, wheat, onion and garlic. Imagine just one crop failure or limited arrivals in a single season has disastrously thrown off track the country's food supply chain and made them inaccessible to the common man, e.g. prices of tomatoes rose by a whopping 125 per cent, brinjals by 110 per cent and onions by 65 per cent since November 2010.

The spectre of climate change threatens agriculture, especially in developing countries where farming is dominated by small scale farmers heavily relying on rainfall. Erratic weather also means continued challenges of pests across crops. Since there are indications that the tropics are slated for more catastrophic climatic changes - more floods, longer droughts, and salinity of water because of sea water incursion - is this the beginning of an alarming situation that could emerge in the near future?

Shortage and expensive labour and price increase on other fronts, especially of petroleum products will also affect food prices. Even marginal shortages will spur price spiral. These concerns catalyze trends further deteriorating global food security.

It is time for introspection. Let us not be over-optimistic of meeting our challenges with existing tools. The fundamental questions are - Is our food policy for production and productivity increase, storage, distribution, pricing and food subsidy scheme appropriate and in the right direction for the future? Are we confident that our present approach to food production methods and the attitude towards newer technologies will ensure enough food for the present and future generations?

The scarcity of the 1960s led to the Green Revolution of the 1970s which ensured the national granaries were full and all had enough food. The public distribution system had enough grains for the marginalized too. However, the challenges on the food front in the new millennium are entirely different.

One of the key solutions to these challenges is agricultural innovation: produce more and conserve more, and thereby improve farmer lives. With rainfall being the most critical factor determining the future of farmers and the economy, there is a dire need to adopt corrective measures soon, along with a sustainable and efficient method of farming, planting seeds with higher yields, and using limited resources.

It is estimated that improved agronomic practices can increase yields by about 50 per cent, while crop improvement can increase yields by more than 50 per cent. All these measures like minimizing wastage in supply chain, improving the productivity of land, water and saline soils, improving agronomic practices and crop improvement have to be used as a package to make adequate food available to our growing population in the next 25 to 40 years. No single measure can help us to achieve full success.

Private players have been focusing on countering these adverse realities with technology, partnering with governments and farmers to improve farm productivity and food quality, thus tackling food scarcity.

Monsanto's worldwide three-point commitment to grow yields sustainably focuses on developing better seeds by helping farmers double yields, conserve resources like land, energy, fertilizer and water up to one-third per unit of output and improve farmers' socio-economic conditions. Our partnerships in India have already begun to demonstrate positive, impactful results in Rajasthan, Gujarat, amongst others. In key cotton-growing states like Maharashtra, Gujarat, Andhra Pradesh and Punjab, the cotton farming scenario has depicted radical change, thanks to Bt cotton.

The technology-induced turnaround has also been witnessed in Burkina Faso, Africa which falls at the bottom of the pyramid in terms of the overall development index. Commercial Bt cotton plantation has shown an unprecedented 14-fold year-to-year increase - from 8,500 hectares in 2008 to 115,000 the following year.

Genetically enhanced seeds were introduced in the world in 1996. In 2010, a record 15.4 million farmers in 29 countries planted 148 million hectares of biotech crops, with 90 per cent, or 14.4 million being small and resource-poor farmers in developing countries. This share has been growing very rapidly in the last five years as the acceptance of GM crops has gone up substantially.

Intensive and innovative scientific research and technology are critical to develop better seeds that have the potential to increase crop productivity by 15-40 per cent. To ensure sustainable supply of higher quality seeds, the seed industry has made a high upfront investment of over Rs. 6,000 crores in R&D and infrastructure over the last 20 years alone. Many companies invest around 8 – 15 per cent of their revenue in R&D involved in developing new high income generating seeds for varying farming conditions.

Private and Public sector seed

researchers continue to invest heavily to develop seeds to deal with climate changes (drought-tolerant), input supply shortages (nitrogen-efficient seeds in case of less fertilizer) and farm labour shortages (weeding options etc.). Farmers need improved high-yielding seeds and increased choice of locally-suited seed varieties to augment the farm productivity and income. India needs technologically empowered flood and drought resistant, salinity tolerant, targeted pest-resistant food crops (rice, wheat, vegetables and fruits) to feed its people and livestock.

As we prepare ourselves for becoming an economic superpower, we must expedite socio-economic reforms and take steps for overcoming institutional and infrastructure bottlenecks inherent in the system. We must create a free market approach to technology development that encourages R&D, innovation, competition, and choice is created. This must also be supported by a science-based and predictable regulatory policy coupled with strict enforcement of Intellectual Property Rights (IPR).

A strong public research network and vibrant seed market in the private sector are the two advantages for our country in the field of modern biotechnology. The immediate task is to integrate the tools of biotechnology in a comprehensive agricultural research and development program. The collaborative efforts between agricultural institutes and other research institutes have to be stepped up so that complementarities and economies of scale can be exploited across crops.

Imagine the potential for our farmers to replicate the Indian cotton success story on 88 per cent of the remaining crops to meet the world's needs. For this to happen, they need to have access to cutting-edge agriculture technologies, agronomic education and market linkages to help them remain globally competitive. We believe we can compete in the global market with agri-commodity powerhouses like Brazil and Argentina. We need to revive, modernize, and make agriculture accessible to markets and sustainable, to empower India to seek its rightful place on the global map.

It is time for us to bring together its resources to chalk out strategies to light these challenges and decide on remedies to ensure food supply at affordable rates. We have to look ahead and partner for the sustainability of agriculture, enhancement of food productivity and production, and enrichment of the nutritional value of the grown food crops. Decision-making on policies and technologies for food production and productivity increase is a collective effort.

By adopting available and new, emerging technologies, with its scientific and technical capability, our country has a huge opportunity to feed not only its millions, but the other millions starving in South Asia and Africa. Already 14 million farmers in 25 countries are raising biotech crops, both for food and fibre, in over 134 million hectares. The numbers are increasing.

The world looks to farmers to do more than just produce food. Agriculture is also central to reducing hunger and provides many, the main route out of poverty. We need to look at ways to boost yields of rice, wheat, sugarcane, pulses, cereals which need immediate investment and collaboration, consider the constraints of land and water and the use of fertilizer and pesticide, assess biofuel policies, explain why technology matters so much and examine the impact of recent price rises.

The power of plant technologies cannot be denied – it helped put our nation in an enviable position by lifting India to the position of world's second largest producer and exporter of cotton; from being a large importer until 2002. Seed biotechnology has emerged globally as the most potent agri input to balance farmer growth and environmental sustainability. It provides solutions for sustainability as it enhances food, feed, and fiber crop production; promotes resource conservation and energy efficiency; reduces the environmental footprint of agriculture using lesser water, land, and energy; improves economic viability for farmers and communities; and advances agriculture product safety.

We envision a prosperous India where inclusive growth means agriculture yield-led growth that improves farmers' lives and helps us also become a contributor to global agriculture needs.

Chairman - Monsanto India Limited

Role of Geo-informatics and its Applications Towards Agricultural Development in India: Some Key Issues

Dipak Sarkar

Agriculture in India is the pivotal sector for ensuring food and nutritional security, and supports 18% of world human population on only 9% of world's arable land and 2.3% of geographical area. About 57% of the total land area in India is under agriculture as against the world average of 11.5% (ICAR , 2011).Agricultural contribution in the Gross Domestic Product (GDP) is declining in India, which in 2008-09 touched at 15.7% from about 30% in 1990-91. During the last two decades, the average annual growth of agriculture sector was less than half (around 3%) of the overall average growth of the economy (6 - 7%) (NAAS, 2009). Global food demand is expected to be doubled by 2050, while global production environment and natural resources are continuously shrinking and deteriorating. There are projections that demand for food grains in India would increase from about 230 Million tonnes presently to 350 Mt in 2025 in order to feed the projected population increase of about 1.4 billion from 1.1 billion presently. (ICAR&NAAS, 2010, www.iiss.nic.in).

Since quite some time, agricultural sector as a whole has been confronted with numerous challenges linked to food and energy crisis and degradation of natural resources coupled with climate change. Inter-Governmental Panel on Climate Change (IPCC) has projected that by the end of this century, global earth temperature is likely to increase by 1.8° to 4.0°C leading to more frequent hot extremes, floods, droughts, cyclones, and recession of glaciers. Therefore, producing enough food for increased demand against the background of changing climatic scenario is a major future challenge. Alternate land use planning viz. agro-forestry, agro- horticulture, agro-horti-silviculture etc. in conformity with location-specific biophysical and socio-economic environment based upon land capability, irrigation potential, detailed soil characteristics and agro-ecological set up is the need of the hour for maintaining the equilibrium between demand and supply as well as mitigating the impact of climate change.

It is also a matter of serious concern that the net cultivated area of about 141 million hectares (46% of the Total Reporting Area) has remained static for the last 40 years and about 43 million ha land (14% of the TRA) is not available for cultivation, of which about 6% is barren and uncultivable land and about 8% is used for non-agricultural practices, which also is in the increasing trend (GOI,2008, Sarkar et al. 2009). Deforestation has reduced our forest cover down to 23%, which is 10% below the standard ecological norms of 33% (Ahluwalia 2006, Samra 2006). Furthermore, the present food grain production is also lagging far behind the population growth rate; the chief reason for this dismal situation is the deterioration in soil health and its productivity. The National Commission on farming headed by Prof. M.S. Swaminathan, therefore recommended the topmost priority to enhance soil health for accomplishing the much needed second green revolution in India (Yadav and Sarkar, 2009).The need for second green revolution in India is also echoed recently by Dr. Manmohan Singh, the Hon'ble prime minister of India while delivering address in 83rd ICAR Foundation Day Lecture at New Delhi on 16 July, 2011(www.icar.org.in), where he stated –"To increase the food production to meet future demands, we clearly need a second green revolution that is broad based, inclusive and sustainable; we need to produce more without depleting the natural resources any further, and we look towards our agricultural scientists for ushering this in".

Since the 21st century is proposed to be a knowledge century, we should not lag behind in triggering the next phase of the Green Revolution by adopting knowledge-intensive precision-farming-based technologies, which are applicable under our conditions, so that agricultural sustainability and profitability can be assured while at the same time the natural resources are conserved.

The adoption of major technological developments in agriculture by the farmers generally takes much time and effort in our country where majority of the farmers are small and marginal, illiterate and resource-poor. This will be particularly so in the case of adoption of knowledge-intensive precision-farming-based technologies. But we must get started to face the challenges of the World Trade Organization (WTO), to compete with the developed world (Sharma,2004).

National Agricultural Policy vis-a vis role of Geo-informatics

The national policy on agriculture seeks to utilize the vast untapped growth potential of Indian agriculture, strengthen rural infrastructure to support faster agricultural development, promote value addition, accelerate the growth of agribusiness, create employment in rural areas, secure a fair standard of living for the farmers /agricultural workers and their families, and face the challenges arising out of economic liberalization and globalization. Technically sound, economically viable, environmentally non-degrading and socially acceptable use of country's natural resources – land, water and genetic endowment to promote sustainable development of agriculture is the ultimate goal. Geo-informatics technologies will help in achieving some of the goals (Marwah,2003).

Geo-informatics is a fast emerging science encompassing the modern tools of Remote Sensing (RS), Geographic Information System (GIS), Global Positioning System (GPS) and simulation models. Combination of these technologies provides a cost-effective means of acquiring high resolution real time data through remote sensing, data management and analysis through GIS and geo-referencing the ground truth data with GPS, putting all data in an information system and utilization of the information for a specific purpose. The key element that differentiates geo-informatics from other areas of information technology is that, all input data are being geo-coded i.e. has an address in 3-D space and is linked to some locality on the surface of earth. Thus, geo-informatics is nothing but application of information technology for the study and management of earth resources (Sharma, 2004).

The advancements in the field of computer tech¬nology, image processing, GPS and mathematical morphology have resulted in the devel¬opment of GIS technology for storage, retrieval, management of spa¬tial data (e.g. maps derived from

remotely sensed data, etc.), attribute data (e.g. soil properties, cli¬matic parameters, etc.) and other related ancillary information more efficiently. The GIS proved to be an effective tool in handling spatial data available at different scales, voluminous point data such as soil information, rainfall, temperature, etc. and socio-eco¬nomic data and to perform integrated analysis of data on various resources of any region with a view to arriving at optimum solutions for various problems.

In India, GIS is being used in various fields such as in optimizing land use plans, assessment of crop wa¬ter requirements, development of degraded and wastelands, management of salt-affected soils, quantification of soil loss to suggest suitable conservation practices, evalu¬ation of soils for alternate land use (ICAR & NAAS, 2010) .Furthermore, GIS hold promise in soil health monitoring through mapping of soil quality parameters, providing information regarding spatial distribution of important soil properties viz. pH, EC, organic carbon, soil texture along with major and micro soil nutrients towards identifying of site-specific problems regarding soil fertility/ acidity/salinity and their management practices for alternate land use. Mapping of soil contaminants (arsenic, selenium, fluoride, etc.) with a view to mitigating ground water and soil contamination of the same, mapping of soil carbon in the present context of climate change and its subsequent effect on soil, water and biota in addition to multi-criteria based decision making (programming) for land evaluation towards land use planning at various levels (watershed/district etc.) are also accomplished successfully by the use of GIS (Sahoo, 2010).

Geo-informatics aided approach towards soil resource mapping

The natural resources sectors are immensely important to India's economy. Optimal exploitation of the resources (both renewable and non-renewable) with proper enriching mechanism calls for cutting across the narrow confines of sectoral approaches and taking a holistic view of the region. Induction of scientific tools and techniques like RS, GPS and GIS are essential for holistic analysis of whole gamut of resources and quick retrieval of the data (Sharma,2004).

Satellite based remote sensing data and the GIS have emerged as vital tools in soil resource inventorying through generation of huge

information which are effectively utilized to characterize soil, identify soil productivity constraints, relate crop growth with soil productivity parameters, delineate soil acidity, soil salinity, water logging and also to make impact assessment for soil conservation measures towards evolving the optimum land use plan of an area.

The availability of high resolution data from Indian Remote Sensing (IRS) satellites viz. Resourcesat and Cartosat, has opened avenues for quicker and more reliable soil resource mapping at large-scale for district and village level planning. Moreover, a unique concept of Integrated Mission for Sustainable Development (IMSD) has been evolved wherein the satellite imagery data are integrated with the socio-economic data obtained from conventional sources to achieve sustainable development. The IRS data is also used for urban planning, flood prone area identification and the consequent suggestions for mitigation measures. The RS techniques have demonstrated their potential in providing information on the character and distribution of various natural resources. Possible application areas related to agriculture are management of land and water resources, crop acreage and production forecasting, crop condition assessment and assessment of damage caused by floods, droughts, crop epidemics etc.

The National (Natural) Resources Information System (NRIS), launched by the Department of Space, Government of India, is oriented towards providing information on natural resources related to land, water, forests, minerals, soils and socio-economic information such as demographic data, amenities, infrastructure etc. to the decision makers. The integration of these sets of data would aid the decision making process and help in achieving sustainable development goals of IMSD.

GIS-aided mapping of degraded and wastelands in India

Land degradation refers to a temporary or permanent decline in the productive capacity of the land and

is one of the most important global issues for the 21st century because of its adverse impact on agronomic productivity, the environment, its effect on food security and the overall quality of life (Eswaran et al 2001, Sarkar, 2002). According to the Global Assessment of Soil Degradation (GLASOD), soil degradation is a process that describes human-induced phenomenon that lowers the current and/or future capacity of the soil to support human life (Oldeman, 1988). Wasteland is described as "degraded land which can be brought under vegetative cover with reason¬able effort, and which is currently under-utilized" or as "land which is deteriorating for lack of appropriate water and soil management or on account of natural causes"(www.dolr.nic.in).

Assessment of the degraded and wastelands in the country has been gaining attention of the planners as need of land by different users are increasing and agricultural lands are shrinking because of degradation. The harmonized area statistics of degraded and wastelands of India based upon GIS mapping is reported to be 120.72 m ha, of which water erosion alone accounts for about 68% followed by chemical degradation (20.5%), wind erosion(10.3%) and physical degradation (0.9%) (ICAR & NAAS, 2010).

Geo-informatics for Precision Agriculture (PA)

Precision Agriculture employs a system engineering approach to crop production where inputs are made on an "as needed basis," and is made possible by innovation in Information and Communication Technology (ICT) such as computers, RS, GPS, GIS and automatic control of farm machinery. It is a holistic approach to manage spatial and temporal variability in agricultural lands at micro level based on integrated soil- plant information, and engineering management technologies as well as economics. Fundamentally, Precision Agriculture acknowledges the conditions determined by soil resources, weather, and prior management for agricultural production. It is well known that soil resources and weather vary across space and over time. Given this inherent variability, management decisions should be specific to time and place rather than rigidly scheduled and uniform. Precision agriculture provides tools for tailoring production inputs to specific plots within a field, thus potentially reducing input costs, increasing yields, and reducing environmental impacts by better matching of inputs applied to crop needs. Modern technologies used in precision agriculture cover three aspects of production: (a) data collection or information input, (b) analysis or processing of the precision information, and (c) recommendations or application of the information (Sahoo, 2010).

Components and Framework for

Precision Farming (PF)

Precision farming is essential for serving dual purpose of enhancing productivity and reducing ecological degradation. Precision Farming, basically, is characterized by reduced cost of cultivation (through optimization of inputs), improved control and increased resource use efficiency, through appropriate applications of Management Information System (MIS). While the reduced cost of cultivation is achieved through optimization of agricultural inputs taking into account economic push and environmental pull related factors, the control mechanisms are introduced by the help of Variable Rate Technology (VRT) systems, model outputs and conjunctive use of RS, GPS and GIS. The MIS comprises Decision Support Systems (DSS), collateral inputs and associated GIS databases on crops, soils and weather. Dynamic RS inputs on in-season crop conditions, crop simulation model outputs on the potential production under the different constraints scenario, and the network of labs and farms, form the essential components of MIS. Increased efficiency does not employ only efficient resource use but also reflects in terms of less waste generation, improved gross margin and reduced environmental impact. Precision Farming thus calls for the use of appropriate tools and techniques, within a set of the framework as mentioned, to address the micro-level variations between crop requirements and applications of agricultural inputs. Inevitably, it integrates a significant amount of data from different sources; information and knowledge about the crops, soils, ecology and economy but higher levels of control require a more sophisticated systems approach. It is not simply the ability to apply treatments that are varied at the local level but the ability to precisely monitor and assess the agricultural systems at a local and farm level (Sahoo,2010).

Site Specific Nutrient Management (SSNM) - A Step Forward Towards Precision Agriculture

Inadequate and imbalanced fertilizer application causes degradation of natural resources due to, steady decline in productivity for vast cereal areas, depletion of soil fertility (nutrient mining),multi-nutrient deficiencies , decline in farm profit, loss of soil organic carbon, increasing soil acidity, increasing soil salinity/sodicity, declining ground water level, arsenic contamination in pockets, drainage congestion etc. This results in stagnating and/or declining crop yields, declining nutrient use efficiency, decline in soil health (Soil quality),environmental pollution and nutrient imbalance in soil due to not supplying optimum dose as per crop / site requirements The approach in mitigating the concerns encompasses adoption of more knowledge intensive nutrient management in a site-specific mode (SSNM) in the back ground of diverse agro-ecologies depending upon potentials and constraints of soils/soil health status, requirement of crops and/or cropping sequence (s)/land use.

Site Specific Nutrient Management (SSNM) is a Geo-informatics based approach (GPS, GIS, RS and Sensors) as opposed to blanket fertilizer recommendation followed over an extensive area irrespective of soils, crop (s) and/or cropping sequence (s)/ land use concerned and this is a step forward towards precision agriculture. The site specific mode takes into account the spatial variations in nutrient status cutting down the possibilities of over use or under use of the costly inputs. A systems approach with well developed analytical frame works, data bases and powerful simulation models help in further improvement of the SSNM approach. The essential pre-requisite for SSNM is GPS and GIS aided mapping of soil properties especially soil nutrients that will provide information on changing soil fertility status under different crop and/or cropping sequence under diverse agro-ecologies together with scope of further monitoring and updating of databases. The activities involved comprise of soil nutrient mapping based upon geo-referenced soil sampling, laboratory analysis for generating dependable analytical data and database structuring in GIS environment/Decision Support System (DSS)

Notwithstanding the need for Precision Farming, the success stories pertaining to Precision Agriculture have been mainly drawn from the developed countries; wherein agriculture is characterized by highly mechanized and automated systems, and is driven by market forces and has been a professionally managed enterprise. Taking into account the predominance of fragmented land holdings, heterogeneity of crops and livestock and concept of farm families in the rural conditions, the model of Precision Agriculture representing the typical Indian agricultural scenario is yet to evolve. While the ecological integrity of farming systems is an imperative need, it is equally important to extend the access of information and market to the small and marginalized farmers. Hopefully, the geo-informatics based Precision Agriculture model for India while addressing these issues would provide an innovative route for sustainable agriculture in globalised and liberalized economy.

Director, National Bureau of Soil Survey and Land Use Planning (ICAR), Nagpur

Information and Communication Technologies in Agriculture

Dr Gopi Ghosh and Ms Deepika Anand

Agriculture has made a significant contribution to India's development over the past four decades, with impressive contributions to food security and poverty reduction. However, the real challenge for the development practitioners remains to sustain the food production levels taking into account the incremental population pressure, urbanization, dietary changes due to enhanced income and increased risks due to climate change and related factors. Moreover, production efficiency and competitiveness, small farmer's viability, shrinking land and water resources, food quality and safety, knowledge and information disparities, increased uncertainties etc continue to be critical bottlenecks.

Still, there remains significant scope for improving performance of agriculture; the main source of livelihood for majority of the poor in India. An emerging tool for achieving faster socio-economic development is through the application of Information and Communication Technologies (ICTs) in areas such as agriculture, environment and natural resources, health, education and governance. Many of these initiatives demonstrated encouraging potential of ICTs in improving efficiency and effectiveness of development interventions benefiting rural communities significantly. As the objective of the Twelfth Plan is set as "Faster, More Inclusive and Sustainable Growth" with better performance in agriculture identified as one of six areas, ICT has to play a stellar role in rural transformation and sustained growth in agriculture.

ICT simply means using any technology to handle information and facilitate communication. Besides Information technology (computer, internet, hardware etc) it includes telephony, broadcast media such as radio, television, cinema and all kinds of audio and video processing and transmission and network based control and monitoring functions. With various proximal and remote sensing applications (GIS, GPS, Geo-spatial modeling, sensor technology, wireless sensor network-WSN etc) and other technologies – both extant and emerging – the ICT provides unique solutions through improved information and communication in the rural domain. Such applications are to be comprehensive; with its potential to benefit agriculture along with other interconnected areas of health, education, governance or employment.

Focus of application of ICT in Agriculture has to cover a range of commodity and farming sub-sectors – food, fiber, fodder, fruits & vegetables, spices, plantation crops, medicinal plants, livestock, dairying, fisheries, forestry, sericulture, apiary. Similarly, it can also be seen in terms of a host of agri-business functions - production processes and planning, land, water and nutrient management, plant protection, animal health care, procurement, grading, storage, transport, processing, trade & marketing, conservation of natural resources, research, education, training and so on.

Historically, Radio (All India Radio) has been disseminating wide range of development information since post-independence. Over the years, 'Krishi Vani in Hindi, 'Ponthottam' in Tamil , 'Ask the expert' through phone in programme, and recently 'Gyan vani' through FM radio stations made good inroads into farm heartlands. Slowly, community radios have emerged to broadcast locally relevant information through narrow-casting and cable casting. Uttarakhand has several such initiatives; besides many NGOs in the South pioneered in this area.

Dr Gopi Ghosh

National TV stations stepped in later to broadcast programmes relevant to local farmers and rural communities – at times targeting the rural women, children and youth. The Krishi Darshan and Kalyani - the health magazine of Doordarshan - have been well received programmes. Enadu TV's 'Jai Kisan', Etv's 'Annadata', IITM_K's 'Krishideepam', 'Pon Vilayum Bhoomi' by Podhigal TV, 'Malarum Bhoomi' by Makkal TV are some other examples. With the proliferation of TV stations, many rural outreach initiatives have diversified in contents and purpose; with encouraging partnerships and critical technical support from many education and development institutions across the country. Similarly many print media, state departments and agricultural universities bring out farm magazines and information booklets in local languages to cater to the demands for timely and value added information and services.

New ICT revolution since nineties, in the form internet, telecom networks and mobile technology has opened up several avenues in the way information is accessed, managed and disseminated. India has the second largest net work of telephone connection covering every part under telecom services. IT and ITES have been leapfrogging. The country wide communication network NICNET by

the National Informatics Center (NIC) offered wider access of such technology and database.

The Common Service Centers (CSC) conceived to be the front end delivery interface for web-enabled public, private and social services are expected to change the face of rural India. National NIC Portal attempts to provide a single window access to over 7000 websites and portals associated with almost every government constituents – both central and states. AGRISNET (Agricultural Information System Network), SEEDNET and DACNET from the Ministry of Agriculture, and many state level ICT initiatives in Odhisha, Gujarat, TN, AP, Rajasthan, Maharashtra, UP, Bihar, MP and others have achieved significant milestones in enabling access of knowledge and information to common people - improving livelihoods, governance, and inclusion. Many public, private, NGO and cooperative initiatives, namely, e-chaupal, e-krishi, e-sewa, e-sagu, i-kisan, knowledge center initiative of MSSRF, Kisan Kendras of Mahindra, Rallis and Tata, EID Parry, NDDB, Gyandoot, Tarahaat, Warna project, etc are quite popular with the populations they serve.

Several portals under NICNET have accessed, stored and made information over a range of topics from soil nutrients, crop management, pests and diseases to market and prices. C-DAC has initiated India Development Gateway having a range of agricultural information. AGMARKNET, KISSAN, i-Kisan, Agri-watch, Indiaagronet, Agropedia and others manage portals having good on-line information for various clienteles. Kisan Call Centers provide information through telephones to farmers through a nation-wide toll free numbers (1800-180-1551) in local languages. Several variants of call centers operate in States (TN, AP). Knowledge banks and knowledge networks such as the Honey Bee network, Haritgyan, Indian Society of Agribusiness Professionals (ISAP), and various thematic e-groups in Google and Yahoo, tend to share specific information in different ways. UN Agencies have initiated Solution Exchange that offers a neutral platform to share knowledge for crafting practical solutions for daily problems in many development fields. Alongside Communities in Water, Climate Change, Maternal health, ICT etc., the Food and Nutrition Community seeks to exchange experience and knowledge amongst practitioners in food, agriculture and nutrition. It has been managed by FAO for the past six years.

The astounding outreach and phenomenal growth of emerging mobile telephony network has opened up an amazing vista. Use of ICT becomes highly affordable and effective in customized content delivery to the farmers at their convenience. McKinsey believes that "India has an opportunity to lead the world by becoming the first truly mobile digital society. As the cost of network access and handsets is going down, wireless networks are going up, and Indian consumers are displaying an insatiable appetite for digital services. In addition, bypassing the personal computer -moving straight to widespread mobile access - simply tends to sidestep a host of hurdles associated with delivering affordable Internet services to a population that is geographically dispersed and relatively poor, in a country where infrastructure development can be problematic." In the not-so-distant future, we may see appreciable progress in innovative uses of mobile technology for a series of development work.

IFFCO Kisan Sanchar Ltd, Reuters Market Light (RML), Tata m-Krishi are good examples of value added services to farmers on weather, crop, animal, market, pricing, government schemes - even deploying voice enabled internet protocol(VOIP) for ease and convenience. Many organizations such as SEWA (Gujarat), Digital Green (AP), PRADAN, BAIF, etc also adopt video as medium for their communication services. In its current wave of revolutionizing ICT applications, the potentials of PDA (personal digital assistant), RFID (Radio Frequency Identification) and Robotics (e.g. by Cornel University) have been witnessed encouragingly.

As agriculture is highly knowledge intensive enterprise requiring quality and timely information for decision making - right from soil selection, product planning, to selling of produce – application of ICT in knowledge management is well placed. Small farm unit living in geographically isolated areas with limited means, under diverse ecological endowment, poor physical infrastructure and financial resources, exacerbate such challenge. The ability of ICT to effectively address the challenge of generation, access, storage, exchange and dissemination of knowledge to millions in rural areas has been well-recognized. ICT can facilitate, in a fast, accurate and cost effective way, many areas of research activities, extension and emergency intervention.

Deployed properly, ICTs have been found to improve farm production efficiency in many ways; in crop, livestock, fisheries or inputs management. Weather monitoring, crop planning or scheduling, crop or yield assessment, pests' surveillance and management, biotic and a-biotic

stress levels, marine fish catch and sustainable management of marine fisheries resources, animal disease surveillance and monitoring etc are highly suitable for ICT adoption. Since long, information about the price, market, export-import dynamics, global food availability has been shared for skilled decision making. Of late, the ICTs in value chain assist in sound procurement planning, promotion of GAP (Good Agricultural Practices), GMP (Good Manufacturing practices), GACP (Good Agricultural and Collection Practices) etc. All these bear significant relevance for food quality, safety and traceability – indispensable in today's global food trade.

One glaring application of ICT is to manage natural resources, i.e. land, water, forests, biodiversity or environment. Land use planning, land records, revenue system, land survey & classification, quality mapping, soil nutrient profiling, soil conservation are areas where ICTs can create wonders in terms of social, economic, environmental and administrative dividends. Similarly, in case of water, water resources utilization, irrigation planning and management, water pollution and quality, surface and ground water profiling and conservation, ICT applications could be of immense value. Remote Sensing and Geo-spatial technologies are applied in forestry– radically improving forest surveillance, deforestation, degradation and conservation. Adoption of ICTs in the realm of biodiversity, ecological monitoring or in reducing adverse impacts of climate change cannot be understated.

With all these exciting possibilities, the next question that arises is what the bottlenecks in realizing these potentials are. ICT uptake still remains a problem for agriculture and rural development. The primary action is to create widespread awareness and interest in people who will economically benefit from such technologies. If they are not convinced, no amount of effort or investment can ensure the acceptance and spread of even the best of these technologies. People must change their belief and be allowed to perceive the intended social and economic benefit through constant dialogue, exchange and engagement. Skills development, training and exposure are essential in human capacity development. Challenge of illiteracy has to be fought with that of e-literacy to enable people to use ICT in their work and life.

Development agencies have to realize that a significant proportion of the digitally excluded are at risk of deepening social and economic exclusion. Digital exclusion cannot be addressed in isolation from other policy issues. Again, unless basic infrastructure like power, telephony, roads and communication, health and education are improved, the e-intervention cannot be sustained.

Creation of and access to ICT infrastructure is the foundation that requires copious public funding. The people do not have means to build such facilities by themselves. Needless to say that the government and other IT partners must engage themselves in various tasks of technology generation, access and research along with the civil society, academia and private sectors.

Mobile telephony provides access to markets, strengthens farmers bargaining power with real time information and marketing alternatives. There is need for convergence between mobile telephony, internet, broadcasting networks and PDAs (Personal Digital Assessment). It is here that durable partnerships between public, private and other stakeholders are critical; where governments enforce enabling regulations and provide funding for basic connectivity and encourage the private sector to provide ICT infrastructure, technological know-how and services. In all these, people or the end users should be the dominant partner in terms of choice and design of technology, interface arrangements, decision on service providers, and assessment of costs and benefits. Essentially it has to be a bottom-up participatory approach.

Very soon, every Panchayat in the country will have an internet equipped service centre to ensure rural access to online services for farmers. The IT department is working to have 25 million of such centers across the country – one in every Panchayat by 2012 as a part of the National Broadband Policy to provide access to high speed connectivity. Along with spectacular mobile penetration, this is a formidable development that has strong promise to alter India's rural landscape – perhaps beyond comprehension.

These will facilitate implementation of many socially relevant interventions hitherto bypassing many; it will also provide endless economic and livelihood avenues in a rapid, inclusive, cost effective and transparent manner. People's indomitable spirit and unique cooperation, and enhanced commitment from both private and public sectors in forging viable links may now ensure that we can really unleash the vast untapped potential of India in near future.

Assistant FAO Representative,
FAO, New Delhi

Agricultural Extension: Perceptions, Priorities and Realities

K D Kokate

Agricultural sector is the lifeline for the overall development of India. For obtaining desired growth rate of 9% and above, it must grow at around 4%. The ever increasing population, climate change, a nd changing dietary habits are continuously putting pressure and at the same time low investment in research, infrastructure development, processing, value addition and marketing is hindering the inclusive growth.

Indian agriculture embraces diverse actors in its endeavour to feed 1.21 billion people. The development of small, marginal & landless farmers is extremely vital for food security as land holdings are shrinking day by day. The contribution of women farmers is also immense particularly, in harvesting, post harvest management, savings and in other operations especially in horticulture and animal husbandry sector. Therefore, a comprehensive inclusive visioning is very essential for effective technology application.

Despite diverse production systems, the food self sufficiency has been realized mainly through resource rich and irrigated production system. The potential of entire disadvantaged area including rainfed is still to be harnessed. Farmers want constantly assured income. The agricultural extension programmes concentrate mainly on the production and productivity. Agriculture has to be made more viable & profitable by means of forward linkages to production, entrepreneurial interactions and scaling up of the successful innovations. This may also attract the rural youth to the farming.

In today's scenario, innovation in agriculture is key to address the challenges. The innovations in agriculture from scientists to Farmer Innovators need to be integrated, validated and scaled up. The innovation-development process consists of the decisions, activities, and their impacts that occur from recognition of a need or problem, through research, development, and commercialization of an innovation, through diffusion and adoption of the innovation by users.

The Indian Council of Agriculture Research (ICAR) has led in responding the contemporary challenges of Indian agriculture through Green Revolution (complimented with National Demonstration, 1964), upliftment of small & marginal farmers (complimented with Lab to Land Programme, 1979), watershed development, soil improvement, crop protection, focus on weaker section (complimented with Operational Research Project, 1974), technology assessment and refinement (complimented with Institute Village Linkage Programme, 1995) .

National Demonstration (ND) on major food crops was launched in 1964. The rationale behind the scheme was that unless the scientists could demonstrate what they advocated, their advice might not be heeded by the farmers. The conceptual framework of national demonstrations was that it was a nationwide project with a uniform design and pattern. The national demonstrations were intended to show the genetic production potentiality of new technologies and to influence both the farmers and the extension agencies.

The Operational Research Project (ORP) initiated in 1974-75, aimed at disseminating the proven technology in a discipline/ area among farmers on a watershed basis, covering the whole village or a cluster of villages, and concurrently studying constraints (technological, extension or administrative) as barriers to the rapid spread of improved technical know-how. The experience with the National Demonstration Project highlighted the issue that demonstration of a particular technology or a combination of technologies in an area on watershed basis proves to be more effective in convincing farmers and provide them greater scope for identifying constraints. The ORPs covered diverse topics like crop farming, mixed farming, integrated pest management, plantation, land reclamation, arid land management, fisheries, etc.

The 'Lab-to-Land Programme', was launched in the country on 1st June 1979 as a part of the ICAR Golden Jubilee Celebration. Under this programme, 50,000 farming families of the country comprising of small and marginal farmers and landless agricultural labourers were adopted by the ICAR through its Research Institutes and Agricultural Universities for their economic upliftment. The programme being of special nature was intended as an in-

tegral part of the extension activities of the concerned participating institutions. No separate staff and other infrastructural facilities were provided in the Project. The programme had two major dimensions; (i) to study the family profile for evolving and executing an appropriate farm family plan and (ii) to provide support both technical and financial for making a substantial change in the economic condition of the poorest sections of the rural community.

The Institute Village Linkage Programme (IVLP) was started by ICAR in 1995 with special emphasis on generating appropriate technologies by refining and assessing innovations generated by scientists in different farm production systems viz. commercial, green revolution and complex, diverse and risk prone. It was implemented through ICAR institutions, SAUs, ZRSs and KVKs following a basket approach. The specific objectives of technology assessment and refinement programme were to introduce technological interventions with emphasis on stability and sustainability along with productivity of small-farm production systems.

Often, the farmers are not aware as to whom and where to approach for field problems. It was felt that the facility of a 'single window' approach at the entrance of the ICAR Institute/ State Agricultural Universities will enable the farmers to have the required information for the solution to their problems related to the areas in which the concerned institute is involved. The Agricultural Technology Information Centre (ATIC) implemented under National Agricultural Technology Project (NATP) is a "single window" support system linking the various units of a research institution with intermediary users and end users i.e. farmers in decision making and problem solving exercise. It provides a 'single window' delivery system for the products and species available from an institution to the farmers and other interested groups as process of innovativeness in technology dissemination at the institution level.

The National Agricultural Innovation Project (NAIP) was started in the year 2006. The overall objective of NAIP is to facilitate the accelerated and sustainable transformation of Indian agriculture in support of poverty alleviation and income generation. The objectives were aimed to achieve through collaborative development and application of agricultural innovations by the public organizations in partnership with farmers groups, the private sector and other stakeholders. The specific objectives are: To build the critical capacity of the ICAR as a catalyzing agent for management of change of the Indian NARS; to promote 'production to consumption systems' research in priority areas/themes to enhance productivity, nutrition, profitability, income and employment; to improve livelihood security of rural people living in selected disadvantaged regions through innovative systems led by technology, and to build capacity and undertake basic and strategic research in strategic areas to meet technology development challenges in the immediate and predictable future.

Concern for Household Livelihood

Household Livelihood Security is defined as adequate and sustainable access to income and resources to

meet basic needs (including adequate access to food, potable water, health facilities, educational opportunities, housing, and time for community participation and social integration). Livelihoods can be made up of a range of on-farm and off-farm activities that together provide a variety of procurement strategies for food and cash. Thus, each household can have several possible sources of entitlement which constitute its livelihood. Entitlements include the rights, privileges and assets that a household has, and its position in the legal, political, and social fabric of society.

A livelihood is sustainable, when it "can cope with and recover from the stress and shocks, maintain its capability and assets, and provide sustainable livelihood opportunities for the next generation...". The risk of livelihood failure determines the level of vulnerability of a household to income, food, health and nutritional insecurity. Food and nutritional security are subsets of livelihood security; food needs are not necessarily more important than other basic needs or aspects of subsistence and survival within households. Food-insecure households juggle among a range of requirements, including immediate consumption and future capacity to produce.

Diversifying Household Livelihood

Extension interventions may aim to reduce the structural vulnerability of livelihood systems by focusing on:

- Improving production to stabilize yields through diversification into agro-ecologically appropriate crops and natural resource management measures (e.g. soil and water conservation);
- Creating alternative income-generating activities (e.g. activities to develop small enterprises);
- Reinforcing coping strategies that are economically and environmentally sustainable (e.g. seasonally appropriate off-farm employment);
- Improving on-farm storage capacity to increase the availability of buffer stocks;
- Improving common property management through community participation.

Convergence of extension

There are many extension service providers in the field, providing different kinds of useful services like information and service support to farmers. They are state, central government agencies, agri-business companies, agri-preneurs, input dealers, manufacturing firms, NGOs, farmers' organizations and progressive farmers. There is duplication of efforts with multiplicity of agents attending extension work without convergence. There should be a co-ordinated attempt to synergize and converge these efforts at the district level and below to improve the performance of various stakeholders. It is essential to route all the state and Central Government extension fund through single agency for effective utilization of crucial resources.

Focus on Market

It has become an absolute necessity to shift extension focus from production-orientation to market-led extension resulting in increasing farm income by adopting end-to-end approach. Market-led extension helps the farmers to minimize the production costs, improve the quality of farm produce, and increase the product value and marketability resulting in increased income of the farmers.

Demand driven and farmer centric information flow

National Sample Survey Organisation (NSSO) survey indicates that 60 per cent of the farmers do not access any source of information for advanced agricultural technologies. As a result, there is a wide adoption gap among the farming community to achieve the vertical increase in production through optimum resource utilisation. The function of agricultural extension, essentially, is helping farmers to progressively improve their efficiency in farming. For this purpose, it has to relate useful, practical technology to the needs and opportunities of the farmers, on one hand, and encourage them to consider, try and adopt such technology if found acceptable, on the other. Extension is now becoming more diversified, technology intensive, knowledge oriented and more demand-driven. This requires the extension workers at the cutting edge level to be master of so many trades, which is neither practicable nor possible. Use of IT in

extension may enable the extension workers to be more effective in meeting the information needs of farmers.

Moving towards Farmer First

The concept of Farmer First (Robert Chamber, 1987) has insights of three broad categories of types of agriculture (Industrial, Green Revolution and the CDR or Complex, Diverse and Risk-prone); the pipeline approaches and methods of transfer of technology (TOT) for the uniform and controlled conditions of industrial and green revolution agriculture may not fit CDR conditions; farmers' practices seen as adaptive performance; the proposition that adoption by farmers is validation of a technology; the comparative advantages of farmers over scientists in innovating for complex systems; and many others. Farmer First is paradigmatically different from TOT, and vital for CDR agriculture.

Beyond Farmer First (Ian Scoones and John Thompson, 1992) stressed perspectives that broadened and complemented Farmer First: the pluralism of different knowledge ; the recognition of knowledge as not a stock but a process; seeing farmers, extensionists , scientists and others as social actors; recognizing political dimensions and the significance of power relations; and elements of a new professionalism in agricultural science.

Farmer First Revisited (Ian Scoones & John Thompson, 2007) differed from the original Farmer First. In Farmer First, it was a mutual recognition of marginalized innovators, the solidarity of heretics, the sense of being a vanguard, of having a common commitment that could be transformative. In Farmer First Revisited, it was seeing how far we had come, how many more domains than just farmer participation were relevant, and how rich the range of innovations had been. In Farmer First, the focus was on the complexity and diversity of farming systems and the creativity of farmers. In Farmer First Revisited, it was the complexity and diversity of domains of action and intervention and of relationships, and the co-creativity of many different actors.

Now, we have far many agencies other than public organizations and various kinds of public-private-farmers partnerships. Earlier farming was an adapting performance. Participatory approaches and processes were central. Now relationships and interactions are seen more clearly to have dimensions that are related to power, trust, transparency, virtual, grass root, peer, and advisory network. Partnerships like public-private, multi-stakeholder partnership etc, and collaborations like co-management, co-breeding, co-creation, co-evolution, co-development, etc. have emerged in present day context.

Learning of different kinds has been evolved- interactive, experiential, alternative, etc. and simultaneously non learning culture also exists in many organizations. Now concern is not only with capacity building but with mind sets, soft skills and language of reflexivity and values.

There is a growing realization that the existing extension system is not adequately responding to the emerging demand of the farmers about the recent technological and institutional development. Also many a times, research system is not getting adequate feedback to plan and conduct demand driven research thereby, a huge gap exists in the quality of research output required at the farm level and that being developed.

Thus, agricultural extension continues to be in transition in order to respond the current challenges. Decentralization, pluralism, cost sharing, cost recovery, participation of stakeholders in development initiatives and the decisions and resources that affect them etc. are some of the elements in extension's current transition. Extension will be more responsive when it strengthens pluralistic extension system which serves the needs of all farm households, including: (i) achieving national food security through technology transfer, (ii) increasing farm income through a more market driven extension strategy that will enable farmers to intensify and diversify their farming systems based on market demand, (iii) empowering farmers by getting them organized into groups based on common interests, to gain more efficient access to both inputs and markets; and, (iv) promoting sustainable natural resource management practices to address soil, nutrient, land degradation, water resource and other major problems, including global warming.

DDG (AE), ICAR, New Delhi

Cyber Extension: e-Empowering the Agricultural Extension

Dr. V.P. Sharma

ICTs or Information and Communication Technologies are emerging as an important tool for the development of societies and have driving forces in the economies worldwide. ICTs are no more confined to assist high-end research and development; the new technologies have made significant improvements in the life-styles and the efficiency-levels in all sectors of economy. The positive impact of ICTs is most visible in service-sector, where the efficiency levels have gone very high. New businesses like "Business Process Out-sourcing (BPOs)", Banking and Insurance, the entertainment industry and other industries and organizations, are all taking maximum advantage of the ICT revolution.

The agriculture sector is gearing itself to make optimal use of the new information and communication technologies. At the Government of India level, a number of important initiatives have been taken to provide IT hardware and connectivity to all organization involved in agricultural education, research, development and dissemination. Simultaneously agricultural content development initiatives have been taken by Ministry of Agriculture, in collaboration with National Informatics Centre (NIC), to provide marketing information of various agricultural commodities to the farming community. Another content-creation and aggregation initiative is being supported by Indian Council of Agricultural Research (ICAR), under its World Bank aided project – National Agricultural Innovations Project (NAIP), wherein the Leading ICT institutions like IIT Kanpur, IIT Mumbai, IITKM, Kozikode and International Crop Research Institute for Semi-Arid Tropics (ICRISAT) have been roped in to guide National Agricultural Research System to design, develop and implement Knowledge

Management Systems (KMS) in agriculture. ICTs are thus emerging as very important tools for agricultural extension, and it is now a must for every agriculture graduate to have working knowledge of computers, communications, internet and world-wide-web.

Information Needs of Farming Community:

India's agriculture has now entered a post-green revolution stage. Demands for agriculture technology are changing and diversifying. Demands for information are changing. In 1960s and 70s, the farmers were asking for crop-technology and packages of practices, whereas now the focus has shifted to market prices, credit-access and value-addition opportunities. The main objective of farmers' concern has shifted from high production to high returns, and hence the issues like quality, timeliness and post-harvest technology are getting prominence in the farmers' queries. Farmers' information needs have expanded considerably during last two decades. One department or agricultural scientists alone cannot address these information needs. There has to be an on-line network of multi-stakeholders in the agriculture-value-chain to address farmers' current and emerging information needs. The Akshaya Project of Government of Kerala has identified the following as the critical information needs for the farming community:

- Access to warehouse, markets with prevailing price information
- Access to (government information on) schemes, subsidies, modern agricultural methods, best practices, soil testing, seeds, plantlets, fertilizers, pest control
- Facilities for grading agricultural produce and ensuring correct price for their produce
- Logistics support, cost sharing possibilities
- Access to micro credit
- Agri Insurance support/faster claim processing

There are many other information needs of the farmers. Information need, by its very nature is a dynamic concept, and hence the ICT enabled systems are more suitable to address the information needs of the clientele groups.

Existing Information Access

Mechanism:

The prevailing information access mechanism of farmers is mostly influenced by the respective state government/Agriculture University's information delivery mechanisms. In early fifties, the Gramsevak/Village Level Worker (VLW) served as a key-man in Community Development Programmes. They had multiple functions to perform and agriculture was just one of the subjects. The National Extension Scheme launched in 1953, was the first scheme to have specific focus on agricultural extension. In early sixties and seventies, the department of agriculture at district level was the sole information provider on the crop varieties, package of practices and also on pest and disease control measures to be taken. Their efforts were complemented by the farmers and agriculture input dealers, by canvassing these messages to the fellow farmers. The launching of Training and Visit system (T&V), under National Agricultural Extension Projects I, II and III, during 1970s and 80s gave a great fillip to information delivery mechanism of State Agriculture departments, as it introduced a system of regular and crop/season specific interaction among agricultural research scientists, state agriculture departments and farmers. The fortnightly workshops were a novel concept to have a regular interaction among the scientists and the extension functionaries. The establishment of KVKs (in almost all rural districts), and support of mass-media particularly the All India Radio and Doordarshan have played a very important role in the diffusion of new agricultural technologies. The print media, the vernacular press also supplemented the extension efforts at local levels. The private T.V. channels are a new entry, and have got tremendous positive feedback from farmers. The other traditional extension mechanisms included demonstrations, farmers meetings and krishi-melas at district, state and national level.

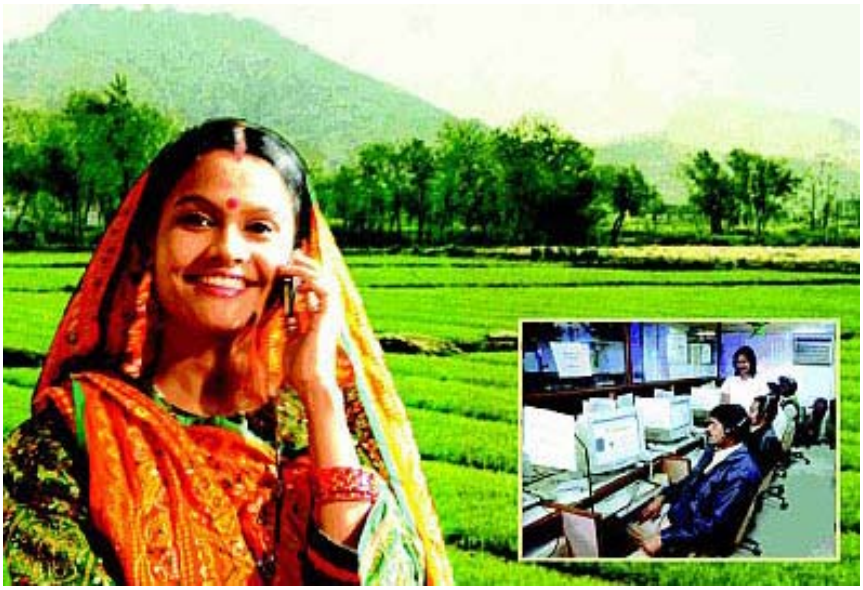
The emergence of ATMA (agricultural Technology Management agency in late 1990s and their expansion of Extension Reforms programmes in 2003 and 2005) at district level provides integrated extension information delivery through Farm Information and Advisory Centers (FIACs) at block level and Farmers' Groups at village level. Currently ATMA is operating in 591 Districts of the Country. Krishi Vigyan Kendras (KVKs), one in each rural district, are another source of Agricultural Information/ advice. The State Agriculture Universities (SAUs) have also established their own extension network in some states (e.g. in A.P. each district has a District Agricultural Advisory and Technology Transfer Centre (DAATTC) with three SAU scientists serving the farmers' needs). The electronic media (Television- both public and private broadcasters and All India Radio) and Print Media (Agricultural Journals, Magazines, Newspaper supplements and dedicated Agricultural newspapers – like Agro One from Pune) are complementing the extension efforts of Department of Agriculture in a big way. According to NSSO Survey, T.V. and Radio have reached out to over 13% and 9% farmers in the rural India, out of a total outreach of less than 41% achieved by all extension channels. Over 9000 Agri-Graduates have established Agri-Clinic and Agri-Business Centres in the rural areas after getting 2 month long intensive training supported by Government of India.

Tele-advisory services have been initiated by Government of India as Kisan Call Center (KCC), wherein any farmer in the country can make a call on toll free line 1551 (thru Land line) and 18001801551 from any mobile network to access state specific question-answer service on agriculture and related areas. Over 6.5 million (65 Lakh) calls have been received and answered (till July 2011) on KCC since January 2004. A number of private multinational companies involved in Procurement/Manufacturing/marketing of agricultural inputs/produce have also initiated extension efforts (using state-of-the-art ICTs) to provide latest production technologies to the farmers. Still, a lot needs to be done to provide integrated, single-window complete and authentic information on agricultural issues to the farmers.

Use of ICTs in Agricultural Extension: Options and Opportunities

Information and Communication Technologies (ICTs) have opened whole new set of options for the agricultural extension scientists, extension officers in the research and extension system to improve the speed, accuracy of the communications at relatively lower costs. The ICT tools like Internet, e-mail, on-line Expert Systems, Call Centres, Short Message Service (SMS) and information portals on agricultural marketing information, packages of practices and subject specific discussion groups on internet have enhanced access of extension personnel to the latest information within and outside the country. Communication is the central mechanism of extension process. ICTs provide new dimensions to communication as a process. These include:

- Access to information resources of the whole world, beyond state and national boundaries (improved reach).
- Most of the time access is free (less cost).
- Instant access to the important resources –people and literature.



- Facilitates two-way communication –e-mails, chat groups, discussion forums.
- Information is available at any time.
- Little or virtually no chance for information-distortion, as the communication is between the user and communicator directly.
- Easy documentation as all the communication is in digital form, including e-mails, audio and video exchange.

ICTs provide a unique opportunity to the agriculture sector to bridge the gap between the Lab, Market to Land.

Proposed Plan of Action:

We are at a very crucial stage of e-Empowerment of Indian Agriculture in general, Agricultural Extension in particular. With full knowledge of constraints of the existing information/service delivery system, successful implementation of pilot e-info delivery projects, awareness of using ICTs to improve extension outreach and general readiness among the extension Staff to absorb and use new technologies, this is the most appropriate time to plan and execute national roll-out of e-Extension.

Some major components of e-Extension may include:

I To integrate all agricultural information on a single "National Farmers' Portal" where the farmer can access all information related to crops, package of practices, availability of inputs, markets, market-prices, government schemes, their entitlements in their local language. The Farmers' Portal may be one-stop portal for all agricultural information (digital content) emanating from all public agencies (Central as well as State Government agencies, departments, Universities and Colleges). Information about all Government schemes/ Programmes may be made available (with FAQs). Farmers' Portal may provide link to all ICAR/SAUs/ Central Government Institutions. All portals developed by NIC (e.g. AGMARKNET, SEEDNET, EMS, HortNET) may be linked to Farmers' Portal. Subject/ Crop specific Portals (e.g. Rice Knowledge Management Portal, Agropedia, ACABC Scheme Portal-Agriclinics.net etc.) may be linked. A directory of Institutions/ Agencies (with their web-address,)/ Experts (with their e-mail ID and mobile number)/ Agricultural Magazines/ Journals/ Newspapers may be prepared, maintained (continuously updated) and linked.
Each Government Department/ Agency may host farmers' charter of their services. All programme details, including implementation schedule (like C-DAPs, SREPs) may be hosted. Resource Map of all resources- farm soil health, plant health, livestock health, water bodies and their upkeep status, fisheries resources and details of all development works carried over the specific parcel of land may also be indicated.

II To establish a 24 X 7 National Agriculture Channel on Television and one Community Radio in each District (with coverage of over 75% of District). The National Agricultural Channel may be managed on time-slot basis, wherein the state and district specific content may be telecasted from various LPTs (Low Power Transmitters) during designated hours. A national Agricultural Information Broadcasting Agency/ Board may plan, coordinate the schedule and content development, management of Krishi Channel.

III Strengthening and enlarging the Services of Kisan Call Centres (KCC): To enhance the capacity and competence of Kisan Call Centre (KCC) to communicate with one million farmer per day (reaching out to all 120 million farmers, at least once in a season, thrice in a year); The services of KCC (Kisan Call Centre) may be made more complete and accurate with participation of all the development officers (JDA, DDA, AO, JDH, DDH, HO, FO) on the answering side with services of all SAU & ICAR scientists. The call escalation may include agriculture and line department offices/officers and SAUs & ICAR institutes. The level I may escalate the calls to concerned subject officials at block level, and then to district level, before escalating to state level experts/ institutions. This may require a major intervention by DAC/DOE to advise the states to own, manage and supervise the KCC operations in respective states.

IV Mainstreaming of CSCs as Kisan Seva Kendras: There are over 96,000 CSCs operational at pres-

ent (as per MIT, 1-8-2011) at the Village level in the country. Further, there is a proposal to establish 1,50,000 more CSCs within next 2 years (under consideration, at advanced stage). All these CSCs are the closest access points for the Farming Community. These CSCs may be re-christened as Kisan Seva Kendras, as majority of their clients are farmers and agricultural Workers. CSCs may be provided basic training facilities – projections system, white boards to act as training centres for the farmers.

V Pro-active Tele-Advisory to Farmers on regular basis: A mechanism may be put in place to provide personalized information (thru SMS/MMS) to the farmers daily, by the Departments of Agriculture/Horticulture/Animal Husbandry/KVKs/SAUs. The Block Technology Teams (BTTs- having representatives from all the above departments) under ATMA may collect and maintain a directory of mobile numbers of all the farmers in the block (village-wise, with associated information on crops, enterprises-Animals, Ponds, Fisheries resources etc.). BTT may work as a secretariat for the formulation of crop/enterprise specific advisories (messages) to the farmers on daily basis and the Block Technology Manager (BTM) may forward the approved messages to the concerned groups (of farmers) daily. Farmers may also send their queries to the BTM, who in turn may report the queries to BTT and may revert back to farmers thru SMS/ MMS. All this interaction may be forwarded to KCC (digitally) so as to document this interaction on KKMS.

This mechanism may require an ICT enabled FIAC (Farm Information and Advisory Centre) at block level, as envisaged in ATMA, to pro-actively interact with Farmers on continuous basis. The ICT equipment required for FIAC is already part of ATMA scheme. There is however, need to provide bulk SMS/MMS handling s/w and uplink support along with a dedicated ICT Support person at BTT/ FIAC.

VI Extension Information Monitoring and Management Cell at district, state and national levels and also in each SAU and ICAR Institute: All the officers and staff involved in extension system need training in monitoring and management of extension information flowing through various media channels. The extension system needs to continuously monitor the needs and perceptions of farmers. The system also must create awareness among the farmers about the schemes and programmes of government. The system must gauge the farmers' needs at the earliest and flag them to their seniors and policy makers.

These cells may be established at every district, state and national levels and also in each SAU and ICAR institute to coordinate the planning, implementing, monitoring and reporting the feedback on every e-Extension initiative including- KCC, television, radio, SMS/MMS and print-media interventions.

Conclusion:

ICT usage in Agriculture has got good start in last ten years. A number of pilot projects have succeeded to reach a stage of national level roll-out. ICT connectivity (internet, telephones, and mobiles) has reached all districts and blocks in the country. Telephone density has also crossed 50% mark. Common Service Centres (CSCs) are also being rolled-out countrywide under Public Private Partnership mode with over 96,000 of CSCs already being in operation. Over 9000 agric-clinic/agri-business centres have been established by trained agri-graduates. Thus, the delivery mechanism for "Agricultural Information" content is almost ready. All these modules need to be put in a larger framework so as all of these initiatives work to achieve common goal of reaching out to farmers in most optimal way. This will require immediate investments in establishing e-Extension mechanisms in State Departments of Agriculture, ICAR and SAUs, besides coordinating body with DAC. This is an absolutely urgent need of the hour, not only to redress the growing imbalance in information, but also to reduce poverty, increase participation, improve governance, manage natural resources and improve opportunities for woman.

E-Empowerment has capacity to make significant positive impact on the livelihood of Indian Farmers.

Director (Information Technology, Documentation and Publications), National Institute of Agricultural Extension Management (MANAGE), Hyderabad.

The views expressed in the paper are of the author only, not of MANAGE.

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Focussed Crops

Horticulture: The Way Ahead

Sanjeev Chopra

With a production of over 230 million tonnes of fruits and vegetables over an area of 20 million hectares , the horticulture sector in India is now a significant contributor to the agricultural GDP of the country, but its contribution to farmers' incomes and livelihoods, nutrition, export earnings, ecology and equity does not get the prominence it deserves because our political discourse and economic commentary is geared to the 'meta narrative' of food security, MSP and PSS for wheat, rice, pulses and oilseeds . In fact, one has to be grateful to the runaway inflation of the humble 'onions and potatoes' that perishables made it to the national attention grid, but for the wrong reasons! While it is true that the sector has received more funds than ever before, and production has increased manifold, the sector now faces the problem of ensuring that the primary producer gets a 'fair and remunerative share ' of the consumers rupee, as in the case of 'primary crops 'like wheat and rice.

How then does one look at the horticulture sector's growth scenario. As in Dickens's classic 'A Tale of two cities': it was the best of times, it was the worst of times! It is the best of times because few other sectors have seen such exponential growth in terms of funding…from just about Rs 700 crores in the seventh Plan to Rs 15,000 crores in the eleventh Plan. The sector now boasts of the National Horticulture Mission, the Horticulture Mission of the Himalayas and the North East, the National Mission on Micro Irrigation and the National Bamboo Mission, besides substantial funding and policy support for the National Horticulture Board and the Coconut Development Board. Besides there are smaller, but focused missions like the Saffron Mission for Jammu and Kashmir, and the National Bee Board. Many state governments are creating ministries and departments exclusively for horticulture, and there is a general sense of 'can do 'attitude!

However the primary challenge to the sector emanates from the fact that almost every policy instrument which regulates this sector was designed primarily for wheat and rice, and by extension, pulses, oilseeds and millets. Thus when it comes to financial inclusion of farmers, provision for fertilizers, price support, and especially the marketing arrangements, the sector faces the 'worst of times'. This does need further elaboration. Take the Kisan Credit Card for example. The very design of this financial instrument which is responsible for providing agriculture credit of more than four hundred thousand crores to the farmer at a concessional rate of interest through interest subventions caters to the 'wheat-rice' cycle, and its norms are designed to cover seeds, fertilizers and pest/weed management. Fortunately, the humble potato fits into this cycle as an alternate crop in West Bengal, Punjab and UP, but the marginal farmer who wants to grow strawberry, egg plants, broccoli or okra for the vegetable market, or wants inputs for the small poly house that s/he has created out of NHM funds does not have access to this concessional credit. Thus the vegetable grower must take credit at usurious rates of interest, often from the intermediary, who then gets a control over the produce even before the cultivation cycle starts. True, there is no 'bar' to the KCC financing vegetable crops, but unless the 'norms' for funding are circulated to the banks and co-op institutions, pious intentions do not get translated into ground reality. Therefore the first point to note is that the horticulture farmer pays a higher 'cost' of credit. This financial exclusion leads to a vicious spiral: because his crop has not been financed, it cannot be

insured. Thus, in the case of a crop loss on account of adverse weather conditions and/or pest attack, the horticulture farmer does not have a 'right' to get compensated. He has to depend on 'patronage' and a visit by a central team to assess the damages, and receive a 'pittance'. Even in the revamped agricultural insurance scheme, and the Weather Based Insurance, horticulture is an 'add-on'. However, horticulture crops are more sensitive to climate change, and therefore require urgent attention. This essayist has made a strong case for convening a meeting with the insurance companies, farmers associations and insurance regulator to take the first steps towards designing product portfolios for the vast range of horticulture crops – from saffron in Jammu & Kashmir to areca nut in Karnataka!

Let us now move to agricultural inputs, including seeds, nutrients and pest/weed management strategies. In addition to the National Seeds Corporation and the State farms corporation of India, almost every state, and many agricultural universities have their dedicated corporations to address the issue of seed supplies. Their primary focus has been to HYVs and hybrids for the major crops, and because there is still a very wide gap between demand and supply in this 'core sector' the horticulture sector, more or less fends for it. True in the case of potato, the CPRI has taken the lead role in the development of Foundation seed, and the Indian Institute of Vegetable Research at Varanasi and the IIHR at Bangalore have developed several varieties, the challenge is not the development of a good seed/ planting material in the lab – but to ensure its commercial production, certification and regulation to ensure that the farmers are not given spurious seeds. Again, the focus of the seed certification labs in the country is primarily geared to 'crops', rather than fruits and vegetables, and face severe capacity constraints in most states. If horticulture were to add its own portfolio, the backlog would be so high, that entire seasons would be missed, thereby rendering the exercise redundant.

From Products to Processes: Accrediting Nurseries, and Redefining their Roles

As such, a better option would be to move into a regime of accrediting nurseries which can supply planting materials and seeds, besides stocking seeds of companies which have their own testing regimes, or have the credibility and brand name, backed by internal research. The National Horticulture Board has recently taken up the task of accrediting nurseries, and the number of stars assigned to each will depend on periodic review and inspection. Thus while getting the 'five star status' will be great for a nursery, being able to retain it will be greater, and the possibility of losing the status will impel the nursery to take all steps in this direction. It may take a few years time, but by the end of the XII Plan period it would be possible for the NHM to give directions that state procurement should only be from 'accredited nurseries'. Over time, the accredited nursery movement may evolve a dynamic of its own, and these could also be the centres for sale of horticulture equipment, bio fertilizers, and other agri inputs.

Breaking the 'land holdings barrier': Protected Cultivation and Micro Irrigation

Taken together, protected cultivation and micro irrigation can break the 'land holdings barrier', which has been the bane of Indian agriculture. Given the fact that India is a land of marginal and small holders, and that it will not be possible to increase the per capita farm size, the only option is to increase the productive capacities multifold to make incomes rise at a pace which compares with the services sector. This is where horticulture sector brings in its unique competitive advantage: with shade nets and poly houses, fan–belt systems and micro irrigation, it is possible for a 300 square meter plot of land to generate an income of up to Rs 3 lakh per annum (an impossibility in a rice-wheat /cotton/sugarcane cycle). True, this will involve higher capital costs but given the support under NHM , with supplementary grants by the state and institutional funding, it would be possible for the new generation of agripreneurs to break free of the ' land holdings barrier'. The question is: are we prepared to invest in the sector on the scale that we are doing for airports and national highways? To cover just 1% of India's cultivable land under protected cultivation, the requirement of funds could be as high as Rs 25,000 crores (back of the envelope calculations). This can however generate incomes and livelihoods in a 'virtuous cycle',

and may be more productive than other interventions, especially as this involves a 'public private partnership' in the real sense!

Reducing Transaction Cost and Time: Repealing APMC Acts

Getting funds for breaking the land Holdings barrier may be easier than getting this Act amended. The 'vested interests' which control these Markets are not agriculture producers, but traders and intermediaries, and because they have 'controlled' these institutions for the last fifty years, they have perfected the art of finding both creative and coercive reasons of holding the system

to ransom. While the DAC has been reiterating the need to amend the Act, several states including Punjab, Haryana, UP, Rajasthan and Delhi – to name few- have not accepted this. Of course every political party sings paeans for the 'toiling farmer' but his right to sell his produce at his farm gate has been compromised by every party across the political spectrum. The time has come to make it abundantly clear that unless Act is repealed, higher production and yields will not translate themselves into incomes for farmers. True, the subject falls under the domain of the state governments, but if an Empowered Committee of State Finance Ministers could take the lead in establishing the VAT regime in the country, this can also be done. The APMC Act was designed to ensure that the farmer brings his produce to the Mandi so that he has greater choice: today the choice is being restricted because of the Act itself. Moreover the markets under APMC have failed to keep pace with technology: as a country which prides itself in IT skills, and BPO sector, less than 1% of our agriculture produce is sold through electronic auctions with transparent price discovery. It is time the Competition Commission of India took suo motto notice of the restrictive provisions of the APMC Acts which had virtually restricted the entry of any new player in this sector, and also prevented any member to introduce systems to usher in a monopoly. While NHM has been supporting 'terminal markets' and many states have come forward to take assistance of up to Rs 50 crores (one third of the anticipated project cost), this has not caught on like wild fire, because any modern system will keep a record of transactions, but the 'guild' which controls the trade does not want any trail. This is perhaps one of the largest 'unorganized sectors' in the country. Can one believe for example, that the total requirements of fruits and vegetables for the NCR region are less than Rs 2 crores per day?

Linking Farmers to Markets!

To a large extent, these issues have been thought through in the National Vegetable Initiative, which, in the first phase, aims to connect cities with a population of 1 million with farmers' clusters. Typically, a city with a population of this size should have at least five to seven thousand vendors, providing door to door, or at least, 'walking distance' service to the home makers and/or institutional consumers. Ideally, with such high volumes the market should have evolved on its own – after all the production and supply chains are in place, even if they are non- transparent and 'cartelized'. However, markets depend to a large extent on information about production, warehousing, logistics, distribution channels and their financial holding capacity and consumer behaviour. This is where the challenge lies– for unlike the agricultural production estimates, which start giving data from the 'sowing stage,' itself, there is no organized system for collection of horticulture statistics. True, the National Horticulture Board brings out a Horticulture data base at the end of the year, and the Marketing Division within the GoI maintains a dynamic portal which records arrivals in the Mandi, the challenge lies in anticipating production, and putting this information in the public domain. Moreover when multiple agencies give information based on their understanding of some crops in limited areas, it tends to distort the market. Take the case of onions, for example. A report on production losses in the late Kharif onion in some parts of the country on account of unseasonal rains triggered a panic reaction last year (2010), even though the loss of production could have been offset by calibrating the trade policy. However if there was a system to report sown area, expected production and storage capacity at different levels, the scenario would be different. Prices will still vary according to the production season, but the 'speculation' which affects both farmers and consumers adversely can be minimized to a large extent. Therefore strengthening the horticulture data base becomes very important if the country has to translate production gains in horticulture into higher incomes for

farmers.

Warehousing, Cold Storages and WRs

The next step would be the establishment of a chain of cold storages, much like the warehouses which the FCI, CWC and the state marketing federations have established for cereal crops. It is true that over the last decade, several steps have been taken to enhance the cold chain capacity in the country, but it is still woefully inadequate. With just about five thousand cold storages in the country, with the bulk of them concentrated in UP, Punjab and West Bengal, and for the potato crop, the country needs another twenty five thousand throughout the length and breadth of the country, especially in the NHM districts. The WR (Warehouse Receipt)has to be extended to the cold storages as well , because while the 'receipts/slips' issued by the cold storage owners are informally traded, there is no legal sanction behind them, and in any case, banks cannot extend loans against these receipts. This is important because the overwhelming majority of cold storages in the country rent out their spaces to small producers.

Distribution Channels

If PSUs have a 'near monopoly' in the procurement and a lead role in the distribution of cereals (the main agricultural crops), they are conspicuous by their absence in the distribution and marketing of perishables (horticulture crops). With the sole exception of Mother Dairy's 'Safal Brand' of outlets in the NCT of Delhi, the distribution is in the hands of private 'guilds' which do not encourage the entry of new players. The APMC Act helps them for it does not encourage new players, and the existing channels do not find any good reason to invest in a modern distribution channel. As long as the entire produce has to come to a central aggregation point, there is no incentive for primary level grading, sorting and value addition at the farmers' field. The intermediary's profit comes from his 'discretion' in sorting, grading and assigning value to different lots, and pushing those to different wholesalers and retailers. Thus the NVI s emphasis on formation of farmers' groups, and training them to sort, grade and do primary level value addition(lot sizes, lot mixes) can go a long way in improving farmers control over his produce. This will of course, call for professional assistance in organizing these clusters into FPOs (much like the co-op support services which NDDB provided to the dairy sector). However, the general consensus is that beyond this level, aggregators will be required to establish and upgrade the supply chains- both to the existing vendors, and to thousands of other 'Karana' stores which are currently not in this domain as they do not have the facility of a 'cold chain' in their premises. In fact more than the distribution of pre graded, pre packaged vegetables, is the issue of logistics support for the new push cart, with pneumatic tires and temperature controlled chambers. The vegetable vendor also has another set of issues, which are beyond the ken of horticulture: these relate to municipal zoning, livelihood, credit and 'inspectors' of different departments- from health to legal meteorology and of course the police! However, when farmers' incomes, and the health of the consumer is at stake, horticulture department will have to encourage and support these networks, and use agencies like the SFAC, NHB and Nafed to take these forward with support from all stakeholders, including corporate and municipal bodies.

Strengthening the Department

The manifesto for the horticulture sector is therefore quite ambitious, and it also has the financial resources and policy matrix clearly laid out. What needs to be done is well known – the question is – how does one begin? The fact of the matter is that the department does not have the foot-soldiers to implement the vision that has been laid out. Most states have staff vacancies ranging from forty to seventy percent, and the staff position itself needs to be reviewed in the light of the new responsibilities and challenges which the sector faces. It has become quite fashionable in policy circles to be critical of the role of government staff, but in the extensive tours which your essayist has taken across states – it is obvious that the departments will have to be restructured to leverage the challenges mentioned above into 'double digit 'growth opportunities!

Joint Secretary, Ministry of Agriculture, GoI

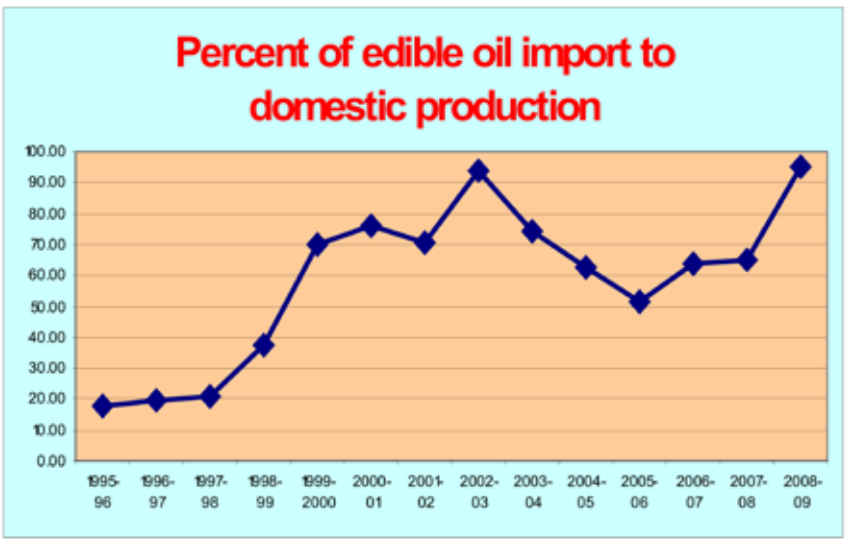
Constraints to Groundnut Production in India

Dr. S.P.Bhardwaj and Dr. Ashok Kumar

The Supply side

India is one of the major consumers of edible oil in the world. Though, production of oilseeds (9 major oilseeds) in India has increased from 5.2 million tonnes to 24.93 million tonnes whereas area has increased from 10.1 million hectares to 26.11 million hectares during the period of 1949-50 to 2007-08. However, the massive increase in production remained insufficient to match the ever rising domestic demand of edible oil. The Technology Mission on Oilseeds was launched by the Central Government in 1986 to increase the production of oilseeds and pulses (TMOP). The aim was to reduce the dependency on imports and simultaneously to achieve self-sufficiency in edible oils. Subsequently, oil palm was also brought within the purview of the Mission in 1992. In addition, the National Oilseeds and Vegetable Oils Development (NOVOD) Board also supplemented the efforts of TMOP by opening of newer areas for non-traditional oilseeds. However it could not make a dent in productivity of oil seeds. That is why the imports of edible oils has been increasing year after year to meet the domestic demand. Consequently, the domestic prices moved up and the import of edible oil and oilseeds has become vital. In recent years different varieties of edible oil have come up like, Sunflower, Safflower, Palm oil etc. Future and forward trading in pulses, oilseeds and oil have come under criticism, owing to the price inflation in such commodities. The percentage of edible oil import to domestic production has increased tremendously over the period. It was only 18 per cent in 1995-96 which has increased to 76 per cent in 2000-01 and 95 per cent in 2008-09, which indicates the increasing dependency on import. Yet, the huge quantity import of edible oils remained ineffective to check the rise in price of edible oils in domestic market.

Dr. S.P. Bhardwaj

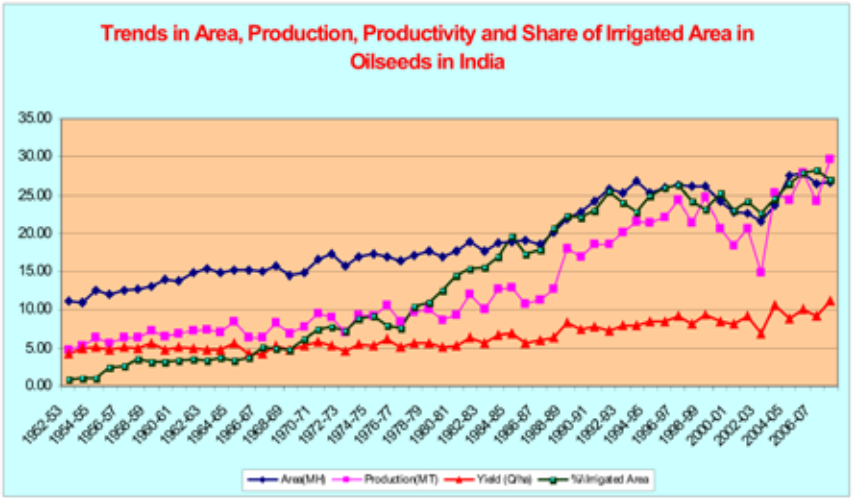


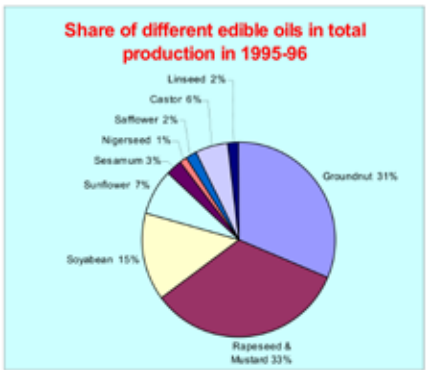
Source: Agricultural Statistics at a Glance, 2011, DES, MOA, GOI

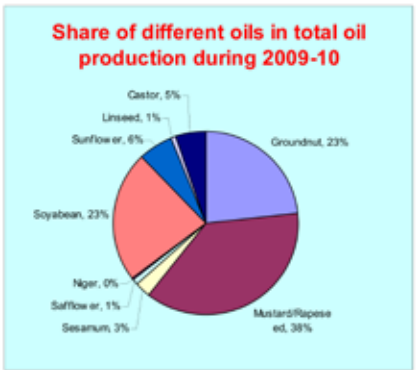
Trend in area, production and yield of oilseed crops in India

The trend of area under nine oilseeds has increased from 4.5 million hectare in 1949-50 to maximum 8.71 million hectare in 1989-90 and after that it has decreased to about 5.0 million hectare in 2009-10. The production of oilseeds was observed maximum in 1988-89 i.e. 9.66 million tonnes and it was decreased thereafter to 5.5 million tonnes during 2009-10 except 9.18 million tonnes during the year 2007-08. The yield of oilseeds has increased from 775 kg/ha during 1950-51 to 1132 kg/ha during 1988-89 with fluctuating trend and the maximum yield 1459 kg/ha was obtained only during 2007-08. This shows that there exists a yield potential but we are unable to achieve due inbuilt constraint in oilseed cultivation.

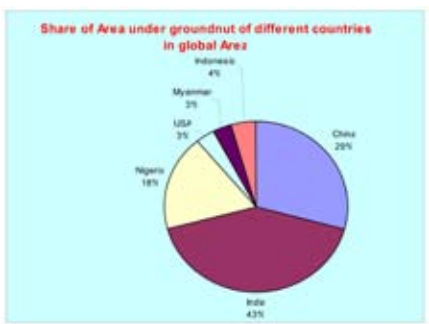
The important oilseed crops grown in this country are Groundnut, Rapeseed and Mustard, Sesame, Linseed, Safflower, Castor, sunflower and Niger. The major share in total edible oils is of mustard and rapeseed, groundnut and soyabean. The share of mustard oil has increased

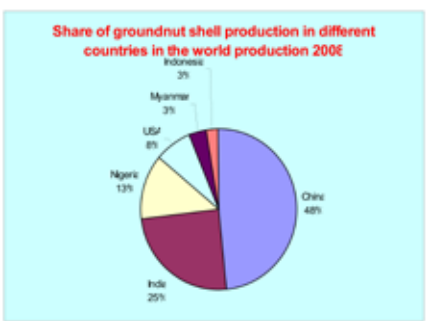


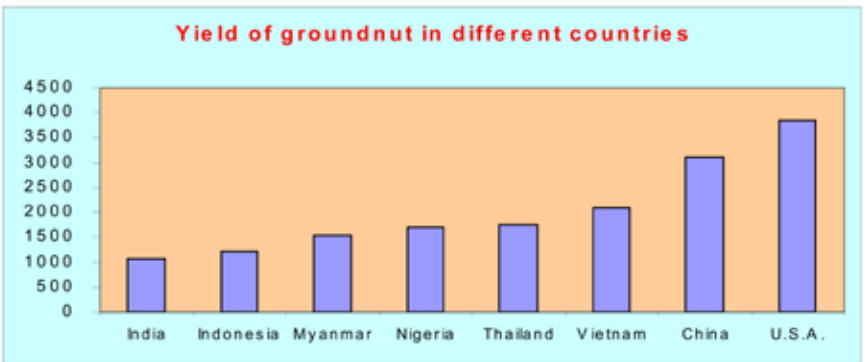




from 33 percent to 38 percent in 2008-09 over 1995-96 in total oil production and soyabean has increased from 15 percent to 23 percent during the same period. However, the share of groundnut, which is one of the most important oilseed crops, has







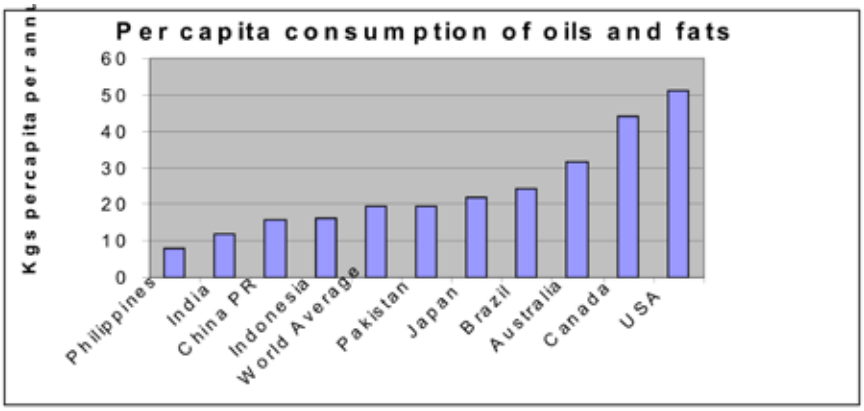
decreased from 31 percent to 23 percent during the same period.

Groundnut (Arachis hypogaea L.) is believed to be the native of Brazil, Peru, Argentina and Ghana. It was introduced in India during the first half of the sixteenth century from one of the Pacific islands of China. The major groundnut-producing countries in the world are India, China, Nigeria, Senegal, Sudan, Burma and the USA. Out of the total area of 18.9 million hectares and the total production of 17.8 million tones in the world, these countries account for 69% of the area and 70% of the production. India occupies the first position, both in regard to the area and the production, in the world.

However the yield of oilseeds in India is far below the other oilseed growing countries. USA has the highest yield in the world and it is followed by China, Vietnam, Thailand, Nigeria, Myanmar and Indonesia, while India has the lowest yield among all the countries. On the consumption side too, USA occupies first position while India occupies the position below the world average.

In India, seventy percent of the area and 75% of the production are concentrated in four states, namely Gujarat, Andhra Pradesh, Tamil Nadu and Karnataka which have only 6 to 10 percent irrigated area of the total groundnut area in India. Groundnut is raised mostly as a rain fed kharif crop, being sown from May to June, depending on the monsoon rains. In some areas or where the monsoon is delayed, it is sown as late as August or early September. Under rain fed conditions, the average yield of semi-spreading and spreading varieties is 1200-1400 kg of unshelled pods per hectare and that of bunch types is 800-1,000 kg. The crops grown with supplemental irrigations produce 3,000 kg more of pods per hectare. The pods yield 70 to 75 per cent of kernels by weight. The yield of haulms is usually two to two-and-half times that of pods.

Groundnut is one of the major sources of edible oil and its consumption in India has been growing steadily over the years. Aggregate consumption increased from around six million tonnes in the early nine-

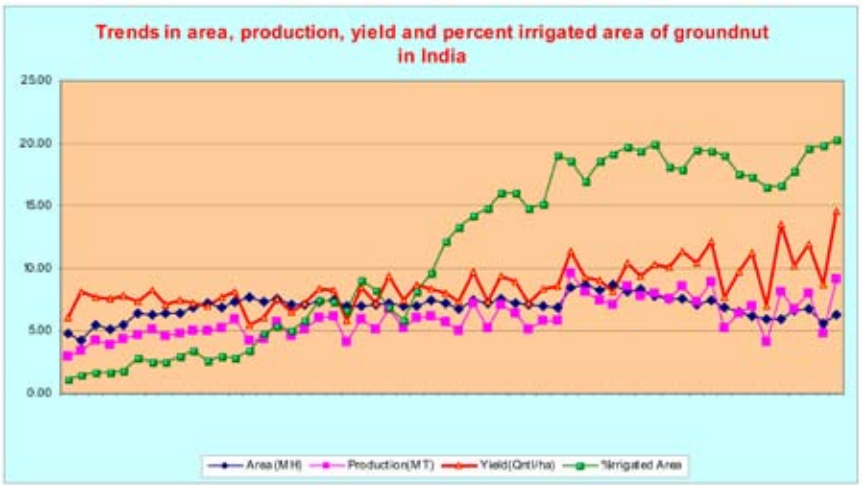


ties to around than 11 million tonnes in recent years. However, per capita consumption of fats and oils in India is far below the world average.

Consumption preferences for different oils vary across different regions in India and also between rural and urban areas. Groundnut and mustard oil together account for 59% and 67% of total edible oil consumption in urban and rural areas respectively. The available estimates of demand show that edible oil consumption is highly price and income elastic.

Trends in area, production, yield and percent of irrigated area under groundnut in India

The trend in area and production has shown a very slow growth while yield has shown a better growth after the year 1977-78 where the percentage area under irrigation has started gaining. The correlation between area under groundnut and production is 0.60 during the period 1952-53 to 2007-08. Further, the correlation between yield and percent irrigated area is about 0.70 and correlation between production and yield is 0.87. It indicates that production is increased due to yield effect and yield is increased due to irrigation as irrigation has influenced the yield of groundnut significantly. However to enhance the productivity of groundnut the uncertainty of rain must be dealt with assured irrigation and other precautions associated with the groundnut cultivation. The major constraints in groundnut cultivations were studied and reported here.



Constraints in Groundnut production and Solutions

Low Plant Population: In most of the states, groundnut is grown as a rain fed crop in kharif season. The plant population is below the optimum level of plant populations. The low population in groundnut crop is due to not using of the recommended seed rate. The probable reason may be the high seed cost. Seed cost itself constitutes more than 25% of total cost of cultivation. Small and marginal farmers can not afford the seed cost. Also, groundnut is considered as most unpredictable legume and sometimes the yields are not even to the amount of the seed rate used. Majority of the farmers are using local seeds that are nondescript and of poor quality. Being a rain fed crop, lack of optimum soil moisture at the time of sowing affects germination. Non adoption of seed treatment against seed borne diseases leads to decay of seed/seedling resulting in uneven population. Therefore maintenance of optimum plant population by taking all precau-

tions is necessary to obtain potential yields. Improved variety seeds after proper treatment with fungicide, e.g. Captan (ethanethiol or ethyl mercaptan) at the rate of 4 gm per 1 kg of seed for sowing and inoculating seed with a culture of Rhizobium are recommended.

Nutrient Management: Energy rich crop is cultivated under energy starved conditions and are cultivated in all types of marginal lands by small and marginal farmers. Investments on inputs involve risk in failure of crop, resulting in huge losses as a result of cultivation under rainfed condition / aberrant weather conditions with breaks in monsoon at critical times of moisture requirement. Farmers rarely resort to nitrogen application with the feeling that groundnut being a legume can meet its nitrogen requirements through atmospheric fixation. But it is essential that a starter dose of nitrogen in small quantities is applied for early growth. Application of lower doses of phosphorus is also required as groundnut requires sufficient

quantity of phosphorus for optimum root growth as well as for the crop to switch over from vegetative phase to reproductive growth and encourage flowering. Better root growth makes the plant to extract soil moisture from extensive areas of soil and delay the moisture stress effect on the crop. Better root development also helps in good root modulation and in turn nitrogen fixation. Farmers do not apply potassium thinking that the soils are rich in K2O. However, high intensity cropping resulting in removal of K2O from soil in abundant quantities lead to its deficiency and warrants its replenishment to soil by application in recommended doses. Use of complex fertilizers by the farmers lead to certain nutrient deficiencies like Ca & S which are essential for groundnut crop. In the absence of application of phosphorus in the form of super phosphate or nitrogen in the form of ammonium sulphate, the crop needs application of Ca & Sulphur in one form or other to produce potential yields. Application of Gypsum which contains both sulphur and calcium in required (500 kg/ha) quantities is essential at the time of flowering.

Nutrient deficiencies: Deficiencies or inadequacies of nutrients viz., Phosphorus, Potassium, Sulphur, Manganese, and Zinc etc., came into light in the recent past. It is firmly believed that multi nutrient deficiencies apart from other factors are possibly contributing towards the decline in groundnut yields in many parts of the country. Identification of several nutrients deficiencies in groundnut growing areas, coupled with the response of this crop to their application deficient elements make us believe that it might be possible to find out a solution to the vexing problem of decline in the yields of groundnut successfully. For this, application of sufficient nutrients (major/macro/micro) either to soil or by foliar sprays based on soil analysis or only when deficient symptoms are observed is required to correct the deficiency. Inoculation of Rhizobium with seed or soil should be invariably taken whenever the groundnut crop is taken in rice fallows or as a maiden crop in new areas. It would help in reduction of input cost.

Moisture stress: There is likelihood of rain fed crop experiencing moisture stress during periods of monsoon breaks. To tide over this problem adopt moisture conservation measures - (Contour owing - Soil mulching) and spray 2% urea at times of soil moisture stress experienced by crop.

Weed Problem: Maintain weed free situation during the first 30-45 days either by mechanical/cultural / or chemical measures. Ensure that there exists no competition between weeds & crop plants for nutrients and moisture.

Soil Health: Cultivate groundnut only in light to medium textured soils with moderate organic matter content. Heavy soils, soils having more organic matter are not suitable for this crop. Maintain well drained conditions. Free the field from waterlogged conditions arising out of heavy rains as quickly as possible. Tilling of soil provides good soil aeration and cuts of evaporation losses of moisture from soil. It also serves as weed control measure.

Principal Scientists, Indian Agricultural Statistics Research Institute (I.C.A.R), New Delhi

Value Addition and Post Harvest Management of Spices

M. Anandaraj, T. John Zachariah and E. Jayashree

Spices have been treasured for its flavor, pungency, aroma and colour they impart to food. The delightful flavour and pungency of spices make them indispensable in the preparation of palatable dishes. Over the years, Indian spices have carved out a niche of its medicinal and pharmacological properties in the world of spices. There are 109 spices listed by International Standards Organisation (ISO) and the Spices Board, Government of India has listed 52 major spices of commercial importance. India produces around 3.8 million tonnes of spices annually, of this about 10% is exported to over 150 countries. The USA, Europe, Australia, Japan, the Middle East and Oceanic countries are the major importers of Indian spices.

Trend in India's Spice Export

Spices export has registered substantial growth during the last one-decade, registering an annual average growth rate of 13.1% in value and 9% in volume. During the year 2009-10, spices exported from India have registered an all time high value both in terms of quantity and value (Table 1). In 2009-10 the export of spices from India has been 502,750 tonnes valued Rs.5560.50 crores as against 470,520 tonnes valued Rs. 5300.25 crores in 2008-09, registering an increase of 7% in volume and 5% in rupee value. India commands a formidable position in the World Spice Trade with 48% share in volume and 44% in value (Spices Board, 2011).

General Trend in the World Consumption of Spices

In Asia Pacific, spice consumption will increase at the rate of 4% in the coming years. It is predicted that ready to eat meat products will consume 40,000 tonnes of spices in the next five years. Consumption of spices is also expected through savoury, snacks, flavours, bakery (ginger, cinnamon, and nutmeg), soups and sauces. Demand for spices in the form of pastes, pulps and wet seasonings are gaining market considering the vast growing economies of many developing countries.

M. Anandaraj

World Awareness of the Potential of Spices

Today, there is scientifically validated knowledge on spices phytochemistry, therapeutic effects of their bioactive principles and mechanism of action. Health benefits include carminative action, hypolipidemic effect, antidiabetic property, antilithogenic property, antioxidant potential, anti-inflammatory property, antimutagenic and anticarcinogenic potential. Of these, the hypocholesterolemic and antioxidant properties have far-reaching nutraceutical and therapeutic value. Most of the medicinal properties are attributed to the secondary metabolites – the essential oils and oleoresins, present in spices. Important flavour

Table 1. Item wise export of spices from India

Item	2009-10	
	Quantity (in Tonnes)	Value (in Rs. Lakh)
Pepper	19,750	31,392.5
Cardamom(Small)	1,975	16,570.25
Cardamom(Large)	1,000	1,788.6
Chilli	2,04,000	1,29,172.80
Ginger	5,500	4,675.0
Turmeric	50,750	38,123.0
Coriander	47,250	22,585.50
Cumin	49,750	54,824.50
Fennel	6,800	5,623.60
Fenugreek	21,000	6,972.0
Nutmeg &Mace	3,275	9,186.50
Curry powder	14,300	18,918.50
Mint products	19,000	1,18,972.0
Oils & oleoresins	6,750	70,875.0
Total spices	**5,02,750**	**5,56,050.00**
		1173.75 millionUSD

Source: Spices Board, Kochi

Table 2. Important flavour compounds in spices

Spice	Important flavour compounds
Allspice	Eugenol, β-caryophyllene
Anise	(E)-anethole, methyl chavicol
Black pepper	Piperine, S-3-Carene, β-caryophyllene
Cardamom	a-terpinyl acetate, 1-8-cineole, linalool
Turmeric	Turmerone, Zingeberene, 1,8-cineole
Ginger	Gingerol, Shogaol, neral, geranial
Mace	a-pinene, sabinene, 1-terpenin-4-ol
Nutmeg	Sabinine, a-pinene, myristicin
Cumin	Cuminaldehyde, p-l,3-mentha-dienal
Fennel	(E)-anethole, fenchone
Saffron	Safranol
Vanilla	Vanillin, p-OH-benzyl-methyl ether

compounds of spices are listed in Table 2.

Medicinal and Pharmacological Properties of Spices

Spices are reputed to possess several medicinal and pharmacological properties and hence find position in the preparation of a number of medicines. Thus, in the indigenous system of Indian medicine (Ayurveda and Unani), spices have a vital role to play. Information regarding the medicinal aspects of spices, which are acceptable in the light of modern knowledge, is described with pharmaceutical codex. In Ayurveda, about 25 spices are used for various herbal preparations and the annual consumption by the Ayurvedic firms in Kerala alone is approximately 3.2 tonnes. Spices which possess some of the important medicinal properties are listed in Table 3.

Ayurvedic herbal drugs and their sources

Spices have been introduced into the Ayurvedic pharmacopoeia at a very early period in its evolutionary history. Table 4 illustrates the herbal formulations with the herbs from the family Piperaceae.

Processing and Value Addition in Spices

Value addition in spices is yet another area of activity in which India is moving forward. The consistent effort by various agencies during the last one decade has improved the share of the value added products in the export basket to more than 53%. India can now boast as the monopoly supplier of spice oils and oleoresins the world over. During the year 2009-2010, India exported 6,750 tonnes of spice oils and oleoresins worth 708.75 crores. In the case of curry powders, spice powders, spice mixtures and spices in consumer packs, India is in a formidable position.

Spices thus open ample opportunity for entrepreneurship. To achieve this one of the key requirement is to diversify the products from spices. Secondary agriculture is the watch word for development for both

Table 3. Major spices and their medicinal properties

Medicinal property	Spices
Cancer	Eugenol, β-caryophyllene
Preventive	Ginger, Black pepper, Nutmeg, Cinnamon,
Clove, Turmeric, Cardamom, Vanilla, Allspice, Mace	Piperine, S-3-Carene, β-caryophyllene
Antimicrobial	Ginger, Nutmeg, Black pepper, Cinnamon,
Vanilla, Turmeric, Clove, Allspice, Cardamom, Mace	Turmerone, Zingeberene, 1,8-cineole
Anti-	Gingerol, Shogaol, neral, geranial
Inflammatory	Black pepper, Cinnamon, Clove, Turmeric,
Allspice, Cardamom	Sabinine, a-pinene, myristicin
Spasmolytic	Cinnamon, Black pepper, Clove, Ginger,
Nutmeg, Turmeric	(E)-anethole, fenchone
Antioxidant	Vanilla, Ginger, Black pepper, Clove, Turmeric
Antiulcer	Ginger, Black pepper, Turmeric, Cinnamon,
Clove, Nutmeg, Vanilla, Allspice, Mace	
Hypoglycemic	Cardamom
Antihepatotoxic	Vanilla
Antiallergic	Allspice
Antimigraine	Turmeric, Allspice, Cardamom, Mace
Antiosteoporotic	Black pepper, Allspice, Clove, Cardamom, Mace
Estrogenic/ Androgenic	Cardamom
Immunostimulant	Turmeric, Mace
Antilithic	Allspice
Anti-insomniac	Allspice, Clove, Mace
Antiedemic	Vanilla

Table 4 Herbal formulations with the herbs from the family Piperaceae

Formulation	Ingredients
Trikatu (Three pungents)	Pepper, long pepper and dry ginger
Pancakola (The five pungents)	Long pepper fruit, long pepper root, wild pepper root, *Plumbago rosea* and dry ginger
Sadusanam (The six hot drugs)	The above mentioned herbs along with pepper

farmers and primary processors of spices. Even though India produces a good quantity of black pepper, ginger, turmeric and cardamom, more than 85% of it is consumed within the country itself. Value addition throw open ample opportunity in export. The present scenario in processing and value added products obtained from important spices are discussed.

i. Black pepper

Black pepper, *Piper nigrum* L. known as the 'King of Spices' takes about 7-8 months after flowering to reach full maturity. In India, the crop is harvested during December –January in plains and January-April in the high ranges of Western Ghats. It is important to harvest pepper at the proper stage of maturity in order to achieve a dried product of good colour and appearance. Recent advances in product diversification have necessitated harvesting of the berries at different stages of maturity which has to be regulated depending on the various end uses (Table 5).

Post harvest processing

The primary processing in black pepper involves threshing, blanching, drying, grading and packing. The berries are separated from the spike usually by trampling with human legs. Mechanical threshers with capacities varying from 200 to 1200 kg//h are available which can thresh quickly and provide cleaner products. Apart from the major quality attributes such as pungency and aroma, the appearance with respect to its colour (brown/ black) is of importance for use of black pepper as a spice in the whole or ground form. Dipping harvested green pepper for a minute in boiling water enhances the enzymatic oxidation and provides a shining black colour to the produce.

At harvest, pepper has moisture content of 60 to 70%, which should be brought to safer levels of 10-11% by adequate drying. The dry recovery varies from 29 to 43% depending on the variety. Sun drying is the conventional method followed for drying of black pepper. Driers developed by various agencies such as solar and mechanical driers are highly efficient for drying pepper.

Cleaning of dried black pepper removes extraneous matter like spent spikes, pinheads, stones, soil particles etc., enhance the value of the produce and help to get higher returns. On a small scale, winnowing and hand picking remove most of these impurities. The cleaned pepper, is sifted into different grades based on size using sieves.

Black pepper is hygroscopic in nature and absorption of moisture from air, notably during rainy season with high humidity may result in mould and insect infestation. Before storage it is to be dried to around 10% moisture. The dried whole pepper is packed and stored in double burlap bags with polythene liners.

Table 5. Optimum maturity at harvest for different pepper products

Product	Stage maturity at harvest
Canned Pepper	4-5 months
Oleoresin and essential oil	15-20 days before maturity
Dehydrated green pepper	10-15 days before maturity
Pepper powder	Fully mature with maximum starch
Black pepper	Fully mature and 1-2 berries start turning from yellow to red in each spike
White pepper	Fully ripe

ii. Cardamom

Cardamom, known as the 'queen of spices', which belongs to the family of *Zingiberaceae,* is a rich spice obtained from the seeds of a perennial plant, *Elettaria cardamomum* M. Cardamom fruits mature in about 120 days after flowering. Due to prolonged flowering period, cardamom capsules ripen successively at 10-15 days intervals over an extended period of 8 months (from August to March). Generally harvesting is carried out at an interval of 15-30 days and completed in 8-9 rounds by hand picking.

Post harvest processing

The harvested capsules carry soil or dirt on their surface and hence they are washed thoroughly in water. The capsules are then treated with 2% sodium carbonate solution for 10 minutes which enables to retain green colour and prevent mould growth. The alkali treated cardamom capsules are spread in trays and cured in curing houses or mechanical driers. Curing in cardamom is the process in which the moisture content of freshly harvested cardamom capsules is reduced from 70-80% to 11-12% at an optimum temperature of 45-55^{o}C so as to retain its green colour and volatile oil to a maximum extent. The cured capsules are graded using sieves of 8, 7.5,7 and 6 mm. The graded cardamom is stored over a period of time, in double lined polythene bags.

iii. Ginger

India and China are the world's largest producer and exporter of ginger *(Zingiber officianale*). In India normally harvesting of ginger is done from January to April, varying with the locations. The crop is ready for harvest in about 8 months after planting when the leaves turn yellow and start drying up gradually. The clumps are lifted carefully with spade

or digging fork and the rhizomes are separated from the dried up leaves, roots and adhering soil. Harvesting is to be done from the 6th month onwards when used as green ginger. The quality of ginger is affected by the stage of the harvest and needs to be scheduled for various end uses (Table 6).

Post harvest processing

The post harvest processes involved in the processing of matured fresh ginger to dry ginger involves peeling, drying and polishing. Peeling hastens the process of drying and maintains the epidermal cells of the rhizomes, which contain essential oil responsible for aroma of ginger. Indigenously, peeling is performed by partially scraping the peel of ginger rhizomes with sharpened bamboo splinters. The scrapped or partially peeled rhizomes are put for drying on clean drying yard. Traditionally ginger is sun dried in a single layer in open yard. The cleaned and partially peeled ginger with moisture content of about 80% is spread thinly under sun and the moisture content is brought down to 10% or even less for safe storage. It takes about 10-15 days for complete drying. The dried ginger presents a brown, irregular wrinkled surface and when broken shows a dark brownish colour. The dry ginger so obtained is known as rough or unbleached ginger. The yield of dry ginger is 19-25% of fresh ginger depending on the variety and the location where it is grown.

iv. Turmeric

India is the largest producer and exporter of turmeric (*Curcuma longa*) in the world. It is estimated officially that about 80% of the world production of turmeric is from India alone. The turmeric crop is ready for harvesting in about 7 to 9 months after sowing depending upon the variety. In India, sowing takes place between June and July and harvesting is done from February to April. Before harvest, the dry leaves and stem are cut close to the ground. The rhizome bunches are carefully lifted and soil adhering to the rhizome surface is removed manually and further cleaned to remove roots and scales before they are collected in the curing yard.

Table 6. Stage of harvest of ginger for various end uses

End use	Stage of harvest (months after planting)
Vegetable purpose and preparation of ginger preserve, candy, soft drinks, pickles and alcoholic beverages	4 - 5
Dried ginger and preparation of ginger oil, oleoresin, dehydrated and bleached ginger	8-10
Green ginger, oleoresin and volatile oil High dry ginger & starch and low crude fibre Dry ginger	7 8 8 - 9
Salted ginger High essential oil High oleoresin High essential oil & oleoresin	4 – 5 7 7½ - 8 8
High oleoresin and oil content	9
High crude fibre & Low protein and fat	6½ - 7
Low crude fibre	7
Less fibre & mild pungency	< 7

Post harvest processing

The turmeric processing consists of washing, boiling/curing, drying, polishing, colouring, packaging and marketing. Traditionally boiling is done in metal or mud pots with water for 1 hr to 1.5 h. Boiling process is continued till white foam start coming out with a special quality of flavour. Boiling considerably reduces the drying time and helps in producing a product of fairly uniform color. Improved turmeric boilers using steam for cooking rhizomes are available in the capacities ranging from 100 -1000 kg/batch. The cooked rhizomes are spread in open yard for drying and it takes about 10-15 days for complete drying. When dried properly, the rhizomes become hard, almost horny, brittle and of uniform yellow colour. Completely dried turmeric holds 8-10% moisture content. The dried rhizomes are

hand polished by rubbing dried rhizomes against a hard surface. By this process colour of turmeric becomes bright or shining. The product is known in trade as 'polished turmeric'. Mechanical polishing helps to remove scales, roots and some of the epidermal layer through the sieve mesh surrounding the polishing drums.

v. Chilli and Paprika

Chilli (C*apsicum annum)* is the most widely cultivated crop among the spices grown in India. It is harvested when the pods are well ripened and partially wither at the plant itself. At this stage they would have superior pungency and colour.

Post harvest processing

The harvested pods are kept in heaps either indoor or in shade away from direct sun light for 2-3 days so as to develop uniform red colour. Subsequent to this, the pods are dried under the sun by spreading them out on clean, dry mat, cemented or concrete surface. The harvested chillies in ripe condition have moisture content of 70-80% and need to be dried for 13-15 days for the reduction of moisture to a safe moisture content of 10% and then stored. In mechanical drying, the chillies are dried at a temperature of 50^{o}C and at air velocity of 1.5 m/s. Solar cabinet driers and waste fired

Table 7. Quality profile of high quality black pepper varieties

Variety	Yield (dry) (kg/ha)	Oleoresin (%)	Piperine (%)	Essential oil (%)
Subhakara	2352.0	12.4	3.4	6.0
Sreekara	2677.0	13.0	4.1	5.0
Panchami	2828.0	12.5	3.7	3.4
Pournami	2333.0	13.8	3.1	3.4
IISR Thevam	1787.0	8.15	1.6	3.1
IISR Malabar Excel	1065.0	13.5	2.96	3.2
IISR Girimunda	2112.0	9.65	2.2	3.4

Table 8. Quality profile of important cardamom varieties

Variety	Average yield (dry), kg/ha	Essential oil, %	1,8- Ciniole, % of Essential oil	Terpinyl acetate, % of Essential oil
IISR Suvasini	1322	8.7	42.0	37.0
IISR Vijetha	643	7.9	45.0	23.4
IISR Avinash	847	6.7	30.4	35.5

Table 9. Quality profile of high quality ginger varieties

Variety	Average yield (fresh) t/ha	Dry recovery (%)	Crude fibre (%)	Oleoresin (%)	Essential oil (%)
IISR Varada	22.6	19.5	3.2	6.7	1.8
IISR Mahima	23.2	23.0	3.9	4.5	1.7
IISR Rejatha	22.4	20.8	4.0	6.3	2.4

Table 10. Quality profile of high quality turmeric varieties

Variety	Av. yield (fresh) t/ ha	Dry Recovery (%)	Crude fibre (%)	Oleoresin (%)	Essential oil (%)
Suvarna	17.4	20.0	4.3	13.5	7.0
Suguna	29.3	12.0	7.0	13.5	6.0
Sudarsana	28.8	12.0	5.3	15.0	7.0
IISR Prabha	37.5	19.5	6.5	15.0	6.5
IISR Prathiba	39.1	18.5	6.2	16.2	6.2
IISR Kedaram	34.5	18.9	5.5	13.6	3.0
IISR Alleppey Supreme	35.4	19.3	6.0	16.0	4.0

Table 11. Quality profile of IISR Viswasree nutmeg variety

Quality parameters	Value, %
Nut oil	7.14
Mace oil	7.13
Nut recovery	70
Mace recovery	35
Oleoresin in mace	13.8
Butter in nut	30.9
Myristicin in nut oil	12.48
Myristicin in mace oil	20.03
Elemicin in nut oil	13.65
Elemicin in mace oil	13.65

Table 12. Quality profile of IISR Nithyasree and Navasree cinnamon variety

Quality parameters	Value, %	
	Nithyasree	Navasree
Bark oil	2.7	2.7
Leaf oil	3.0	2.8
Bark oleoresin	10.0	8.0
Bark recovery	30.7	40.6
Cinnamaldehyde in bark oil	58	73
Cinnamaldehyde in leaf oil	14	15
Eugenol in bark oil	5.0	6.0
Eugenol in leaf oil	78	62

Table 13 Value added products from spices

Spice	Value added product
Black pepper	
Green pepper based products	Canned green pepper, green pepper in brine, cured green pepper, frozen green pepper, freeze dried green pepper, dehydrated green pepper, green pepper oil, green pepper pickle, mixed green pepper pickle, green pepper sauce and green pepper-flavoured products.
Black pepper based products	Whole black pepper, sterilized black pepper, ground black pepper, cryoground black pepper powder, pepper oil and oleoresin.
White pepper based products	Whole white pepper, white pepper powder.
Other products of black pepper	Pepper mayonnaise, pepper cookies and pepper tofu. Pepper extract is a valuable adjunct in the flavouring of sausages, canned meat, soups, table sauces and certain beverages and liquor. Pepper oil is used in perfumery and also for manufacturing soaps. Products like lemon pepper, garlic pepper, sauces and marinades have pepper as major ingredient. Curry powders and spice blends have pepper as one of the major ingredient.
Cardamom	Bleached cardamom, decorticated seeds and seed powder, cardamom volatile oil, cardamom oleoresin. Other products include encapsulated cardamom which is free flowing and having uniform flavor, cardamom tea, cardamom coffee, cardamom soft drink mix.
Ginger	Ginger powder, salted ginger, ginger oil, ginger oleoresin, ginger-based beverages like ginger beer and ginger ale, ginger candy, ginger paste, salted ginger, salted ginger, crystallized ginger.
Turmeric	Ground turmeric, turmeric oil, turmeric oleoresin, curcumin
Chillies	Paprika oleoresin, chilli colour, chilli pungency, dehydrated chilli, canned chilli, brined/pickled chill fermented chilli, brined/pickled chilli, fermented chillies.
Nutmeg	Nutmeg powder, nutmeg oleoresin, nutmegs butter, mace oleoresin mace oil. Nutmeg flavor is used in many kinds of baked goods, confections, puddings, meats, sausages, sauces, vegetables, and such beverages as eggnog.
Cinnamon	Cinnamon bark oil, cinnamon oleoresin, cinnamon leaf oil, cinnamon powder, cinnamon root bark oil
Clove	Clove powder, clove oil

driers are also developed for drying of chillies. Packing of dry chillies is done using jute cloth, paper or paper cartons with polythene lining of 300 gauge.

The colour of chilli spice powder is due to the presence of red-pigmented carotenoids. The main pigments are capsanthin, capsorubin, zeaxanthin and cryptoxanthin. Carotenoids are very stable and intact in plant tissue. However, when chillies are processed by drying and grinding into spice powder, the carotenoids easily auto-oxidise due to effects of heat, light and oxygen. This leads to a more orange and less intense colouration.

vi. Nutmeg and mace

Nutmeg and mace are two different parts of the same fruit of the nutmeg tree, *Myristica fragrans*. Nutmeg is the dried kernel of the seed and mace is the dried aril surrounding the seed. Fruits are harvested when they split open on ripening.

Post harvest processing

Processing of nutmeg starts with the removal of mace surrounding the nut followed by drying of nut and mace separately. Firewood is generally used to dry nutmeg. Nutmeg is spread to a thickness of about 5-8 cm on wooden trays having openings at the bottom for hot air circulation. The trays are placed approximately about 3 m above the furnace and the heat produced by burning firewood is used to dry nutmeg. Drying of nutmeg is completed in 5 days when the kernel inside the seed rattles on shaking. Mechanical driers for drying nutmeg operate at a temperature of 40-45°C and can produce nutmegs without shell breakage or fungal contamination.

Conventionally, mace is dried in the sun, kitchen fireplace utilising the heat from the stove, improved chulas made of tiled hollow bricks or in mechanical driers. It takes about 4-5 h for complete drying of mace. The scarlet red colour of mace is due to the presence of the pigment lycopene and is highly sensitive to heat and light. During drying, scarlet-red colour of mace changes to light red or reddish brown colour. Hot air mechanical driers operating at temperature of 50-55°C produce uniformly coloured dry mace of high quality.

Quality profile of important spice varieties

The medicinal property and aroma quality of spices are attributed to the volatile oils present in spices. The non-volatile part of spice extracted using organic solvents is called the oleoresin. The high yielding varieties of black pepper, cardamom, ginger, turmeric, nutmeg and cinnamon released by Indian Institute of Spices Research along with the quality profile is tabulated in Tables 7, 8, 9 and10.

Value added products from spices

A variety of value products from spices are available in market. A list of commercial value added products that are prepared from pepper, cardamom, ginger, turmeric, chillies, nutmeg cinnamon and clove are tabulated in Table 13.

Conclusion

There is assured market for processed spice products like curry powders, oils and oleoresins. The demand for spices as nutraceuticals world over is showing an upward trend. Spices and its derivatives offer great scope under food related Agriculture Industries. Post harvest management of spices has great scope considering present International trade scenario. We expect a huge jump in the export of curry powders and other value added products in the coming decade.

Indian Institute of Spices Research, Kerala

Industry

Mechanization and Secondary Agriculture for Prosperity in Agriculture

Pitam Chandra and K. N. Agrawal***

Pitam Chandra

For the past several years, Indian economy has been growing at rates ranging from 6 to 9% essentially due to the manufacturing and service sectors. The growth rate of agriculture sector has been far short of the planned figure of 4%. It is only during 2010-11 that agricultural growth rate was observed to be about 6.6%. The low growth rate of agriculture sector is worrisome because it impacts country's food security and income and livelihood of about two-thirds of country's population. The disparity in the growth rates of agriculture and other sectors leads to several socio-economic problems in the society. Therefore, while 8-9% economic growth for the country is commendable, it is essential that this growth rate has an additional attribute of inclusiveness.

It is said that essentially seed, fertilizer and water brought about the first green revolution. While seed, fertilizer and water would continue to be essential inputs, the need for technology is more than ever for bringing efficiency and profitability to agriculture sector. Farmers today are investing in the education of their children and the next generation of farmers would look for profitability and prestige in their vocation.

Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) has been very important in the recent past in several ways. The dynamics of migrant agricultural workers has undergone a big change. Because of the economic empowerment due to MNREGA, agricultural workers have reduced their movement to far-off places. As a result, lack of agricultural labour in States like Punjab, Haryana and Kerala is leading towards increased reliance on labour-saving machineries. Recent spurt in the demand of paddy transplanters is a consequence of the non-availability of labour for completing timely transplanting. Sectors like coffee, tea, spices, and plantation crops have begun to realize the importance of mechanization since labour availability is getting more uncertain and expensive.

To cope up with the current situation, India needs second green revolution. With no possibility of increase in net cultivated area, intensive agriculture with higher input use efficiency coupled with precision application of inputs and better management practices will hold the key to success. New issues arising out of global warming and associated climate changes would call for development / adoption of farm machines management practices to mitigate the situations. Success of the second green revolution would be significantly affected by the quality and extent of engineering inputs to ensure timeliness of farm operations, higher input use efficiency, extending the temporal and spatial coverage of agriculture, efficient management of biotic stresses, human safety in farm and off-farm operations, energy management and renewable energy sources, environmental quality, post harvest processing and value addition, residues and by-product utilization, bio-processing, and food safety and quality.

Low profitability of farming in India continues to be a matter of concern. Considering that there are 115 million farm holdings in the country and the net cultivated area is just 142 million ha, it is obvious that a farm holder needs much more than just crop cultivation for meeting his/her financial obligations. Experience has shown that wherever agriculture has become profitable, the rural-to-urban

and mountains-to-plains migrations have had a turn-around.

The simple relationship of profitability requires costs to go down and the incomes to rise. Cost cutting is achievable through checking the wastages and ensuring the quality of inputs. Backward linkages with the input suppliers and engineering interventions to minimize the input applications are, therefore, necessary. Similarly, the produce needs to be harvested at the most appropriate stage and handled carefully until it is marketed at remunerative prices.

Based on the experiences of developed nations and those in our country, there is enough reason to believe that the higher agricultural growth is positively correlated with the increasing farm mechanization. Clearly, this relationship between mechanization and agri-growth needs to be appreciated and strengthened. The sale of tractors and agricultural machinery during the past two years has been registered about 15% or more growth. The performance of agricultural sector has been promising on several fronts. The growth rate of 6.6 percent during 2010-11 accompanied by impressive growth in tractors and agricultural machinery sales is indicative of the positive correlation between mechanization and agricultural growth.

The expectations from agricultural mechanization are as follows.

- Sustainable increase in productivity and cropping intensity
- Conservation of inputs through precision in metering and placement
- Enhancement in income of agricultural workers
- Benefits to all categories of farmers
- Creation of worker-friendly environment
- Reduced cost of production leading to greater profitability

While developed world mechanised its agriculture to create surplus labour for the industrial sector, in India it has been directed to help farmers and farm workers do their job speedily, provide a quality job, acquire additional capacity to achieve timeliness in field operations without much hardship and drudgery. It has also helped in achieving precision in metering and placement of inputs for better crop stand, better response to inputs and increased productivity. Farm mechanization imparts dignity to farm work breaking social inhibitions. Bullocks and other draft animals continue to have relevance in India for socio-economic reasons particularly to marginal and small farmers. With mechanization, farm power availability has increased, yet lot of efforts and investments are needed particularly in Eastern and North Eastern states, hilly, mountainous, and tribal areas.

India has witnessed steady growth in production and use of electro-mechanical power sources particularly 4-wheel small tractors, power tillers, diesel engines and electric motors and matching equipments since 1960s. The rate of growth in sector is 8-10 % per annum. During the year 2010-11, India produced about 5.5 lakh tractors. Though power tiller manufacture started about the same time as tractor but the demand has been low, possibly due to wetland cultivation in kharif and upland during rabi for which power tillers are not very suitable unless soil is in friable range. New and renewable sources of energy have been harnessed for agriculture, agro-processing and rural living.

There is a close high correlation between degree of agricultural mechanization, energy use and agricultural production and productivity. However, over mechanization as in Punjab resulted in indebtedness of the farmers, as the acquired farm power and machinery assets are not fully utilized. Farm power availability in Punjab is the highest in the country and so is foodgrain productivity.

Agricultural mechanization in India is essentially a post-independence phenomenon. Energy intensive operations were mechanised first like irrigation, seedbed preparation and sowing, threshing and cleaning, harvesting, and transport. India is one of the largest producers of small 4-wheel tractors in the world with a wide range of matching implements and machines. However, spread of

Table 1: Traditional and improved implements and machines available for different unit operations of agriculture

Unit Operation	Traditional	Improved
Seedbed preparation	• Desi Hal & variants (AD) • Moulboard Ploughs (AD) • Spike Tooth Harrow • Spring Tooth Harrow (AD) • Singh Patela (AD) • Bakhar (AD) • Dufan an Tifan (AD) • Wooden Planker (AD) • Mallet, Flail (M) • Scoop/Buck-scraper (AD) • Bund Former (AD) • Floats (AD) • Spade, Pick Axe, Crowbar	• Single Action/Reversible MB Ploughs • Disc Ploughs (TM) • Sub-Soiler (TM) • Tandem/Offset Disc Harrow (TD/TM) • Rigid/Spring Tyne Tillers (TM) • Tiller with Crushing Roller (TM) • Puddlers (AD &TM) • Scraper/Leveller (TM) • Laser Land Leveller (TM) • Raised Bed Former, Ridger, Furrower (TM) • Post Hole Digger/Auger (TM)
Seeding & Planting:		
Rice	• Broadcasting, Lehi, Bayasi • Manual transplanting • Zero-Till Drill (TM)	• 8-row Mechanical Rice Transplanter (SP) • Pre-germinated Paddy Seeder
Wheat	• Broadcasting • Desi Hal with Seeding Funnel • Dufan and Tifan	• Raised Bed Seeder (TM) • Seed/Seed-cum-Fertilizer Drill (TM) • Zero-Till Drill (TM) • Strip-Till Drill/Roto-Till Drill (TM)
Maize, Cotton	• Manual Seedling/Dibbling • Desi Hal with Seeding Funnel	• Seed-cum Fertilizer Drill (TM/AD) • Seed-cum-Fert Planter (TM/AD)
Vegetable	• Dibbler	• Planter (M, TM) • Garlic planter (M, TM) • Veg. Transplanter (TM)
Potato	• Manual on flat bed or furrow • Karaha to cover (M)	• Automatic Potato Planter • Semi-automatic Potato Planter (TM)
Sugarcane	• Manual	• Set-Cutter Planter (TM) • Stubble Shaver (TM)
Weeding & Interculture	• Physical • Manual with Khurpi/ Khurpa • Dora (AD) • Datari (AD) • Ridger (AD) for earthing	• Wheel-hoes (M) • Cultivator with Full & Half Sweeps (TM) • Rotary Power Weeder • Power Tiller for Alley Management • Ridger (TM) for earthing

farm mechanization is not uniform throughout the country. It is more visible in the Green Revolution areas. It has not adequately penetrated in East and North-East India, hills and mountain regions, tribal areas particularly amongst marginal and small farms.

Indigenous manufacture of irrigation pumps, tractors, power tillers and their attachments such as mouldboard ploughs, disc ploughs; disc, spring and spike tooth harrows; seed and seed-cum-fertilizer drills started in 1960s. Indigenous R&D on farm implements and machines led to development and adaptation of vertical conveyor reapers (walking type, riding type, PT & tractor mounted), improved serrated sickles, power threshers (crop specific and multi-cropped), winnowers, rice transplanters, weeding and interculture equipments, power weeders, grain combines, laser land levellers, scrapers and graders, zero-till drill, raised-bed planter, vegetable trans-planters and diggers for some of the vegetable crops. More efforts are needed for mechanization of fruit and vegetable crops, sugarcane and other commercial crops. With steady increase in labour wages and dearth of farm labour there is increasing demand of farm mechanization failing which agriculture is going to suffer.

Table 1 gives traditional and improved implements and machines available for different unit operations of agriculture. Farm Machinery and Power industry accounts for over Rs.50,000 crore annual turnover excluding Farm Implements and machinery manufactured/fabricated by the craftsmen.

Mechanization and Improved Profitability

A 2010 study by the Centre of Evaluation for Global Action (CEGA) of University of California at Berkley on the 'Barriers to Farm Profitability in India' concluded that the lack of mechanization was an important

Plant-Protection	• Hand Compression Sprayer • Rocking/Pedal Operated Sprayer • Hand Rotary Duster	• Knap Sack Sprayer with long boom (M) • Knap Sack Power Sprayer (M) • Tractor/PT operated Sprayers (TM, PT) • Aero-Blast Sprayers (TM)
Irrigation	• Swing Basket (M) • Dhekuli (M) • Mhote/Charas (AD) • Rahat/Vasher Rahat (M) • Flooding, Basin, Furrow Irrigation • Ponds, streams, reservoirs • Dugwells, Baulis	• Centrifugal Pumps • Submersible Turbine Pumps • Axial Flow Pumps • Ponds, Reservoirs • Dugwells • Tubewells • Streams • Flooding, Basin, Furrow irrigation • Drip-surface, sub-surface • Sprinkler, Micro-sprinklers
Harvesting & Threshing	• Sickle-plain/serrated (M) • Fruit Plucker (M) • Sythe, Dao, Gandas (M) • Animal Treading, Beating with flail • Olpad Thresher (AD) • Winnowing Fan (M, P)	• Vertical conveyor Reaper (Walking) • Vertical Conveyor Reaper (SP) • Vertical Conveyor Reaper (TM, PT) • Power Thresher (R, W, Sorghum etc) • Power Multi-crop Thresher • Maize Dehusker • Maize Dehusker-Sheller • Potato Digger/Digger-Shaker • Grain Combine • Straw Combine • Sugarcane Harvester
Cleaning and Grading	• Supa, cleaning basket • Chhalna, Screen • Hand picking • Winnowing/Winnower • Pedal Operated Screen Cleaner • Fruit Graders	• Power Operated Pre-cleaner (P) • Air Screen Cleaner (M) • Vibratory Separator/ Gravity Separator (P) • Oscillating Multi-screen Cleaner/ Grader (P) • Spiral Separator (M) • Disc Separator (P) • Fruit & Vegetable Washer (P) • Fruit & Vegetable Packaging Line (P), etc.
Drying	• Drying in Standing Crop • Sun Drying • Shade Drying	• Solar Dryers • Heated Sand Dryers • Heated Air Batch/ Circulatory Dryers (Oil, crop residue fired) • Heated Air Tray Dryers • Vacuum Dryer, etc.

AD = animal drawn, TD = tractor drawn, TM = tractor mounted, PT = power tiller operated, M = manual, P = power-engine or motor, R = rice, W = wheat.

constraint in achieving higher farm profitability. Considering a very wide spectrum of land holdings in the country and equally wide spectrum of resource base of these farmers, a uniform model of mechanization is ruled out. Farm implements and machineries are not expected to be owned by all farmers. While larger farm-holders may own some farm machines, small and marginal farm-holders would not be able to afford the farm machinery ownership. Custom hiring of farm equipments has been found to be the solution in such cases.

Depending upon the prevalent farming systems, entrepreneurs could choose a combination of services for custom hire so as to earn uniformly throughout the year. Such entrepreneurs have been found to earn a few lakh rupees per annum conveniently. Custom hiring activities of farm machines and equipments taken up by some individuals and self help groups have shown very encouraging results. A small-scale tractor/ machinery repair shop could be established after adequate training and an annual income of about Rs. 2.5 lakh could be earned by repairing the tractors and farm machinery.

The limited mechanization efforts in the country so far have been highly encouraging. Who would have imagined a decade ago that zero till drills would transform the wheat cultivation in rice-wheat cropping system? Today, the country is saving about Rs. 600 crore in terms of input costs and adding Rs. 300 crore worth of grain annually. The gains are at all levels: national, farmer, entrepreneur, and environment. Pre-germinated paddy seeders are becoming very popular in comparison to transplanted paddy cultivation due to huge savings in seed, water, labour without compromising on rice productivity. Even where transplanted paddy is the

norm, paddy transplanters are leading to significant labour savings. Nursery raising and transplanting jobs are being out-sourced to entrepreneurs who provide the services whereby both the farmer and the entrepreneur get benefited. A self-propelled paddy transplanter in one season provides a net income of about Rs. 75,000 to the entrepreneur.

Labour shortages are compelling farmers to even outsource all farm operations for a given crop and thus obviating the need to own any piece of farm machinery. In Madhya Pradesh, under the 'Yantradoot' scheme spread over 25 villages, Directorate of Agricultural Engineering, MP Government reported field experiment data on wheat cultivation under traditional equipment vis a vis improved mechanisation package where crop specific farm implements were introduced during Rabi 2010-11. The yields of wheat and gram during Rabi 2010-11 increased by 40% and 25% as compared to those without the introduction of farm machinery. They indicated that the reduction in the cost of production of wheat due to mechanization in their Yantradoot villages was about Rs. 3000/ha. Similar mechanization efforts are needed across all crops and commodities for all-round benefits and increased overall farm profitability.

Secondary Agriculture

Considering the specific farming situation in India where huge post harvest losses occur and farmers' income is miserably low, the concept of secondary agriculture has evolved. It envisages that farmers are not only engaged in primary agriculture to produce different food and non-food commodities but they also participate in the processing and value addition activities leading to reduced post harvest losses and higher income. Secondary agriculture simply means processing and value addition to the primary produce. After meeting the food and feed requirements, the remaining biomass should also be beneficially utilized. Secondary agriculture emphasises the manufacture of high value industrial products from agricultural produce, residues and by-products to create greater industrial activity, preferably in production catchments, for greater benefits to society by way of income and employment generation. This is an integrated approach to utilize all the harvested biomass to convert it into value added products in a bio-refinery mode so that not only the benefits are maximized but the environmental issues on account of waste disposal are also adequately addressed.

India losses about Rs. 45,000 crore annually by way of post harvest losses and about 40 % of the country's population does not have access to adequate food. Post harvest processing and value addition sector has enormous potential in terms of employment, income generation in production catchments, and mitigation of socio-economic stresses at the bottom of the Indian Pyramid. Concerted efforts in this area would lead to significant reduction in losses and economic prosperity in farm and rural sector.

While the produce, after harvest, is still in the production catchments, the farmers and other rural folks could process the produce to some extent and add value to it, enhancing their livelihood opportunities and income. The processing by-products are available for further value addition. Several technological packages have been developed and, in some cases, demonstrated to potential entrepreneurs and industries for commercialization. A strong linkage with private sector is at the base of this proposal for its relevance and success.

Agro processing in the production catchments is another profitable venture. Depending on what is produced in the catchment, appropriate agro processing centres (APC) could be set up for primary and secondary processing. This decentralized model of agro processing not only generates additional income in the rural sector; it also helps in minimizing post

harvest losses besides several other social & environmental benefits.

An APC was established to meet the post-harvest processing needs of farmers in the cluster of villages of Kundana Panchayat (consisting of 10 villages) which is successfully running for the last 20 years. Ragi, paddy, corn and pulses have been the major crops for which primary and secondary processing is needed. Inventory of machines at the time of installation were; Destoner (0.5 tonne), Burr mill, Mini rice mill, Multi-crop thresher, Maize sheller, and Winnower. The cost incurred was Rs. 2.65 Lakh. The tariff charges were fixed at Rs. 0.15 for cleaning and Rs. 0.15 for milling. The processing demand for the centre increased beyond the capacity of the destoner and it was replaced with a higher capacity (1.5 tonne/h) of destoner.

The marketing of the processed products was done through voluntary agency outlets. After a successful running and gaining sufficient experience, the centre enlarged its processing activities in potato chips making, spices milling by employing women to make the processing centre more sustainable and to provide additional employment, and also surplus quantities of these produce were grown in the villages around Aradeshalli. Apart from the profitable venture, the centre served the local populace to process their produce at their door steps at subsidised rates.

Mr. Santok Singh (age 38 years, higher secondary) is basically an agriculturist and had been engaged in the business of livestock, particularly buffalo trading and milk marketing, before establishment of APC in the year 2005. He established an agro processing centre in his village Rode in 2005. The capital investment was about Rs. 20 lakh (Rs. 7 lakh machinery + 13 lakh land and building). The APC consisted of one traditional atta chakki, two improved chakki, a mini rice mill, and an oil expeller with filtration unit. Most of the work is done on custom hire basis but raw materials (agricultural produce) for at least one to two months are being purchased at the time of harvesting season. The customers are satisfied with the quality and they do not have to wait for processing of their produce (especially wheat), and therefore, they simply exchange raw material with final products. Moreover, the consumers prefer to purchase other household items from his shop while coming to process their produce. The annual profit from APC is Rs. 13.36 lakh, and the Payback period is just 18 months. The APC engages 5 persons from the family.

Concluding Remarks

The success of these propositions, however, depends on enabling policy framework, integration with markets, and skill development. Every individual in the rural sector needs to be targeted for imparting a variety of skills. Massive efforts and infrastructure are needed to ensure skills. Time is now to establish an Agricultural Technology Institute in each district for effective and targeted dissemination of farming skills and knowledge.

The levels of farm mechanization and post harvest value addition need to be increased substantially to not only increase the farm productivity but also to enhance farm income and employment. Suitable empowerment of Krishi Vigyan Kendras for technological refinement and assessment related to engineering inputs is essentially needed.

Clearly, agriculture of today has come a long way in comparison to that of 50 years ago. Agriculture of tomorrow would be knowledge based and encompass the whole production to processing continuum with engineering interventions for enhanced profitability. Heavy investments in skill development, agro-service sector and rural infrastructure would be required to ensure profitability, prestige and partnership in Indian agriculture.

Director and **Sr. Scientist,
Central Institute of Agricultural Engineering, Bhopal

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Livestock

Ensuring Livelihood Security Through Livestock Sector

*M.C. Sharma**

*Rupasi Tiwari***

Global food demand is ever increasing and expected to be doubled by the year 2050 due to exponential increase in population while the agricultural productivity is declining, largely due to shrinking of resources particularly cultivable land. Under such a situation, role of livestock sector to fulfill growing food demand is of paramount importance in terms of nutritional security and employment generation particularly among the landless, small, marginal farmers and women, and thus is a dependable "bank on hooves" in times of need. With the galloping growth in human population, the demand for crop and livestock production is ever increasing. With the concept of 'Food Secure India', the significance of livestock and poultry products becomes enormous. The livestock sector has emerged as one of the key components of agricultural growth in developing countries. It plays a critical role in the socio-economic development and welfare of India's rural population not only as a source of food (milk, meat and egg) but also draught power, manure, hides, skin, hairs, bones, blood, fat, drugs etc. Distribution of livestock wealth is more egalitarian compared to land. Hence from the equity and livelihood perspective, it is considered an important component in poverty alleviation programmes. The Indian livestock sector is the endeavor of small holders and is a centuries old tradition and over 70% of rural households depend upon livestock farming for supplementary income. This sector is highly gender sensitive and about 90% of the activities related to care and management of livestock are carried by family's women folk.

The contribution of livestock sector to National GDP varied from 4.8-6.5% during the last two decades (Working Group Report 2006). Accelerating the GDP growth in livestock sector to 6-7%, which is equitable, benefiting mainly the small and marginal farmers and landless labourers would be a major source of income and provide additional employment opportunities to people in the rural areas. A sustainable and financially viable livestock farming, which will generate wealth and self employment through entrepreneurship, is the need of the day.

Livestock resources

India possess 530 million livestock, which includes 199.08 million cattle, 105.34 million buffaloes, 71.5 million sheep, 140.5 million goats, 11.34 million pigs, 0.61 million horses and ponies, 0.57 million mules and donkeys, 0.52 million camels, 0.08 million yaks, 0.26 million mithun besides 489 million poultry (18th Livestock Census, 2007). India ranks first with respect to buffalo, second in cattle and goats, third in sheep and fifth in poultry population in comparison to the world livestock and poultry population. Total Livestock population in India has increased from 292.8 million in 1951 to 530 million in 2007 at the rate of 1.06%. In contrast, population of horses and ponies, camels, pigs, mules and donkeys has shown a trend of negative growth.

Economic contribution of livestock

As a result of gradual transition from subsistence to market system, the economic dimensions of livestock keeping have gained significance. The value of output from livestock and fisheries sectors together at current prices is about Rs.4,08,386 crore during 2009-10, which is about 29.7 per cent of the value of output of Rs 13,76,561 crore from agriculture and allied sectors. Livestock in total contributes 3.93% (Rs. 2,41,177 crore) of national GDP and 22.14% of the agricultural GDP. The contribution of milk in national economy is higher (Rs 2,28,809 crore) than paddy (Rs 1,35,307 crore), wheat (Rs 1,03,226 crore) and sugar cane (Rs 37,366 crore) (Annual Report, DAHD&F, MOA, 2010-2011)

Contribution of livestock sector to food and livelihood security

Livestock sector not only provides essential protein and nutrition to human diet through milk, eggs, meat, raw material/ by products such as hides and skin, blood, bone and fat etc. but also plays an important role in utilization of non-edible agricultural by-products. India continues to be the largest producer of milk in the world (15.70% of total milk) having 112.5 million tonnes production with 263 g/day/capita availability (2009-10). The milk production followed quadratic trend during 1979-80 to 2009-10. If the same trend continues the milk

production will reach to a level of 135 million tonnes by 2015-16. Crossbred cattle, indigenous cattle, buffaloes and goats contribute about 22.86, 20.25, 53.37 and 3.52%, respectively to total milk production. The average daily milk yield of indigenous cattle is quite low (2.1 kg) as compared to crossbred cattle (6.9 kg) and buffalo (4.6 kg). So far the fullest production potential of our livestock could not be tapped and there is an urgent need to enhance the levels through genetic improvement along with modern husbandry and health practices.

Poultry development in the country has shown steady progress over the years by producing 59,844 million eggs in 2009-10 as against 1,832 million eggs in 1950-51 with the availability of 51 eggs per head per year in 2009-10 in contrast to 5 eggs in 1950-51. The egg production in India has witnessed an exponential growth during 1979-80 to 2009-10 and is expected to touch the level of 83,200 million eggs by the year 2015-16. India produced about 63 lakh tonnes of meat in the year 2009 against 16.96 lakh tonnes in 1961 with an annual growth rate of 2.01%. Buffalo contributes maximum (33.66%) followed by cattle (20.90%) and poultry (17.13%) in the total meat production of the country. The total meat production has shown logistic trend with an annual growth rate of 5.4%. During the year 2009-10, the total wool production was 43.2 million kg as compared to 27.5 million kg in 1950-51. India contributed 2.2% of total world's wool production and Rajasthan is the highest contributor (29%) to the wool production of the country. Among the animal by-products, 9.17 lakh tonnes of hides and 1.89 lakh tonnes skins were produced during the year 2008-09, which is 10.53 and 6.36%, respectively, of the total world production(Annual Report, DAHD&F, MOA, 2010-2011)

Contribution to employment generation

The role of livestock sector in employment generation needs no emphasis. Rural women play a very important role in animal production and participate actively in areas like animal feeding, milking, breeding, cleaning and providing health care to the animals. As an adjunct to agricultural, livestock production contributes substantially to poverty alleviation and creates employment opportunities, particularly in rural areas. This sector has great potential for bringing about socio-economic transformation in rural India. According to National Sample Survey Office's latest quinquennial survey (July 2004-June 2005 NSS 61st round), 6.7% of the work force in rural areas was engaged in Animal Husbandry Sector as compared to 5.5% in rural and urban areas combined in the country. The proportion of workers in Animal Husbandry & Fisheries Sectors together was 7.0% in rural areas as compared to 5.8% in rural and urban areas combined in the country. (Annual Report, DAHD&F, MOA, 2010-2011)

Growth in Milk production

India's dairy industry is considered as one of the most successful development programmes in the post-Independence period. The total amount of milk produced has increased from 23 million tonnes back in 1973 to 112.5 million tonnes 38 years later in 2011.

India in recent times has been

100 per cent self-sufficient in milk, with total imports/exports of only 0.3 million tons per annum. Today, India is ranked as the world's largest milk producer with an annual output of 112.5 million tonnes. With an annual growth rate of 4%, India's milk production accounts for 15% of the total global output. Although India's dairy sector has performed well in meeting the demand of milk in the country, the milk demand is now increasing at a much faster rate than production. The Demand of milk is estimated to be around 180 million tonnes by 2021-22. "If India wants to meet its burgeoning demand of milk, the milk production in the country has to grow by 5.0 million tonnes annually, double than the present growth which is 2.5 million tonnes per annum, by enhancing the productivity through holistic approach." said Amrita Patel, Chairman, National Dairy Development Board (NDDB), at the 38th Dairy Industry Conference in Bangalore on 18 Feb., 2010.

The fact need to be appreciated that individual farmers inevitably lack the means to invest in improving cattle yields, and fodder prices have increased 30-40% in last 4-5 years. Therefore, to match an estimated demand of 180 million tonnes of milk by 2021-2022, two pronged strategies have been suggested one in the improvement of milk animals, optimum use of feed and fodder and increasing the share of organizing sector. Moreover, government can start schemes for the promotion of dairy and products relating to diary by announcing loan at very cheap rates or subsidies on to dairy loans, import free equipments related to dairy and harsh tax on to export of animals feed. Several areas of the dairy industry can be strengthened by following strategies

1. The induction of state-of-art technologies from India/ overseas to augment milk production and milk processing.
2. Raw milk handling needs to be upgraded in terms of physico-chemical and microbiological attributes of the milk collected.
3. Better operational efficiencies are needed to improve yields, reduce

waste, minimize fat/protein losses during processing, control production costs, save energy and extend shelf-life.

4. Latest packaging technology can help retain nutritive value of packaged products and extend their shelf-life.
5. Good scope exists for value-added products like desserts, puddings, custards, sauces, mousse, stirred yogurt, nectars and sherbets.

Growth in Egg and Poultry Production

India has emerged on the world poultry map as the 3rd largest egg producer (59.8 billion eggs) and 5th largest poultry meat producer (2.6 million tons) at global level. Poultry production in India has become the most dynamic and fast expanding segment of our livestock economy with an average annual growth rate of about 5% in layer and 10% in broiler sectors over the last decade. The share of chicken meat has steadily gone up to nearly 25% of total meat output in India. The Indian poultry industry worth Rs.400 billion accounts for about 0.6% of India's GDP and 10% of the GDP attributable to livestock sector.

The remarkable growth achieved in poultry sector is due to several factors like initiation of pure line breeding within the country in both public and private sectors leading to availability of elite commercial layer and broiler chicks and parallel development of other input sub-sectors like feed mill, hatchery and farm appliances, poultry biologicals, feed analytical and disease diagnostic labs., modern mechanized poultry and egg processing plant, vertical and horizontal integration in poultry farming, easy availability of soft credit, and above all ever-increasing demand of poultry products, etc.

Indian poultry sector is characterized by a mix of small (low input – low output), medium (medium input – medium output) and large (high input – high output) farms. While layer farms are scattered, especially in rural areas the commercial broiler farms are mainly concentrated around urban and peri-urban areas. The constraints faced by large commercial poultry enterprises/big poultry farmers are different from those confronting the small farmers. The formal category with large throughput, higher efficiency of production, processing and marketing suffers less than the latter category of farmers who mostly depend on the middlemen for disposal of their produce which results in wider price spread. Thus, in spite of Indian poultry industry becoming a success story, low volume of processing and market inefficiencies of perishable food like egg and chicken meat, erratic seasonal demand-supply pattern, particularly for eggs and wide fluctuations in the selling price of poultry products are some of the constraints facing this industry. Some of the remedial measures such as escalating prices of poultry feed , intensive breeding and selection, low-input technology utilizing improved dual-purpose indigenous chicken varieties, minimizing regional imbalance in poultry production , infrastructure development, regulating and promoting production of poultry products of superior quality and sales and promotion of egg consumption via mass media will go a long way in creating efficient poultry production, processing and marketing interface to accelerate the pace of growth of Indian poultry industry.

Major Challenges and threats in livestock sector

One of the major challenges facing our livestock industry is the launching of the WTO due to which we have to be more cautious about the quality of the livestock produce if we have to compete in the international market. The major SPS concerns for India include the quality and safety of Dairy and Meat products. It is imperative that the principle of Hazard analysis critical control point (HACCP) systems, Code of practices on good animal feed, good hygienic practices (GHP) and good manufacturing practices (GMP) and cold chain system are followed. India should also put in place Prevention of Infectious and contagious diseases in Animals Act and take effective measures to eradicate "A" category diseases as notified by OIE. For the hygienic practices for milk production, Codex standards are required not only for the livestock products for export conform to stipulated safety and suitability standards but also that the raw milk used in the manufacture of the products is produced using GHP and GMPs. Extensive extension programs should be implemented to ensure this. Better physical infrastructure for reference laboratories for monitoring and surveillance of the contaminants and their levels and strengthening of information systems for risk analysis are needed.

In this era of WTO, there is a tremendous scope of promoting the backyard livestock keeping in India into commercial micro enterprises through entrepreneurship develop-

ment programmes and entrepreneur favourable government policies. Apart from rearing of livestock, the livestock based industry has vast scope of generating additional income and employment through its various allied enterprises such as the commercial livestock rearing units, livestock input industry, livestock product processing units and organic livestock production units which can be help in increasing employment and income in the rural areas. But there are a few mahjor threats/ challenges before the livestock sector which if removed can still enhance the contribution of this sector to Indian economy.

Economic losses due to livestock diseases

Occurrence of diseases causes heavy economic losses in terms of livestock health and production. Introduction of exotic breeds have increased the incidence of diseases especially Foot and Mouth Disease (FMD), Haemorrhagic Septicaemia (HS), peste-des-petits ruminants (PPR), Brucellosis, Mastitis, Blood protozoon diseases etc. The contribution of livestock and fisheries sectors to the total GDP during 2008-09 was 4.07 per cent as compared to 4.70 percent during 2004-05. This reduction in contribution to the GDP might also be due to economic loss in livestock sector incurred due to the diseases.. Unless we make sincere efforts to control and manage common diseases like FMD, HS, mastitis and Brucellosis, we will be far away from achieving the targeted milk production of 160-170 million tonnes by 2030.

The economic loss due to FMD is tremendous as it causes death of young animals, reduction in milk yield and quality and quantity of meat, abortion, infertility and poor quality of semen. FMD also restricts the possible export of livestock and livestock products. In India alone 902 outbreaks of FMD occurred during 2009-10 affecting more than 26,500 animals. HS in cattle, buffaloes, sheep, goats and pigs accounted for 296 outbreaks. Mastitis is a multi factorial problem of dairy animals affecting milk production adversely. The loss caused by mastitis is due to reduced milk production, cost of treatment and culling of animals. As per annual report of the Department of Animal Husbandry, Dairying and Fisheries, more than 26,300 animals mostly cattle were affected by mastitis in the year 2009-10. Diseases of livestock like FMD, mastitis, PPR, Pox, CSF, BT, IBR, HS, BQ, TB/JD, Leptospirosis, Anthrax, enterotoxaemia, brucellosis, rabies, parasitic infestations etc still remain a major threat to our livestock population and are, causing great economic losses in terms of morbidity/mortality, treatment cost, trade, etc.

In order to reduce the losses due to animal diseases and to enable livestock owners to derive optimum gains from their animals, the Government of India during 11th Plan (since 2010-11) has launched following major initiatives under the Centrally Sponsored Scheme 'Livestock Health & Disease Control (LH&DC) in the area of disease control.

National Animal Disease Reporting System (NADRS): The present disease reporting relies on postal communication and is neither timely nor complete. Many a times due to this delay, animal diseases assume serious proportions before control and containment steps can be initiated, thereby causing avoidable social and economic losses to livestock owners and the country's economy. The Department of Animal Husbandry, Dairying and Fisheries has initiated a computerized system of animal disease reporting. The system will enable the animal health officials, farmers and other stakeholders to report disease information via SMS and internet. The computerized system will facilitate fuller and timely reporting of animal diseases, thereby enabling their effective management and also allow development of disease forecasting models for formulation of effective disease prevention strategies.

National Control Programme on Peste des Petits Ruminants (NCP-PPR): The Department has initiated a control programme with an ultimate objective to eradicate this disease from the country in a time-bound manner on the lines of Rinderpest eradication. The programme involves vaccinating all susceptible goats & sheep and their three subsequent generations (approx. 30%). The first phase covers Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Goa and UTs of Lakshadweep, Daman & Diu, Dadra & Nagar Haveli, Andaman & Nicobar Islands and Puducherry. The second phase will be taken up in the 12thPlan, by the end of which the disease is expected to be fully controlled.

National Control Programme on Brucellosis (NCPB): The National Control Programme on Brucellosis (NCPB) envisages mass screening of cattle & buffaloes to ascertain exact incidence of the disease in an area/ village/ block/ district of state and vaccination of all female calves between 4-8 months in the areas where incidence of the disease is high.

Extending coverage of Foot & Mouth Disease Control Programme (FMD-CP): The FMD Control Programme was initiated in 54 identified districts spread over eight states and five union territories in the country with the objective of creating several FMD-free zones. The programme has

shown the desired results in terms of reduction in the incidence of disease compared to other areas. Hence, the programme has been expanded to another 167 districts covering the entire southern peninsula, including Maharashtra, Goa and Gujarat, Haryana and Punjab in Phase I. After covering 221 districts in Phase I, remaining districts in the country will be taken up in Phase II. The vaccination will be gradually stopped and the entire country declared free from the FMD by the year 2025.

Avian Influenza: At present there is a World Bank assisted project on 'Preparedness, Control and Containment of Avian Influenza' which envisages surveillance, capacity building in terms of training and laboratory infrastructures, logistics support for undertaking control and containment measures at the time of outbreaks. 23 laboratories have been assisted to BSL 2 compliant and 6 BSL 3 labs are being set up at regional levels. The project will be over by March, 2012. This is a programme of national importance for prevention, control and containment of HPAI in the country. Hence, it is proposed to have a new scheme under Central Sector to sustain the present activities of the programme under World Bank continuously after completion of the existing project.

Needed Interventions for reducing economic lossess due to diseases

Disease-free zones need to established and supported by effective veterinary legislation, transparent and timely disease reporting systems, surveillance systems including industry and international coordination in close association with Indian Veterinary Research Institute, Izatnagar and state animal disease diagnosis laboratories. Ground-level authentic data is mandatory for realistic Risk Assessment in terms of identification and prioritization of the diseases to be targeted, development and implementation of control strategies and proper utilization of the limited available resources for the successful outcome. Adequate veterinary personnel are necessary for successful outcome of Disease control, vaccinations and zoosanitary interventions campaigns. A realistic assessment of veterinary requirement and strengthening of veterinary services is crucial for effective disease management, control and eradication, animal and animal products identification and traceability, veterinary diagnostic laboratory activities; sanitary inspection; activities of food hygiene laboratories, etc. (Draft Report of Sub-group on animal health and climate change for XIIth five year plan (2012-2017), IVRI, Izatnagar.) Apart from these macro initiatives a number of micro initiatives right at the farmers level need to be taken such as :

- Educating the animal owners about the economic importance of epidemic diseases
- Creating awareness about the standards for livestock produce marketing especially in global market
- Educating them about importance of produce from disease free animals and
- Imparting skills in scientific disease managemental practices

Impact of climate change

One of the environmental threats which our planet faces today is the global climate change. These changes are harmful to both human beings and animals. Inter-Governmental Panel on Climate Change has projected that by the end of this century global earth temperature is likely to increase by 1.8-4.00C. This global climate change could potentially lead to scarcity of water and food resources and may also cause spread of infectious diseases and heat-related deaths. The global climatic changes have been found to have significant effects on several pathogen related parameters including its density, genome and resistance; switching of the reservoir hosts; mode and rate of transmission; enhanced susceptibility of the hosts, disease pattern; and pathology. Bluetongue in Europe and Rift Valley Fever in goats in East Africa are two documented examples of increased vector-borne disease risk in goats associated with climate change . Microbial agents and their vector organisms are sensitive to climatic factors such as temperature, humidity, precipitation, surface water, wind and changes in vegetation. It has been predicted that not only the vector-borne diseases, but the helminthes infections, particularly of small ruminants like fascioliosis, schistosomosis, etc., will also be greatly influenced by these changes in temperature and humidity. While drastic climate changes may have few direct impacts on livestock and poultry diseases; the climate variability impacts on food production and nutrition can affect the susceptibility of hosts for other diseases. To mitigate the climatic stress on the livestock few measures need to be taken up urgently viz., Strengthening of technologies such as carbon sequestration, Rainwater harvesting and irrigation water management, Geographic information system (GIS): will tell which pathogen will flourish under their preferred condition, Strong veterinary health services: through medication and vaccination of animals in the area where diseases emerged due to climate change, Identification of heat resistance genes, Providing suitable shelters, Checking the water and air pollution and Checking the vector population.

Feed and Fodder Scarcity

Feed & fodder cost constitute about 60-70% of cost of milk production thus cultivated fodder has an important role in meeting requirement of various nutrients & roughage in our country to produce milk most economically as compared to concentrates . The livestock needs feed, which not only meet nutrient requirement but fills the rumen to satisfy the animal. During the period of fifties land available for fodder production was 18% but at present it is only 4.5%, which is a big gap in demand and supply of fodder. As the population of animals is half of the human population, hence land for fodder production should also be half of the grains production i.e. 25% land re-

quired for fodder production but it is decreasing day by day.

The Scenario of feed and fodder availability till 2025 reveals that there will be a deficit of 64.87 percent of green fodder as against the requirement of 759 million tones, while the deficit of dry fodder will be24.92 percent as against the requirement of 162 million tonnes . (Draft report of the working group on animal husbandry and dairying for five-year plan (2002-2007, Govt. of India, Planning Commission, August – 2001). The status revelas that urgent necessary steps are needed to mitigate the emerging crisis in relation to feed and fodder scarcity in the country. Development of alternative and non conventional fodder resources, newer feed supplements, development of newer bio-technological tools for enhancing the utilization of poor quality feeds and fodder and use of hydroponics technology for fodder production need to be taken up at national level

Processing of livestock products

Forty-five percent of the total milk produced in the country is consumed as raw, and the rest is converted into value added products . Ghee and curd are important milk products; about 28% of the milk is converted into ghee and 7% as curd. The rest is processed as butter, khoa, milk powder, cheese etc. However, processing is by and large a household activity. Producers unable to market milk convert it into ghee, curd and khoa for home consumption as well as for market. A part of milk production is also used in sweet manufacturing. Value addition to meat is extremely low. Most of the meat and eggs produced in the country are consumed fresh, and hardly about 2% of the meat output undergoes value addition

Most of our livestock owners sell the livestock produce as such without thinking much about how to earn more through the same produce. In our country, majority of the livestock owner rear 2-3 animals and practice animal husbandry as a subsidiary occupation. They mostly sell the excess of milk, meat and eggs. They hardly process these products for increasing their shelf life, palatability or appearance. The requirement is of changing our strategies and emphasizing on value addition of the livestock produce and developing markets for these produce. The abundant quality of cheap buffalo and cattle meat from the unproductive animals can be processed into convenience meat products to enhance their value in domestic and overseas market. Processing enhances palatability, provides convenience and variety to consumers, facilitates utilization of low value cuts,

meat trimmings and by-products and generates employment opportunities. Therefore our strategies needs to go beyond production and has to emphasize on value addition and marketing of livestock produce.

Poor marketability of livestock products

The livestock produce have a short shelf life and get perished quickly in absence of proper cooling or storage. These processed products are highly susceptible to contamination unless stored in special cooling system. Milk and meat have shelf life of 4-5 hrs in normal room temperature. Eggs have a shelf life of 4-5 days in winter and 2-3 days in summer and while fresh milk and meat could be stored in deep freezer for longer period, egg could be stored at 4°C for ‘8-10 days without deterioration of the nutritional value. Thus, it is always necessary for some intermediary processing and sterilized packaging of the livestock products before long distance transport for marketing. Due to lack of knowledge about these processing technologies the livestock owners are forced to sell their produce in local market or to middlemen at a very low price. The middlemen and intermediary traders earn a lot by doing the processing such as chilling and pasteurization of milk, sterilizing of meat products and attractive packaging of these produce. Due to these intermediary traders our livestock products market cost rises and sometimes above the rate in the International market, due to which the consumer prefers to purchase the low cost imported products. Therefore, an urgent necessity is there to educate the livestock owners about the post harvest processing of the animal produce and its proper transportation, packaging and storage, so that they can earn the maximum share of the consumers money.

Weak animal husbandry infrastructure

The existing facilities of animal health care are inadequate. At present, here is one veterinary center for every 14299 animals where as the recommendation of National Commission on Agriculture (NCA) is to have one Veterinary Center for every 5000 animals, and therefore, most of the states are lagging far behind the NCA recommendation. Accordingly, it is necessary to increase and strengthen the existing veterinary health care facilities to take care of precious livestock. Moreover, the veterinary infrastructure, especially in rural areas, is generally poor and dilapidated. There are only 8,732 veterinary hospitals/ polyclinics and 18,830 veterinary dispensaries in the country providing service for the huge livestock population.Therefore, there is an urgent need of assistance for establishment of more

veterinary hospitals (on the basis of one hospital for every 5000 animals). In order to address the dire need to set up buildings for new veterinary hospitals and dispensaries and to strengthen/ equip the existing ones suitably, Government of India has initiated a programme for establishing new hospitals & dispensaries and strengthening existing hospitals and dispensaries. This component is being implemented on 75:25 sharing of expenditure between the Centre and States. However, the pattern of assistance for North Eastern States is 90:10.The Scheme has been well accepted by the States.

Today, there are 42 Veterinary Colleges, 10 Veterinary Universities and 3 Deemed Universities in India, which provide veterinary education in the country. However, with the burgeoning body of knowledge, changing global trade and economy scenario and emerging diseases of global concern, there is a paradigm shift in the attitude and approaches to impart veterinary education. Today, only around 48,000 veterinarians against the required strength of 70,000 in the country are rendering their valuable services to cope up with the situation. In view of these facts, it becomes evident that as such, there is an urgent need to have more trained manpower in the form of veterinarians, which can be achieved by establishing more number of veterinary colleges and universities in the country to impart quality veterinary education and continuing veterinary education (CVE).

Major strengths in the livestock sector

The livestock sector has huge amount of strength due to which it has emerged as one of the strongest subsectors of agriculture sector in India. The major strength is the advancements that have taken place in the technology generation for improving the health and production capability of the animals.Recent advancement in molecular biology, biotechnology and nanotechnology has revolutionized the field of animal disease diagnosis and prophylaxis. Now pen-side and sensitive sero-diagnostics using synthetic and recombinant antigens are available for many diseases, which are very useful in sero-surveillance. Further, nucleic acid based diagnostics like PCR, Real time PCR, probe based diagnostics for detection of important diseases like IBR, FMD, HS, swine fever etc are now being used routinely. Many laboratories are working towards developing high throughput chip based diagnostics for important diseases of livestock. Biotechnology/nanotechnology developments have also revolutionized the field of vaccinology including vaccine delivery system. Recombinant vaccines are being developed that have the advantages of better immunity and long shelf life. Biotechnology tools are also being used to improve our indigenous breeds using transgenic and stem cell technology.

Further the availability of competent and comparatively low-cost manpower in India, increasing demand for livestock products all over the world , Institutional finance availability for livestock production in the country, more stable economy leading to foreign investments, and competitive advantage in world market due to low producer prices of livestock products are certain other strengths of the India's livestock sector, due to which it is marching ahead with a growth rate of 4-5 during the last few years.

Conclusion

In India, livestock produce is produced by the masses in contrast to mass production in developed countries. Livestock sector makes multifarious contributions to the rural development in the country. Not only does it provide food and nutritional security but also acts as a subsidiary source of income for the farmers, in the mixed crop-livestock systems. Thus, livestock production is associated with livelihood security of masses over a period of few decades there has been a tremendous growth in the livestock sector in terms of production, processing and value of output from livestock and trade. Its contribution to the national GDP and to the agricultural GDP has increased substantially. Further it acts as a source of subsidiary income for the small and marginal farmers who possess a major share of the livestock population of the country. For them the livestock acts as a cushion and provides ready cash during the problems of crop failure .Moreover livestock production is more women oriented as women contribute more than 70 percent to the labour requirement and thus by being at their home and tending the livestock they generate good amount of income through the sale of excess livestock produce. Thus the livestock sector acts as a major source of income and employment generator along with ensuring the food safety of the country. There is scope for creating substantial employment and entrepreneurship development in livestock sector through value addition and converting the challenges under WTO-SPS era into opportunities. Quality assurance of livestock produce is critical for promotion of trade. The challenges before our country is high disease incidence in livestock, poor per animal productivity, feed and fodder scarcity, poor market linkages, poor infrastructure facilities, lack of quality control and traceability issues of livestock produce, and weak extension activities. India can meet these challenges by exploring the opportunities viz. untapped livestock resources, burgeoning demand of livestock products, low cost man power, lucrative investment destination, higher rate of technology generation and stable economic environment. Further appropriate knowledge management in the livestock sector especially among the livestock owners can resolve various problems thereby enhancing the productivity of this sector. The strategies to mitigate the challenges should focus on productivity enhancement, value addition in the livestock products, backward and forward linkages at national and international level.

Director, ** Senior Scientist and In charge, ATIC
Indian Veterinary research Institute, UP

The New Generation Value Added Food Products:

Functional Dairy Foods!

Animesh Banerjee

Consumers' approach to health and wellness has changed dramatically, over the decades, globally. Today, enhancing consumers' health span through the consumption of healthy food is more meaningful than mere enhancing of the life span. Growing consumer interest in the role of nutrition for health and well-being has become a driver to the success of the functional food sector. Additionally, with the growing ageing population world over coupled with the increased scientific evidence for the efficacy of functional food have triggered a rapid development of functional food markets, initially in the developed world followed by the developing nations.

The functional food market globally had a combined value of $16 billion in the world in 2005 (Leatherhead Food International 2006). Among functional foods, dairy-based functional foods account for nearly 43% of the market, which is almost entirely made up of fermented dairy products. In comparison, the Indian market is still at a very nascent stage. However, with the growing girth of urban India and with it the various life style diseases, consumers are looking for healthier solutions in their food choices. Therefore, the number of products in the Indian supermarkets with specific functional benefits is increasing and functional dairy products such as probiotic yogurts top that list.

The functional food components which have originated from dairy sources are known as functional dairy foods and this group has demonstrated health benefits beyond its basic nutritional values. Arguably, probiotics are the main bioactive components of fermented functional dairy foods and numerous economic indicators show that probiotic-enriched products are still in the forefront of innovation in the functional food sector (Champagne 2009). Recent statistical data indicate that the share of probiotic products in the functional food market is continuously increasing. According to Heller (2008) there were 523 new stock keeping units globally in 2007 in the probiotic foods and beverage sector.

Similarly, the probiotic yogurt market in Latin America expanded 32% per annum between 2005 and 2007 (Crowley 2008). It is estimated that the annual sales growth rate of probiotic drinks and yogurt would be 5% between 2006 and 2011 (Anonymous 2007). The sales growth rate of fresh probiotic dairy products in the USA in 2004 was much higher than cheese (9–10% vs. 2%) (Fletcher2006). The European probiotic food and beverage market is estimated to reach $163 million by 2013 (Champagne 2009). Dairy products (beverages and non-drinkable products) containing Omega-3, phytosterols, isoflavins, conjugated linoleic acid (CLA), minerals, and vitamins also have a prominent role in the development of functional foods.

Today, a number of dairy-based beverages are marketed all over the world. The dairy-based beverages market is still a niche market compared with the sales of yogurt and plain milk, and dairy beverages containing probiotics and /or prebiotics dominate the functional dairy beverages market.

Apart from milk- based beverages, whey or soya-based functional beverages are also gaining popularity. Fermented beverages constitute

an important part of the human diet because fermentation is one of the cheapest ways of preserving the food, improving its nutritional value, and enhancing its sensory properties (Gagadaet al. 1999). Functional dairy beverages can be categorized into two basic groups: (I) fortified dairy beverages (including probiotics, prebiotics/fibres, polyphenols, peptides, sterol/ stanols, minerals, vitamins and fish oil), and (ii) whey-based beverages (both fruit juice-type and dairy-type).

A report, published in the Australian Dairy Food journal, during 2007, on a study conducted by ACNielsen Global Services, identified some key trends relating to consumer purchases in food and beverages: A continued focus on health, freshness and naturalness; the need for convenience; and the Continuing need for value. The report further stated that overall global growth rate in food and beverage products would vary significantly within regions and categories. In the beverage category, yoghurt based drinks topped the list, which showed double-digit growth.

Today's lifestyles are gradually demanding healthier beverages to quench thirst, which are primarily dominated by coloured, carbonated drinks. Besides, consumers also prefer beverages that are fun, portable and convenient and of course taste good. Milk and milk-based drinks are certainly the answer! It caters to all kinds of needs over and above its nutritional benefits. Some of the dairy beverage products can be enriched with active ingredients such as omega-3 fatty acids, cholesterol-lowering ingredients and probiotics besides micronutrients. Such products are being targeted at the niche market globally.

There is a rapidly growing functional food market with products such as probiotic yoghurt drinks, cholesterol-lowering drinks, drinks with high fortification levels for children and sports drinks. However, not sufficient focus has been given to whey-based beverages, traditional fermented dairy drinks. Whey contains key proteins, carbohydrates, minerals, trace elements and vitamins and is virtually fat free. The utilization of dairy by-products such as whey with the addition of fruits, cereals and active ingredients in carbonated beverage forms could revolutionize the existing beverage market.

As per a report published by Frost & Sullivan in 2011 "An Insight into the Indian Neutraceutical market", the Indian functional foods market is estimated to be about $ 1.2 billion with a market growth rate of approximately 19%. The major functional foods in the Indian market are foods enriched with probiotics e.g. yogurts, omega fatty acids, and vitamin & mineral fortified foods. The functional beverages market has seen a flurry of launches in the energy drinks, and fortified juices segment in the recent past.

According to a survey conducted by M/s Euro monitor International, though probiotic branded product manufacturing is, at present, at a nascent stage in India, a radical change is taking place, for instance, branded yoghurt/curd and cultured milk/lassi are growing at a rate of 14 percent and 33 percent respectively. Leading players in the Indian dairy industry like Amul, Nestle, Mother Dairy and Britannia are already in the probiotic milk and milk product market in terms of health-friendly dairy products, sour milk drinks, which include the popular Indian lassi, is still far ahead, in terms of sales, of probiotic yoghurts, with sales of US$6.8 million in 2009 compared to US$1.3m for probiotic yoghurts.

The Indian joint venture between Yakult and DANONE established in 2005 to bring Yakult probiotic drinks to the Indian market is expanding with Bangalore targeted as the point of entry for southern markets. In 2008, Yakult in partnership with DANONE, launched its world famous brand of probiotic yoghurt. At the time of the launch, fortified/functional yoghurt was practically non-existent in India. During its first year, Yakult's sales reached US$470,000, then US$1.08m the next, only to double again in 2010 to reach estimated sales of US$2.05m.

The key to successfully marketing these products is excellent product delivery and contemporary and customized packaging solutions (e.g. single serve shots) to maintain freshness, naturalness, convenience, and adding to the consumer perceived value of functional foods. The key challenges therefore would be in creating an integrated supply chain with macro production and warehousing hubs along with robust distribution solutions which ensures product quality and safety in the entire chain.

Further, in a country where dairy products are a staple such as milk, dahi, paneer etc and a large proportion of it is still unpackaged, building higher perceived value for functional dairy foods in consumers minds, through consumer relevant claims that they trust, and are willing to pay higher premiums for, will be the other big challenge that health and wellness products, and probiotics in particular, will have to face.

It is noteworthy that even the regulatory bodies have acknowledged the fact that functional foods is a growing market in India, and therefore under the aegis of the Food Safety and Standards Authority of India (FSSAI), a new regulatory guideline for Functional Foods is being drafted. It will be important to ensure that while providing a good governance framework for functional dairy foods, the guidelines also provide opportunity for innovation in this sector.

Some of the recently conducted surveys projected a mammoth Indian consumer market growth. Among food products, value added milk products and especially probiotic products are expected to top the list. Further, such products significantly improve the overall profitability of the entire product portfolio of dairy companies. It is thus only fair to say that India is becoming an attractive destination for investments in the functional dairy food sector!

Former President, Indian Dairy Association & Former Executive Director, National Dairy Development Board, Delhi

Livestock Deserves Fodder and Feed Security in India

K. A. Singh and Sunil Kumar

K.A. Singh

Livestock has been a major source of livelihood security to agrarian people of India since ancient times. Importance of livestock sector is well recognized during extremes of weather like floods and droughts also as it supports rural mass for their well being. India sustains about 15 percent of the world's livestock population but their productivity is quite far from world average. The major constraint in the productivity of Indian livestock is non- availability of adequate quantity and quality of forage. With current change in dietary pattern and food habits and migration of people from one region to another region, demand for livestock products has increased. To keep pace with the demands, the livestock sector has to tune itself by increasing the productivity of livestock. In India out of 55 micro-regions as much as 43 micro- regions are deficient in fodder availability. There are regional and seasonal disparity in fodder production and availability. Due to lack of sufficient post harvest and storage facility, surplus fodder is not properly utilized. Diversion of fodder from surplus to deficit areas is meagre. Edible crop residues diversion to non-agricultural use is a current practice which needs to be checked. National Consultation on Conservation Agriculture has suggested promoting integrated crop- livestock conservation system and minimizing conflict of demands on crop residues. In India, the livestock production and agriculture are closely linked, each one being dependent on the other and both crucial for the overall food security of the people. In the current decade, food security is being pursued at policy and intervention level through appropriate mechanism. But, feed and fodder security to huge livestock has been neglected so far. Policy and organizational set up has not been much productive and effective to deal with the complexities of forage resource development in India. This paper deals with critical appraisal and corrective measures for fodder and feed security to livestock wealth of India.

Livestock in national economy

India has the largest livestock population (around 500 million) in the world and expected to grow at the rate of 1.23 % in future. The importance of livestock in India's economy can be judged from the fact that 90 million farming families rear over 90 million milch animals. An estimated 70 million rural milch animal households are engaged in milk production. Small and marginal farmers account for three quarter of these households. It forms an important livelihood activity for most of the farmers, supporting agriculture in the form of critical inputs, contributing to the health and nutrition of the household, supplementing incomes and offering employment opportunities. According to current livestock census in 2003, there has been marked shift in composition of livestock towards small ruminants. This is attributed to natural resource degradation in arid and semi arid regions and high growth in meat sector. Buffalos and goats are becoming increasingly important in most of the agro-eco regions. In XI plan targeted growth in milk, meat and egg production has been projected at the rate of 5, 6 and 12 %, respectively, to produce 130 million tones milk, 7 million tones meat and 95 billion eggs by 2012.

The contribution of agriculture and livestock sector in national GDP is steadily reducing. During 2007-08

it has reached to 16.34 and 4.19% for agriculture and livestock sector, respectively. But market opportunities have opened up for the livestock sector following the economic liberalization. This is indicative of the fact over two decades down fall in livestock sector is less as compared to agriculture. There are expectations of faster growth in demand for livestock products due to expected increase in income combined with the high-income elasticity of demand for livestock products. Export earnings from livestock products have increased from Rs.1500.93 crores in 2001-02 to 2253.33 crores during 2004-05. Meat and poultry products accounted for 83 percent of total export earnings. Export of milk and milk products also improved and accounted for 17 percent of the export of livestock products. This sector contributed 5.4% of total GDP in 2002-03 (22.7% of total output from Agriculture & Allied Sector). The value of Milk group (Rs. 103804 crore) was more compared to paddy (Rs. 73965 crore) and wheat (Rs. 43816 crore). There is immense possibility of export of livestock products. But it is not fully harnessed owing to India's ability to adjust with open trade regime under the WTO. The sector's ability to capitalize on new market opportunity is also constrained by the easy access and quality of support services.

Role of livestock in livelihood

In recent years, more emphasis is on promotion of diversified agricultural growth with dominant role for animal husbandry and poultry farming, for income augmentation and employment generation to supplement the limited income and employment opportunities especially for the small and marginal holdings. The agricultural sector sustaining more than 1 billion population is crucial for the socio-economic development of India. The crop husbandry and animal husbandry are complementary to each other and each makes the other sustainable. Livestock sector engages about 5 percent of rural labour force and generates employment for 7.5 million workers. Livestock are ubiquitous in poor communities across the developing world. An estimated two-thirds of resource-poor rural households keep some type of livestock. The poor often keep a mix of different species, trading off specialization for better protection against risks. Livestock systems of the poor reflect the resource constraints that they face (e.g., financial, access to information and services, and landlessness), as well as their varied reasons for keeping livestock, which include food, income, manure, power, financial instruments and social status.

For small and marginal farmers, animal husbandry based on family labour and residues and by- products of crops grown on their own land continue to be a substantial source of income and employment. Small and marginal farms account for only 32% of the total land but own 59% of total bovines. The animal land intensity in India is high with an average land holding size of 1.57 ha supporting nearly 2.94 bovines. This in turn puts pressure on common property resources. Dairying has come to be India's largest self-sustaining rural employment programme. It is estimated that 70 million households' livelihood is linked to the livestock sector, which is critical for sustenance and supplementing the income of farmers though the average productivity is low. According to report of the inter ministry task group, 2005, Animal Husbandry and Dairying is an ideal sector for generating round the year self employment in rural areas. Animal husbandry provides job opportunity to about 20 million people (principal status 11 million and subsidiary status 9 million) besides people employed in sale, re-processing and transport of animal products at secondary market level.

In a study at IGFRI, it was found that the contribution of animal husbandry in farmers' income in arid (39%) and semi arid region (41.47 %) was higher compared to other ecosystems. In arid (landless-43.58, marginal-37.01, small-42.95 %) and semi arid regions (landless-53.49, marginal-44.55, small-43.96 %), the animal husbandry was a major contributing factor in income of resource poor farmers. The animal husbandry was major contributor across all categories in arid and semi arid region and semi arid-landless reported 53.49 % income from animal husbandry component.

Table 1: Supply and demand scenario of forage and roughage

Year	Supply		Demand		Deficit as % of demand	
2010	395	451	1061	589	62.8	23.5
2015	400	466	1097	609	63.5	23.6
2020	406	473	1134	630	64.2	24.8
2025	411	488	1170	650	64.9	24.9
2030	418	503	1207	671	65.5	24.9

Source: Based on 10th & 11th year plan document

Table 2: Grazing resources

Resources	Area(million ha)	Percentage
Forests	69.41	22.70
Permanent pastures, grazing lands	10.90	3.60
Cultivable wasteland	13.66	4.50
Fallow land	24.99	8.10
Fallow land other than current fallows	10.19	3.30
Barren uncultivable wastelands	19.26	6.30
Total common property resources other than forests	54.01	17.70

Table 3: Projected availability, requirement and deficit of crude protein (CP) and total digestible nutrients (TDN) (including concentrates)

(in million tonnes)

Year	Requirement		Availability		%Deficit	
	CP	TDN	CP	TDN	CP	TDN
2010	47.75	344.93	34.18	262.02	28.44	24.04
2015	49.39	356.73	35.98	273.24	27.15	23.41
2020	51.04	368.61	37.50	281.23	26.52	23.70
2025	52.68	380.49	39.31	292.45	25.38	23.14
2030	54.37	392.70	41.20	304.11	24.22	23.32

Structure of livestock farming in India

In India, mixed crop-livestock farming and pastoralism are the two common production systems prevalent in rain fed agro-eco regions. Dry land and alpine-temperate hilly regions traditionally harbour the 'grasslands' of India, providing pasture/grass to the livestock for some parts of the year. In these mountain regions livestock, has historically played an important role in people's livelihoods. It has been found that development of small holders' mixed crop-livestock production is one of the most effective methods of livelihood generation and poverty alleviation. In milkshed areas, commercial dairies by medium and large farmers and some private organizations flourish. This section largely contributes in terms of exports and earning foreign exchange to the country. The peri-urban production system has developed around cities and towns that have high demand for milk. The peri-urban dairy farmers rely mainly on purchased feed. They are commercially oriented and respond to improved technical input supply and marketing services. Presently, only a very small fraction of the livestock sector exists as industrialized system. Examples include commercial poultry farms, dairy farms and a few commercial goat and pig farms.

Forage and feed – demand and supply scenario

At present, the country faces a net deficit of 61.1% green fodder, 21.9% dry crop residues and 64% feeds. Supply and demand scenario of forage and roughages and grazing resources has been presented in Table 1 & 2. To meet the current level of livestock production and its annual growth in population, the deficit in all components of fodder, dry crop residues and feed has to be met from either increasing productivity, utilizing untapped feed resources, increasing land area (not possible due to human pressure for food crops) or through imports. In animal feed supply, coarse cereals have a major role and four major cereals viz. maize, barley, sorghum and pearl millet account for about 44% of the total cereals. At the current level of growth in forage resources, there will be 65% deficit in green fodder and 25% deficit in dry fodder. This situation indicates that green forage supply has to grow at 3.2%, to meet the deficit. The projection of nutrient and protein availability along with deficiency till 2030 is presented in Table 3. Due to more emphasis on food production at the national level, the actual potential of quality fodder for animal feed has not been fully utilized. There is also need to have policy intervention on crop residues for industrial use allowing only non-edible crop residues for packaging and other industrial use.

Forage resource development is less attended area

Scenario of forage recourse development and their management in India is governed by many factors. The area under cultivated forages has been static since last few decades. There is lack of statistics/ databases on area and production under fodder crops. Despite the advances made in research and development in forage production and utilization, the pace of growth of forage based dairy systems could not gain momentum. Timely availability of quality forage seeds is one of the important limiting factors. The seed chain from breeder to certified seeds does not exist at national level (NSC) as in food crops and also the institutional mechanism in most of the states. Despite huge demand of forage seed, indented breeder seed is not fully lifted due to inefficient marketing. Fodder section at centre and in most of the states is not adequately manned and in many cases they are vacant since 10 to 15 years.

There is lack of awareness about fodder production, utilization and marketing aspects among the farmers as well as extension workers. The adoption of the technologies for conservation of surplus green fodder during monsoon, efficient utilization of existing fodder resources and its value addition is poor. The aspects related to proper livestock care like housing, water provisioning etc. receive little attention. The allocation of funds for fodder development is very low out of the total fund allocation for the animal husbandry sector. Linkage among various organizations related with fodder in some or the other way is missing. A holistic viewpoint what is needed is not in existence. Lack of marketing opportunity to sell surplus fodder at remunerative prices is also an important factor in extending the area under forage production like other commercial agricultural crops. This aspect needs a regional focus in this matter. The natural resource base for fodder is under severe pressure and already is in a degraded state. The agencies (like forest department) managing these resource

Action point	Strategy
Forage production and management	
Integrated management of grazing lands	Emphasis on using silvipasture / hortipasture technologies to rehabilitate grazing lands and increase pasture under Joint Forest Management.
Converting wastelands in to pastures	Conversion of wastelands can help in expanding pastures and other grazing tracts. Silvipasture can enhance the productivity of wastelands 2.5 times. Even if 50 % is brought under silvipasture, there is potential to meet shortage of fodder.
Participation of people in management of community grasslands	Involvement of local people in managing grasslands/ grazing lands for regulated grazing and maintenance of carrying capacity.
Fodder production and stall feeding	Area under cultivated forages is static hence emphasis on forage production from non- competitive land use like farm bunds and channels in plains and terrace risers in hills; growing dual type sorghum, pearl millet, maize and cowpea varieties; adoption of food-fodder cropping systems, year round fodder and feeding based on local forage resources in arid and semi arid region with emphasis on intensive fodder production system and conservation in rainfed areas.
Utilization of non- traditional lands for forage production	Vast tract of unused land along roadsides, railway line and other wastelands could also be utilized effectively through leasing out for certain period for forage production and regulated grazing.
Post harvest management	
Fodder conservation	Bailing, densifying, silage, hay making, complete feed block, leaf meal preparation at peak period of surplus harvest of forages to be used during lean period.
Value addition	Enrichment of crop residues particularly rice straw and other leguminous crop residues for proper storage, balanced feeding with green fodder and minimizing wastage and storage loss; use of leaf meals (leguminous crop residues- lentil, gram, khesari) and subabool, stylo, gliricidia etc. to substitute costly concentrate.
Fodder bank	
Creation of Fodder mission, fodder and feed banks	In XI plan, fodder mission is under process of formentation by DAHDF. This will envisage comprehensive approach of forage resource development, distribution, marketing and utilization by different stake holders. As a component of it, policy on fodder bank is required to establish to regulate deficit and fluctuating requirement of fodder and availability of fodder during the natural calamities.
Establishing Livestock Food Corporations	Establishing Livestock Food Corporations in each state with operational unit as District head quarter ensure enhanced and sustained production of fodder and feed crops and adoption of recommended livestock management technologies.
Linkages for harvesting synergies	
Linkage between MoEF and MoAC (DAHDF)	Fodder development programmes in forestry projects need to be linked with livestock in the vicinity for effective utilization, resolving conflict between wildlife and domesticated cattle of forest dwellers; use of 25 % of fodder trees in JFM & social forestry programmes
Linkage between DAC & DAHDF	Development of functional groups between the two department for monitoring, indents and up scaling breeder seed requirements in forage crops, formulation of policy on edible crop residues, data base requirements(NSSO under DAC) and managing drought and flood situations.
Policy intervention	
Central level	Database for policy decision, Central Variety release Committee (CVRC) for considering straw yield and proximate analysis for release of food varieties, National Seed Reserve, Support price for forage & marketing of the seed, Edible crop residues, policy on export of oil seed cake, regulation on pesticide residues contamination in livestock products, National Grazing policy & common Property Resources (CPRs)
Central & state level	Dynamic organizational setup for forage development, Credit facility for fodder production and marketing, Increase in investment in forage resource development, Legal protection to grasslands, Utilization of non- traditional lands for forage resource development, Fodder Mission & Policy on Fodder Bank, Managing forage resource supply during natural calamities like drought & flood.

bases do not have adequate concern towards fodder for the livestock, particularly in forest margin. Transportation costs of planting materials, feed ingredients, bulky crop residues and green fodder etc. make it economically unviable. The research outputs and superior forage varieties have not made required impact due to less emphasis from various stakeholders. The challenges affecting the growth and promotion of forage production in India are identified as under:

(i) Deficiency in organizational set up

Lack of momentum in feed and fodder development in the country owes much to the poor organizational structure. Agriculture has come a long way through green revolution but livestock sector could not grow beyond AI (artificial insemination) and veterinary services. Livestock sector continues to be a subsidiary activity. In majority of the states, the fodder development programme has been given lowest priority. The functionaries have no expertise on forage resource development and utilization. In most of the Animal Husbandry Directorate, Department of Animal Husbandry, Dairy & Fishery, the plight of feed & fodder department is very week. There is urgent need to appoint fodder line staff with requisite agriculture qualification to support AHD as is practiced in Punjab. At central level, position of Joint Commissioner on feed & fodder need to be revived and made functional for required policy and regulatory support.

(ii) Ineffective policy support

The forage resource development is a more complex issue than food and commercial crops. Due to multiplicity of forage crops grown in different season and region, surplus and deficit in different regions, non commercial nature of crops and production of forage with minimal inputs from degraded and marginal lands has led to huge gap in fodder availability and requirement. Some of the following prominent aspects related to policy are required to provide favorable environment for accelerated forage development in India.

(a) Database of fodder production and utilization

There is no realistic database on area production, productivity and availability of feed and fodder. The databases on the availability of fodder in different seasons in various regions vis a vis livestock's requirement are also not available. NSSO working under Department of Agriculture & Cooperation needs to be oriented for taking up survey on regular basis on statistics of fodder production and utilization. This will help in formulating policy and action plan for specific region and target group of animal.

(b) Investment in forage resource development

The feed and fodder sector suffers from paucity of investment. For instance in XI plan, out of total approved allocation (4903 crores) for animal husbandry and dairy sector (DAHDF, GOI) only 2.88 % (141.4 crores) has been earmarked to feed and fodder development. There is need for enhancement in funding for forages at national and state level. The poor investment in this sector has adversely affected the growth of livestock sector with various stake holders.

(c) Credit facility

Credit facility to feed and fodder related activity is meager or many a times altogether absent. GoI has to identify such pivotal points for accelerated livestock development. Virtual funds of GoI executed by NABARD for livestock related actively needs to be further extended for marketing and credit system through regional banks.

(d) Support price for forage and marketing of seed

Forages may get boost with provision of minimum support price to forage grown. This will in turn accelerate marketing of forage and their seed. Farmers are de-motivated due to low seed yield and unassured remuneration for their produce. At present, indents of breeder seed are less than the production. Suitable pricing of feed and forage produce and marketing will increase area under superior varieties.

(e) Edible crop residues

Crop residues constitute more than 50% of forage resource of the livestock. Large quantities of edible crop residues are being diverted to non- agricultural purposes- like packaging, fuel to brick kilns. This diversion needs to be checked through appropriate policy measures.

(f) Policy on grazing and common property resources

Effective grazing and common property resources policy do not exist till today. Draft Grazing and Livestock Management Policy (1994) and Draft National Policy for Common Property Resources Lands (CPRL's) formulated by Government of India has not been effectively implemented. Wastelands have great potential to meet feed and fodder shortage of the livestock. Management of forest fringes, permanent pastures and grazing lands and wasteland for maintaining their carrying capacities can only be safeguarded by strong policy.

(g) Legal protection of grasslands

Indian grasslands have been most misused and neglected since many decades. Grasslands valued as grazing resources need to be established by appropriate policy and institutional mechanism. Effective headway has to be insured by involving community participation. Laws should be invoked for restoring the diversion of grasslands to other use.

Action points for ensuring feed and fodder security

Feed and fodder security can be achieved through focused R&D on production, conservation and utilization of forages supported with policy on protection and promotion of livestock based farming across the regions. Following approaches will go long way in tapping the available potential to increase fodder and feed supplies to wealth of huge livestock population.

Indian Grassland and Fodder Research Institute, (UP)

Role of Rural Poultry in Poverty Alleviation

K M L Pathak , S C Gupta Neelam Gupta and Vineet Bhasin

India has the pride of place in the World Poultry History for its outstanding role in the evaluation of modern Layer and Broiler breeds based on the Red Indian Jungle Fowl and the Aseel otherwise known as Indian Game Bird. Poultry production for egg and meat is considered to have been more than 5,000 years old in India but it was not given much importance in the early days and few birds were kept in the household for domestic consumption. All development in Poultry Industry in the country was made possible in the last 50 years. Now Indian poultry industry is well established and has worldwide status. There are about 60,000 full-scale poultry farms in India in urban and peri-urban regions and additionally few lakh of small poultry farms holding 50 to 1000 birds in rural areas. The Indian poultry industry engages more than 3 million farmers and 15 million agrarian farmers. India ranks 17th in the world poultry production and its poultry productions are most economical in the world. Out of the total global egg production, 3.6% is produced in India and the production cost of these eggs is lowest in the world. The total egg consumption is projected to more than double from 46 billion in 2010 to 106 billion in 2020. During the same period, total poultry meat consumption is likely to expand from 984 million kilograms to 1,674 million kilograms. The improvements in the marketing infrastructure may accelerate the production growth to keep pace with the projected demand expansion.

In spite of gross neglect for over ten Five Year Plans, the Poultry sector in India made outstanding contribution to the National Economy and Food Security System. It brought pride and glory to the country by ushering the Poultry Revolution pushing India as the fifth largest producer of eggs in the world. Over the entire planning era, both egg and broiler production registered the highest growth rates consistently in the entire agricultural sector. Currently, milk and eggs are the cheapest food items considering their nutritive value and are available at every street corner in urban areas up to midnight while poultry meat is the most affordable meat for the common man.

This poultry revolution was largely an urban phenomenon centred in urban and peri-urban areas in the form of Poultry Estates around major cities and towns with large human population providing the essential market and also essential infrastructure for successful poultry operations on factory scale. This Urban Poultry Revolution was in fact a silent revolution without much fanfare and publicity and was achieved in a short span of around two decades based largely on private investment pioneered by the Gentleman Farmer. This Urban Poultry Revolution is based entirely on the most modern technology right from the breeding stock to healthcare, feeding and management. By and large, around 70% of eggs produced in the country are from the organized urban sector while the unorganized rural sector still contributes around 30%. To these members of the weaker sections, poultry farming is a way of life and inseparable from the desi birds surviving largely on foraging and scavenging.

Poultry Scenario in India

Aseel is the most popular breed of indigenous poultry primarily used as Indian Game Bird. The term Aseel indicates a type and not a breed since there are several breeds under this type like Reza, Yakhud, Khagar, Peela etc. with breeders specializing in one or more of these breeds. Aseels enjoyed a very high status in ancient India with Rajahs and Nawabs patronising them. Kingdoms had fallen over betting in cockfights. In short Aseel- rearing had a status symbol. In spite of the decline in the frequency of cockfights, no festival in rural India can be completed without this activity. Andhra Pradesh is considered the home of the Aseel.

In modern times, while all ur-

ban markets are flooded with white-shelled eggs and white broiler birds and their carcasses, there is hardly any trace of the desi bird or its eggs at these centres. However, there is still a cross-section of the urban elite who yearn for the desi egg and chicken meat and are willing to pay a higher price because of the superior table qualities. There are special items of Indian cuisine like chicken tikka, Tandoori chicken etc for which the broiler meat is a poor substitute. Even the desi egg has a taste of its own. However, the small traders are not able to capitalize on this opportunity because of scattered centres for collection as well as marketing and the problem of quality control. With the rapid growth of the popularity of Indian curries and other items of Indian cuisine in Western countries and also the great spurt in tourist traffic there is a distinct possibility of exploiting the desi egg and meat for internal consumption as well as for export. However, it is for the Government and Govt. agencies like Tourism Departments to initiate such programmes for the business community to follow later.

Rural Poultry

Rural poultry production constitutes important component of agricultural economy in India as small poultry units are practically capable of more significant contribution to alleviate malnutrition, poverty and unemployment. A spectacular progress has been made from subsistence to sustainable production system. Backyard poultry population in India has increased only by 16% in the last 30 years from 60 to 70 million, while China's 76% of total egg comes from rural backyard production. India requires both mass production as well as production by masses. India accounts for 3.6% of global egg production, i.e., 61 million tonnes. The annual growth rate of egg production is 5 to 8%. India has the lowest cost of egg production in the world at 2.55 US cents per egg. However, the poultry production and consumption in the domestic market is slated to grow. Indian poultry industry has been a major contributor to the food-

processing sector in the country. From backyard activity to major commercial operation the poultry sector has undergone a paradigm shift.

Backyard Poultry

The poultry farmer keeps an average flock of 1 to 9 birds, which contributes to household livelihoods in multiple ways: the sale of eggs is a regular source of income; birds are occasionally sold to make some cash to cover above□average or unexpected expenditure such as school fees or doctor's fees and medicines; the consumption of eggs and poultry meat is a valuable source of nourishment for family members; poultry litter is excellent manure and contributes to enhanced crop/fish productivity in mixed production systems; birds contribute to social and human capital and are often taken care of by women, thereby favouring an equitable allocation of resources within the household. It is difficult to quantify the overall contribution of poultry to household livelihoods.

(i) There exists a variety of production systems at the village level—including a free range system, semi scavenging poultry production systems, semi intensive multiple batch broiler systems, and semi intensive all in all out broiler systems.

(ii) Farmers keep birds of different breeds, with different productive performance in terms of the number of eggs laid, growth rate and live weight.

(iii) At any point of time, farmers have a flock that may include day-old chicks (DOC), pullets or grown hens and a few cocks, whose overall contribution, including both monetary and non monetary benefits, to household livelihoods is hard to measure. However, an analysis of the unique data assembled through the documented Good Practices show that small but tailored interventions in backyard production systems provide handsome returns (up to over 200 per cent per year) both in terms of monetary income and availability of animal food.

Poultry are inseparable from mankind whether in urban slums or the rural areas not to speak of tribal

areas and backward harsh environments. Rural poultry do not need any land, birds are easy to manage with these hardy birds managing themselves most of the time in a set pattern returning home faithfully for the night and regularly laying eggs at home. They are rugged, disease-resistant and well adapted to the harsh rural environment. With better nutrition, their egg production can also be stepped up substantially. Even stock multiplication is easy with the hen brooding its eggs and tending to the young chicks till they can protect themselves. The only essential thing that these hardy birds need is a good night shelter. With all these attributes, poultry farming in the rural environment can be a powerful tool for poverty alleviation and social justice. To the rural poor, this can be a 'Rainless Harvest' with egg production and stock multiplication proceeding unhampered irrespective of rain or drought. It is the women that are largely involved in poultry farming. In every village market and fair, poultry and eggs are major commodities.

Development of Rural Poultry

The rural environment is much more complex in every aspect when compared to the urban scenario educationally, socio-culturally and economically. The two great assets of the rural sector are: willing people and plenty of desi chickens. If we can provide a few more inputs like superior genes, improved health-care and some feed support, wonders can be achieved in a few years of sustained effort. Nothing is too much when it comes to pushing these people stagnating below the poverty line for generations above that line.

After achieving the Poultry Revolution to strengthen the genetic support to this activity, the ICAR set up All-India Coordinated Research Projects one for Layers and another for Broilers. The Agricultural Universities also stepped up research efforts in the Poultry sector. Consequent on these intensive efforts over two decades ago, several new strains of poultry had been developed by several centres which showed promise for use in rural areas in the unorganized sector to provide success for the rural poor. These constitute environments where the exotic chicken used in the urban sector cannot survive. These are Giriraja, Krishna-J, Vanaraja, Gramapriya and Nandanamto name a few. There are over a dozen different strains claimed by their creators to be extremely popular in different locations. Of these Giriraja and Vanaraja are the two varieties, which transcended state boundaries conquering a major part of the country.

Of the several strains released some are of dual-purpose type while others are of layer type. Obviously all these strains cannot operate with equal efficiency in the same environment. However, by and large most of the strains have performed to the satisfaction of the rural poor. It is not too late even at this stage for the ICAR and GoI to move into this area to explore the possibilities of the planned exploitation of such rich resources to alleviate rural poverty by launching comprehensive, long-term projects in drought-prone area, tribal areas and other poverty-stricken areas. At this juncture it is appropriate to look into the terms Rural Poultry, Family Poultry, Back Yard Poultry etc., which are loosely used to talk about poultry in areas beyond the organized urban sector.

During the past couple of decades with increasing urbanisation and sky-rocketing of land prices everywhere due to population explosion and allied factors, back-yard poultry units have vanished to a great extent from the middle-class and lower middle-class leaving poultry largely in the hands of rural poor in single digit numbers who can only maintain these birds through a system of foraging and scavenging. To these deprived sections of our society, poultry constitute instruments of social justice and measures for poverty alleviation. Against this background of poultry ownership, there are only two major groups of Poultry keepers, the economically advanced Gentlemen farmers raising commercial units of exotic stock and the economically poor rural farmers, labourers and inhabitants of arid regions and tribal areas etc., who supplement their meagre income by raising a few desi chickens. It may therefore be appropriate to term the poultry raised by the urban elite as Urban Poultry and the poultry raised by the rural poor the bulk of which belong to the desi group as Rural Poultry.

Action Programme for Development of Rural Poultry

The several strains of poultry that have been released during the last two decades are mostly of exotic inheritance and are not really ideally suited for the rural scenario in the hands of the weaker sections. Most of them are also of a dual-purpose type and a few of layer type. The creators of these strains claim that most of them give annually around 150 eggs or even more. Several of them have overall proved their genetic worth and survival capacity by their field performance. This has been proven by the increasing demand for these particularly Giriraja, Vanaraja, Krishna-J, Gramapriya etc., with which the centres of their origin are not able to cope. It is appropriate that ICAR and GoI should step in at this juncture to strengthen such programmes.

It is necessary to mention that there is one singular commendable example of a private breeder who had the courage to enter this complex area of poultry breeding and tinkering with desi germplasm to create a new meat strain to cater to the market in Maharashtra. This pioneer is Anant D. Samant of Mumbai who struggled for quite a long time with desi germplasm to evolve Kalyani-D.K for meat purposes based on which he was able to build a prosperous desi Poultry Meat market. After evolving Kalyani-D.K, he distributed the breeding stock to his selected clients to multiply the stock and the number of farmers raising this strain and has thus consolidated his business. This single example of a breeder in Mumbai running prosperous business based on desi poultry extending over a large area of Maharashtra is a trail blazer of the market still available for desi chicken meat and eggs. Against this background, scientists should use their knowledge of genetic engineering to improve the new strains they created based on exotic inheritance by infusing the required dose of indigenous inheritance to create a more efficient bird with higher productivity, greater disease resistance and higher adaptability to the harsh rural environment. They may even go a step further by creating new breeds of hybrid chickens combining exotic and desi inheritance of selected breeds and regulating the level of desi inheritance to get the best results. However, it is essential to remember that we cannot create Magic Birds that can produce in plenty with meagre inputs under harsh environments.

Against this background, the development of rural poultry should be on a multi-pronged drive based on short-term, medium-term and long-term planning. A committee of Poultry scientists from the ICAR and the Dept. of Animal Husbandry and Dairying should be set up immediately to work out the full details of the various plans.

Short-term Measures

The GoI has several large Central Poultry Farms with immense infrastructural resources which are not currently being utilised to a large extent. Each of these farms should take up multiplication of birds of such strains, which have been already

largely accepted by the farmers. The breeding stock of each strain has to be supplied to a specified Central Farm for multiplication. The State Govt. concerned where the farm is located should take up the responsibility of collecting the demands from the rural areas, distribute to the concerned farmers, realize the cost and pass on to the Central Farm. There should be a complete co-ordination between the Central Farm and the Research Centre, which evolved the strain. There should be a feedback mechanism between the farmers and the Central Farms, which in turn should pass on the required technical information about the birds to the Research Centre concerned.

Medium-term Measures

After the essential prerequisite of identification of the expert Poultry Committee of the Poultry strains which have inherent potential to develop rural economy and have already been accepted by the farmers, appropriate genetic inputs have to be made to improve their efficiency in several parameters. Since most of these strains are of exotic inheritance the first input should be induction of desi inheritance to improve their disease resistance and foraging ability etc., without depressing egg production or growth.

Of the several desi strains available Naked Neck, Khadaknath and Frizzle Fowl appear to offer the greatest potential on the basis of work done at CARI. The next most important issue is the percentage of Desi inheritance that has to be inducted and this can be decided only after generating several genotypes. Desi inheritance can be the lowest level of 25% while 37.5% can be optimum to promote egg production as well as meat production and quality alongside of disease resistance. This type of work can be replicated with other genetic combinations in other centres the total number of which should not exceed four. A poultry venture scheme funded by Government of India operated through NBARD includes following components: farmers / individual entrepreneurs, SHGs, NGOs, Cooperatives, Publilc and Private Sector Undertakings etc.

1. Breeding units for low input technology birds and turkey / ducks / other species of poultry – Rs. 30.00 lakh
2. Feed godown, feed unit, analytical labs – Rs. 16.00 lakh
3. Marketing of poultry products (transport vehicle, cold room, etc.) – Rs. 25.00 lakh
4. Egg grading, packing and storage for export – Rs. 80.00 lakh
5. Retail poultry dressing units – Rs. 5.00 lakh
6. Egg / Broiler carts – Rs. 0.10

lakh

7. Central Grower Units – Rs. 20.00 lakh

Long-term Measures

This is a programme which is entirely based on new exotic breeds and the same old desi strains mentioned earlier. The exotic breeds are White Leghorn (WL), Rhode Island Red (RIR), New Hampshire (NH) and Austrolorp (AL). These breeds have been suggested because they have been used in the country for the longest period, have performed well with a hope that sufficient number will still be available in the country. In them we have the great advantage of the stock being acclimatized to local conditions being bred for several generations. The desi breeds used will continue to be Naked Neck, Khadaknath and Frizzle Fowl or any other that may be found to be equally good. The exotic breeds selected are of dual-purpose nature except the White Leghorn.

The ICAR is planning poultry mission that would be oriented towards rural poultry production. The proposed breeding programme should involve three breeds, two of which will be exotic and the third one desi with the aim of producing a bird that is superior to the current strains in egg production and vastly superior in meat qualities. Since this is entirely research project and is making its beginning, the project should be sponsored by the ICAR. Three centres may be selected, PDP, Hyderabad, CARI, Izatnagar and GADVASU, Ludhiana. The breeding programme adopted is on the same pattern except for the use of three breeds. In view of the best available dual-purpose breeds acclimatised to Indian conditions being inducted we can expect to produce an excellent dual-purpose strains excelling in both egg and meat production of high quality. In the first part of the programme, there will be two breed crossing with variation of inheritance pattern between the exotic and the desi parents. In the second part three-breed crossing will be undertaken and inheritance pattern modified. This project is of a path breaking nature and if funded fully and given a good start without any lapses in inputs, can be expected to produce outstanding results and produce infallible Instruments of Poverty Alleviation for the Weaker Sections. This breeding stock can be used in any of the developing countries without any reservations.

There is every reason to expect this project to be a success if implemented with the right staff and full infrastructure including liberal funding. Strains produced under this project can be expected to give 180 to 200 eggs with excellent meat after the pullet year instead of layers being sold for throwaway prices after pullet year of laying. What is even most exciting is that these new strains can be efficient even in other developing countries, which will be grateful to India for its global contribution once again in Poultry History.

If this work on appropriate poultry for rural development is pursued through implementation of appropriate field programmes as indicated earlier all over the country for over one decade we can liquidate rural poverty and protein malnutrition in children. This programme will usher in the Rural Poultry Revolution pushing India as No. 1 egg producer in the world within a decade of intensive development, a matter of pride for one and all. This will not only strengthen our Food Security System but will also ensure protein Nutritional Security, which is even more important. At this juncture, it is extremely important to realize that notwithstanding the Genetic Breakthroughs in the Poultry sector unless this is strongly supported by Nutrition and Healthcare, all these efforts will be nullified. These new Poultry Strains are only efficient machines, which can perform on efficient fuelling in the form of nutrition.

Role of National Meat and Poultry Processing Board

National Meat and Poultry Processing Board is an autonomous body launched by Government of India on 19th Feb 2009. This apex body was launched to work as a National hub for addressing all key issues related to Meat and Poultry processing sector for the systematic and proper development of this sector. The Board would serve as a single window service provider for producers/manufacturers and exporters of meat and meat products, for promoting & regulating the meat industry, as a whole and it would result in large number of employment opportunities. It would also help the rural farmers for increasing their income.

Conclusion

Considering the impact of the rural poultry on poverty alleviation, it is essential for Govt. to launch comprehensive programmes of development of the desi chicken on a long-term basis. Given the initial all-round support, such dynamic programmes can gain momentum and can in due course move on their own steam. If these programmes are started all over the country on 100% grant basis in all states simultaneously, within one decade the country can make a Rural Poultry Revolution pushing a large percentage of the poor above the Poverty Line. Rural poultry production potentially constitutes an important part in the economy of India. It was in dormancy in the past due to the illiteracy of the rural people, but now, it is slowly re-emerging to become a worthwhile component in future.

Animal Science Division
Indian Council of Agricultural Research, New Delhi

Major Initiative

Revitalizing Rainfed Agriculture for India's Second Green Revolution

We need a second green revolution that is more broad-based, more inclusive and more sustainable… this must explicitly embrace dryland farming.

- Hon. Prime Minister Manmohan Singh (11 July 2011)

William D. Dar

Rainfed agriculture in India

Dryland (rainfed) agriculture is pivotal to the economy and food security of India. About 60% of the total cultivated area is rainfed, supporting 40% of India's food demand of 1.2 billion people. Moreover, rainfed agriculture also supports 60% of livestock population. Likewise, coarse cereals (87.5%), pulses (87.5%), oilseeds (77%), rice (48%) and cotton (65.7%) are predominantly grown in rainfed areas.

India ranks first among countries that practice rainfed agriculture in terms of extent and value of production. Even if full irrigation potential is achieved, about half of the 142 million hectares cultivated area will most likely remain dependent on rainfall. This shows the crucial role of rainfed agriculture in attaining India's food security.

Based on the current population growth rate, about 500 million people will live in rainfed areas by 2025 when India's population is expected to reach 1.5 billion. The per capita land availability will shrink to less than 0.1 hectare. Hence, in rainfed areas, landholdings will substantially shrink too small to allow the economic cultivation of some conventional crops.

Besides calories from cereals, ensuring protein security will be an important issue in view of the predominantly vegetarian populace and the dwindling availability of vegetable proteins (pulses).

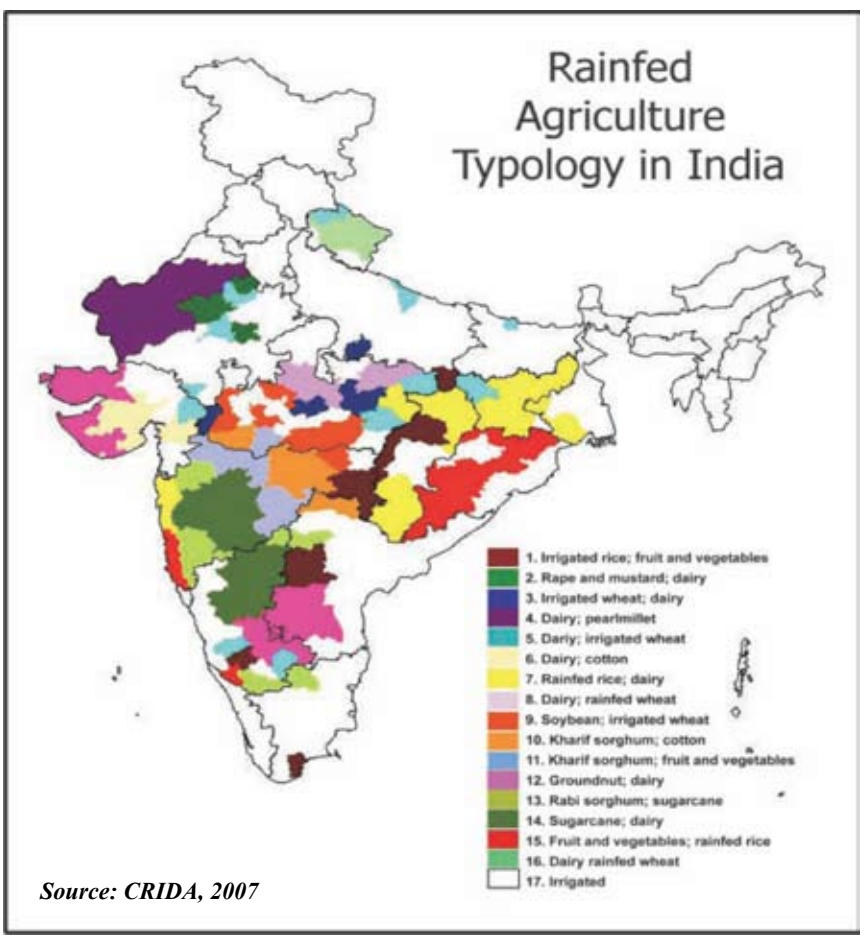
The big challenge

The rising 'perfect storm' which is a confluence of climate change, food and energy crisis, land degradation, loss of biodiversity and population explosion is the biggest threat to global agriculture in this century.

Rainfed areas will be the hardest hit mainly due to increasing water scarcity, frequent droughts, rising temperatures, new pests and diseases, shorter growing seasons and degraded natural resources. Thus, agriculture in the coming years would mainly revolve around water management, water-related issues and soil health.

During the last 30 years, India's food production nearly doubled from 102 million tons. Almost all of this increase resulted from higher yields (an outcome of scientific innovations) rather than expansion of cultivated area. This has contributed to a significant reduction in poverty from 55% to 26%.

Despite this gain, agricultural



Source: CRIDA, 2007

productivity in rainfed areas continues to remain low and unstable due to weather variations, degraded soils and continuing poverty of farmers. This is compounded by recurrent droughts, warming temperatures, and rising food and fuel prices.

Despite its impressive economic growth, India is still home to the largest number of poor people in the world. With about 250 million people in poverty, India accounts for one-fifth of the world's poor, and is expected be the world's most populous country in the next two to three decades.

In order to feed its burgeoning population and changing food habits, India's biggest challenge is to wage a second Green Revolution under the aegis of climate change.

The key: Mobilizing scientific innovations through India-ICRISAT partnership

At the 83rd Foundation Day of the Indian Council for Agricultural Research (ICAR) on July 11, Prime Minister Manmohan Singh emphasized the need for a second Green Revolution, emphasizing the importance of dryland farming and integrated watershed management. Along with this, he underlined that the success of the second Green Revolution would be the outcome of managing water and climate change besides that of the agricultural economy.

India's first Green Revolution was sparked by cutting edge scientific innovations developed and adapted through the partnership of the Government of India (GOI) with the international agricultural research community.

The second Green Revolution requires the same, except that the locus should be in rainfed areas which were bypassed by the first, with watershed management as an entry point. Towards this, increasing investment in strategic research for development and mobilizing scientific innovations through partnerships will be the key. Aside from water management, support for dryland crops will also be crucial.

In this context, the strong partnership between India and ICRISAT will spearhead the country's second Green Revolution in rainfed areas. India has been a vigorous partner of ICRISAT with a current investment of more than US$ 7 million. The country is also exemplar for other rainfed areas in Asia and sub-Saharan Africa.

ICRISAT conducts research on five highly nutritious, drought-tolerant crops – chickpea, pigeonpea, groundnut, pearl millet and sorghum. It also develops sustainable management of rainfed farming systems through integrated watershed management, and enables policies and institutions for sustainable food, nutrition and energy security.

Scientific innovations for sustainable rainfed agriculture

Participatory integrated watershed management

The comprehensive assessment of rainfed agriculture in the world has clearly demonstrated that current farmers' yields are lower by two to four folds of achievable yield. Long term experiments at ICRISAT have demonstrated that improved management of rainfed areas can produce an average of 5.4 tons grains/ hectare/year which could support 22 persons.

With farmers' practice, the same soil type (rainfed vertisol) produces only 1.1 ton/ /hectare/year which can support only five persons. To bridge this yield gap, a consortium of partners (ICRISAT, ICAR-CRIDA, Govt. of Andhra Pradesh, National Remote Sensing Center, CSOs and private companies) developed a participative integrated watershed management model. This approach improved the overall condition of natural resources and increased the income of 6,000

Indian households from US$ 133 to US$ 533 in five years.

The comprehensive assessment also showed that watersheds can become a growth engine of sustainable development in dryland areas. Thus, this model is now being out scaled in 300 watersheds in 13 states in India. It has enhanced the productivity of 2 million households in Karnataka Bhoochetana. Widespread deficiencies of micronutrients in the dryland areas of India have also been alleviated, increasing crop yields by 30–100 percent.

The first report of the National Commission on Farmers submitted to the Ministry of Agriculture, India, highlighted the foregoing consortium model. The successful innovations of this model have been included in the new common watershed guidelines in the "Employment Guarantee Scheme" of India released by the GOI in 2008.

Drought resistant and climate change- ready crops

During the last 35 years (1976-2011), 198 improved varieties of sorghum (35), pearl millet (80), chickpea (36), pigeonpea 21) and groundnut (26) have been released with India, raising production and incomes of millions of smallholder farmers. Moreover, 44,723 national germplasm accessions have been repatriated from ICRISAT to NBPGR. In addition, the ICRISAT genebank has provided 357,204 accessions of its mandate crops to India.

Chickpea: Four of the six most popular chickpea varieties in India are from the ICAR-ICRISAT partnership. These are JG 130 (I), JG 11 (II), ICCV 37 (V) and JG 16 (VI). Likewise, short-duration fusarium-wilt resistant desi and kabuli chickpea varieties have contributed greatly to increases in area and productivity of chickpea in central and southern India. ICCV2, the world's shortest duration kabuli variety, was released in India. Farmers who planted this variety obtained an additional income of Rs 2658 ($60) per hectare over those growing the ruling local variety Annegeri. In Gujarat and Maharashtra the net income increased by 84%.

Pigeonpea: Hybrid pigeonpea developed through cytoplasmic male sterility (CMS) system (world's first) paved the way for its commercial production. It substantially increased the productivity of red gram offering hope of a pulse revolution in India. Hybrid pigeonpea variety ICPH 2671 produces 48% more yield over the popular counterpart Maruti. ICRISAT in collaboration with private and public sector seed companies have commercialized hybrid pigeonpea for its wide cultivation by farmers.

Groundnut: In Ananthapur district, India's groundnut granary, the local groundnut variety of 60 years was replaced by ICRISAT-NARS improved variety ICGV 91114, increasing yields by 23%. It is more drought tolerant with larger seeds, has more uniform harvest maturity, disease tolerance and better palatability of its straw for livestock. An estimated additional 42,000 tons of groundnut is being produced annually, worth US$3.7 million by 30,000 farm households. On average, net income from this crop increased by 35% with an extra US$110/1.5 hectare/farmer. Cows fed with these haulms also produce 11% more milk. Seed multiplication of this variety has been taken up by thousands of farmers in the district.

Sorghum: In Asia (excluding China), India has the highest level of adoption of improved cultivars (65% of total sorghum area). Of this, more than 4 million hectares is planted to over 54 hybrids developed by private seed companies based on ICRISAT-bred parental lines. Of the 70 sorghum hybrids cultivated during the rainy season on 3 million hectares in India, 54 are based on ICRISAT-bred parental lines or derivatives. The first sweet sorghum hybrid CSH 22SS was released by the National Research Center for Sorghum (NRCS) using the ICRISAT-bred female parent ICSA38.

Pearl Millet: Over 80 pearl millet hybrids based on parental lines or derivatives from ICRISAT, are cultivated in about 4 million hectares (45% of pearl millet area in the country). Pearl millet hybrid 'HHB 67 Improved' (India's first public marker-assisted cultivar) resists downy mildew and saves US$ 8 million from its damage. The development of HHB 67 remains the greatest landmark in breeding early-maturing pearl millet cultivars.

Improving yield and stover quality in sorghum and pearl millet: ICRISAT and the International Livestock Research Institute (ILRI) collaborate for the simultaneous improvement of yield and stover quality in sorghum and pearl millet. Identified genotypes of sorghum and pearl millet are used in plant development with greater

biomass and nutritive value without sacrificing grain yield.

This collaboration has showed nutritionally important differences in fodder quality among cultivars. Furthermore, fodder quality differences in digestibility have been exploited in most rainfed crops without affecting grain and pod yields.

Biotechnology

Biotechnology is a modern science tool that offers vast opportunities on enhancing crop traits for rainfed areas. Besides developing appropriate technologies to assist the breeding of dryland crops, ICRISAT has also developed efficient screening procedures for biotic and abiotic stresses that allows for the accurate phenotyping of a large numbers of germplasm accessions, mapping populations and breeding populations.

Showcasing the development, commercialization and application of biotechnology innovations is the Platform for Translational Research on Transgenic Crops (PTTC) which is a joint undertaking of the Department of Biotechnology (DBT), GOI and ICRISAT.

Following are major biotechnology techniques and methodologies developed at ICRISAT which can be harnessed for rainfed agriculture:

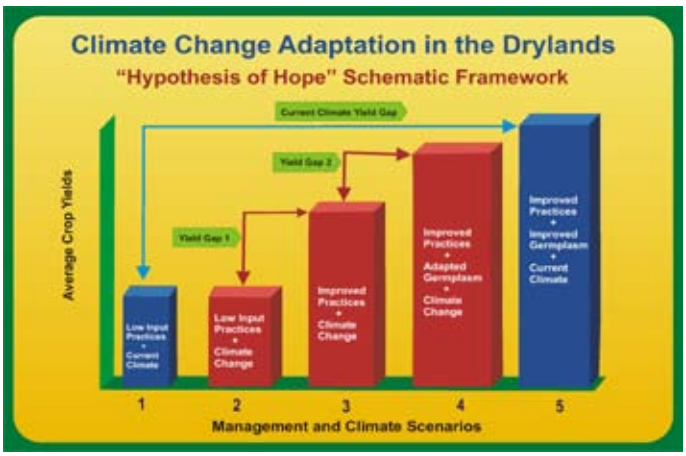
1. Efficient protocols for the genetic transformation of groundnut, pigeonpea and chickpea
2. Sensitive diagnostic tests for virus identification
3. Cost-effective diagnostic kit for aflatoxin detection
4. Techniques for greenhouse and field disease screening
5. Methodologies for rearing insect pests and their natural enemies, and protocols for the assessment of impacts of insect resistant transgenic crops on non-target organisms
6. Technology for rapid advancement of generations in sorghum, chickpea, pigeonpea and groundnut
7. Crop models for photoperiod sensitivity assessment in sorghum
8. Techniques for embryo rescue and wide hybridization

Moreover, ICRISAT's research capacity has been greatly enhanced through its Center of Excellence in Genomics with an additional investment of US$1 M for state-of-the art molecular genomic technology from the DBT-GOI.

Assessing and managing climate risk

Recurrent drought and season-to-season variability in rainfall is one of the big challenges in the drylands. Hence, strategies must be designed for farmers to mitigate the adverse effects of poor seasons and optimize opportunities during better times. Along with this, rainfed farming communities must be able to cope up better with rainfall variability associated with climate change.

The vast germplasm resources conserved at ICRISAT genebank under preferred international standards are key strategic resources available to find novel variations needed in a climate change scenario.



ICRISAT models show that even under a climate change regime, crop yield gaps can still be significantly narrowed down with improved management practices and adapted germplasm for warmer temperatures. This means that science-based innovations and technologies are the world's best bets in surmounting climate change.

Public-private-people partnerships

Through its Agribusiness and Innovation Platform (AIP), ICRISAT commercializes scientific products and innovations to help rainfed farm-

ers. The AIP is a flagship initiative which serves as the umbrella for public-private-people partnerships, enhancing the development and commercialization of science-generated products and innovations to benefit the poor.

AIP is a consortium of three programs: Agri-Business Incubation (ABI), Innovation and Partnership (INP) and NutriPlus Knowledge (NPK). AIP collaborates with private and public institutions where partners work with ICRISAT to bring research outputs into markets. Members have access to research expertise and products of ICRISAT and its partners. For instance the ABI program enables startup agri-business companies to tap ICRISAT's scientific and managerial resources.

To move the ABI program further, ICRISAT has facilitated the establishment of 10 Business Planning and Development Units (BPDs) in five research institutions of ICAR and five State Agricultural Universities under the Network of Indian Agribusiness Incubators (NIABI).

ICRISAT also facilitates a Hybrids Parents Research Consortia (HPRC), to share the crop parental lines with the private sector organizations for R&D purposes. Through HPRC, ICRISAT provides genetically improved diverse breeding lines and hybrid parents to Indian public and private partners. These hybrids have enabled farmers to realize higher yields, enhanced incomes and improved livelihoods. At present, the HPRC has 75 member companies.

ICT-mediated knowledge sharing

Access to information and knowledge by farm communities, intermediaries and decision-makers is another key to India's second Green Revolution. Towards this, ICRISAT established a coalition of partners to establish a Virtual Academy for the Semi-Arid Tropics (VASAT) at <http://vasat.icrisat.org/>. VASAT is a global repository of information and learning resources for dryland agriculture which can be accessed online.

Likewise, the VASAT coalition has created breakthrough platforms such as the Agropedia at <http://agropedia.net> and Agrovoc at <http://agrovoc.mimos.my>, and has contributed to the use of GIS for farm level advisories.

ICRISAT has also adopted new ICT tools such as Web 2.0 in communicating with stakeholders. ICRISAT's website at <http://www.icrisat.org/> is synchronously linked with its blog <http://blog.icrisat.org/> and social media platforms at <http://www.facebook.com/ICRISAT, http://www.twitter.com/icrisat> <http://www.youtube.com/user/icrisatco?feature=mhum>,

Mobile ICT tools are also available to answer queries from farmers and support decision making among NARES, community-based organizations and rainfed communities.

Pathway to prosperity in the drylands: Inclusive market-oriented development (IMOD)

To get rainfed farming communities out of poverty for good, one pathway has been proven effective: the generation of surpluses that are stored for later use or sold into markets to earn income. Stored food provides a buffer in times of hunger, and higher incomes make it possible to purchase more food when needed.

More income also enables farm households to purchase inputs, labour, tools, livestock, insurance and education. This enables another round of investment and productivity growth, creating a self-reinforcing pathway out of poverty.

The inclusive market-oriented transformation of rainfed agriculture is the sustainable pathway to get the poor out of poverty for good.

Innovations through partnership-based research will serve as the engine of this transformation by increasing the resilience of rainfed farming communities and strengthening people's capacities.

Moving forward

The current drought and famine in the Horn of Africa illustrates adverse environmental conditions which are regular challenges in the dryland tropics. With climate change, this is expected to worsen and if not addressed now, could inflict more damage to people, crops and livestock in other parts of the globe too.

For its second Green Revolution, India in partnership with the international community must pursue science-based approaches demonstrated by the initiatives in this article. A significant development is the GOI's prioritization of dryland farming in its 12th Plan beginning April 2012.

Towards this, ICRISAT and ICAR has agreed to work even more closely to make India self- sufficient in groundnut, pigeonpea, chickpea and coarse cereals in the near term.

With strengthened and sustained support, ICRISAT and its partners in India could offer tested science-based innovations to help extricate vulnerable rainfed communities from poverty for good.

Director General
International Crops Research
Institute for the Semi-Arid Tropics
(ICRISAT)

The Gateway of Aquaculture- CIFA

The Central Institute of Freshwater Aquaculture (CIFA) is a premier research Institute for freshwater Aquaculture in India within the ambit of the Indian Council of Agricultural Research (ICAR), New Delhi. The present institute had its beginning as pond culture division of CIFRI at Cuttack in 1949 and subsequently as freshwater aquaculture research and training centre (FARTC) at Kausalyaganga, Bhubaneswar

The centre blossomed in to an independent Institute during 1987 and was named as the Central Institute of Freshwater Aquaculture that served as a centre of excellence in research, training and extension in aquaculture research with a visionary outlook to become an International Institute of Excellence on Freshwater Aquaculture Research and Development for Tropical Countries. The Institute is endowed with a sprawling campus of 147 ha area at Kausalyaganga, Bhubaneswar, Orissa with 350 ponds having about 50 ha water area. CIFA has completed more than two decades of its existence as an independent Institute and also served as the lead centre on carp farming for the Indian sub-continent under the Network of Aquaculture Centres in Asia- pacific (NACA), Bangkok.

Indian aquaculture production has shown over six-fold increase in last the two decades, from 0.51 mmt in 1984 to 3.4 mmt at present. With an average annual aquaculture growth of 6%, the sector has turned into a major fish producer in the world, contributing significantly to the Indian agriculture GDP and nutritional security. All of these changes are driven by research and development in the freshwater aquaculture. The developments over the years are visible everywhere starting from small-scale ponds to the large-scale commercial operations. There are many species, many regions and many ways of fish production wich are traced back to the research initiatives made in CIFA.

The central focus of the institute is developing production technology of major carps, minor carps, catfish, prawn, ornamental fish and molluscs. Besides, the researched linked to the production are fish genetics and biotechnology, nutrition and physiology, fish health management, environmental monitoring, aquaculture engineering, economics, statistics and extension. The institute is also taking considerable efforts in transfer of technology, training of trainers, training of farmers and policy advocacy in important areas of aquaculture. This

Dr P. Jayasankar

institute was the proud recipient of the Best ICAR Institution Award in 1996 in recognition to its coherent achievements in all fronts.

CIFA has three regional centres located in Rahara, West Bengal, Bangalore, Karnataka and, Vijaywada, Andhra Pradesh to cater to the regional need for research and extension. A fourth RRC is being established at Anand Agricultural University in Gujarat. A Krishi Vigyan Kendra is located inside the campus dedicated for transferring the recent technologies to the fields. Other facilities of the institutes are well equipped laboratories, library, bioinformatics centres, guest house and

hostel for farmers.

The Mandate of CIFA is

- To conduct basic, strategic and applied research in freshwater aquaculture
- To undertake studies on diversification of aquaculture practices with reference to species and systems
- To enhance production efficiencies through incorporation of biotechnological tools
- To provide training and consultancy services.

The programmes, projects, activities are aligned to fulfill the mandate of the institute. Institute has got several Institute-based research projects and received attention of external funding agencies for conducting research on various basic, strategic and applied researches pertaining to freshwater aquaculture.

Many hatcheries have been established for diversified species like carps, catfishes, freshwater prawns and ornamental fish. For demonstration for intensive culture systems of – flow-through culture, cage culture, integrated faming systems have been developed at CIFA. For preparation of pelleted feed, a feed mill having capacity of 1 ton/day is available inside the campus. For dissemination of CIFA technology ATIC and ARIS cell is working under Social Science Section. A large Aquarium house with an area of 2000 m2 provided with 50 freshwater and marine aquaria with biotope concept, more than 100 varieties of freshwater Indigenous and commercial varieties are displayed for common public.

The institute has a number of achievements to its credit. To name a few: prolonged and multiple carp breeding, intensive carp production technology for 10-15 tonnes /ha/yr in static ponds, diversification of carp culture and multiple cropping, induce breeding of major and minor carps, carp polyculture with domestic sewage with production of 3-5 tonnes/ha/yr , multiple breeding of the peninsular carp Labeo fimbriatus, breeding and rearing of pearl spot Etroplus suratensis in freshwater environment, breeding and seed production of catfishes, C. batrachus, H. fossilis, P. pangasius, W. attu, H. brachysoma, and O. pabda. successful breeding and culture of Anabas and Murrels, standardization of breeding of important Northeastern and Western ghat species of indigenous ornamental fish species, cage and pen culture, designing and fabrication of FRP portable carp hatchery, feed and fertilizer dispenser, automatic feeder, mechanical harvester, large-scale seed production of Macrobrachium rosenbergii, M. malcolmsonii and M gangeticum, Grow-out culture of freshwater prawn with production of 1-1.5 t/ha/yr, cryopreservation of carp milt and development of low-cost handy cryofreezer for gamete cryopreservation.

Other contributions to aquaculture are fertilization measures and schedules for different categories of ponds, development of different implantation techniques for production of round and designed pearls, standardization of the doses of major micro and macronutrients for enhancing the productivity, development of the technology of wastewater treatment through aquaculture with duckweed and fish-based system, biofertilization with Azolla as substitute for chemical fertilizers in fish ponds, design and construction of hatcheries, farm ponds, etc., design and development of closed-loop recirculatory

system and flow-through system for industrial aquaculture, water budgeting for hatchery production of carps, catfishes and grow out culture systems assessed as base line information.

Genetic improvement in rohu through selective breeding has been achieved with over 17% higher growth responses per generation after eight generations. About three dozens of microsatellite DNA markers have been developed from rohu genome, applicable for genetic diversity analysis, inbreeding check and selective breeding in Indian major carps. DNA markers have been developed from Indian major and minor carps, with a view to accurately identifying the species at seed stage. A set of microsatellite markers has been characterized from Macrobrachium malcolmsonii and M. rosenbergii for population genetic studies. Characterization of vitellogenin, GnRH, GTHe and a couple of other important gene in IMC has been achieved. Embryonic stem cell and spermatogonial stem cell technologies have been initiated with considerable success. Standardization of tagging of prawn juveniles with elastomer tags for selective breeding. Nutritional requirement, nutrient digestibility and certain digestive enzymes in carps and catfishes have been studied for formulation of feeds for various growth stages of carps, catfishes and prawns, development

of larval, post larval, grow out and broodstock diets for freshwater giant prawn, ready-to-cook and ready to serve breaded buttered carp fingers, nuggets and slices etc. for value addition.

The major achievements in the fish health management are formulation of a chemical mixture, CIFAX, effective in controlling the Epizootic Ulcerative Syndrome (EUS), development of ELISA-based immunodiagnostic kits to diagnose important fish bacterial diseases viz., aeromoniasis, edwardsiellosis, bacterial gill disease, development of 'Immunoboost-C' an immuno-potentiating agent to raise healthy carp seed, and CIFACURE to treat microbial infection in ornamental fish, Development of nested RT-PCR based diagnostic against white tail disease of freshwater prawn caused by nodavirus.

CIFA also conducts several contract research and consultancy services in collaboration with national and international agencies for the development of aquaculture in the country and abroad. Various products developed by the institute has been patented and commercialized through different agencies. Future thrust areas of research are aquaculture diversification, breed improvement, fish genomics and proteomics, fish nutrition and physiology, fish and shellfish health management, water and wastewater management in aquaculture, organic and integrated aqua-farming, socio-economic impact and policy research, and application of information and communication technology (ICT) in aquaculture.

The institute is also actively engaged in human resource development through organization of national and international training programmes and technology dissemination through developmental projects. Under the rural aquaculture programme, CIFA has operated many lab to land programmes to support the farmers with tested technologies and at present the NAIP project for developing rural livelihood of three major districts of Orissa is in full swing. For the North East region, a large number of training and demonstration programmes are being carried out on different aspects of aquaculture in Meghalaya, Arunachal Pradesh, Assam and Manipur.

Let us work together with a slogan "grow fish and grow with fish" for enriched health, wealth and safe environment.

Director, Central Institute of Freshwater Aquaculture (CIFA), (ICAR), Orissa

Traceability and Traceability Initiatives by APEDA

Sudhanshu

Traceability in general is the ability to trace the history, use or location of an entity by means of recorded information. It also provides the ability to follow the movement of food through the specified stages of production, processing and distribution.

Traceability as per Codex Alimentarious Commission defines that it provides the ability to follow the movement of food through specified stages of production, processing and distribution.

As per ISO 8402, Traceability provides the ability to trace the history, application or location of an entity by means of recorded identifications. Also it enables to clearly specify the requirements such as period of time, point of origin and identification.

In raw terms, it may be said that traceability implies that it may or may not be required or may begin at a certain point within the production chain or may end at a point before the end of the chain. It may relate to the origin of materials including raw materials, the product processing history and the distribution and location of the product after delivery.

Now after defining the term traceability, the question comes why traceability is required these days? The answer to this question is that, food safety and traceability is becoming concern of importing countries. Also it is required due to increasing consumer awareness about food safety aspects. Due to some of the following stringent regulatory/buyer requirements, traceability becomes the need as a part of the supply chain:

- US FDA speed related traceability requirement
- EU Food law(178/2002)
- US Bioterrorism act
- ISO 22005 : 2007
- HACCP (ISO 22000-205)
- BRC(UK), IFS(German/French), SQF(US), Can-Trace(Canada), Food sanitation law(Japan) etc.

In today's world, the consumer is informed and aware and hence the consumer concerns and need also demand for tools like traceability. These days consumers ask themselves many questions before making a purchase. The commonly asked questions are: Is this healthy? Does it contain Peanut or other allergens? Is the packaging recyclable? Is the farming and harvesting done in a sustainable manner? Could I get this at a lesser price? Was this grown organically? Has the product been tested on animals? For a proper answer to these questions, there has to be a system which takes care of all concerns to a possible extent?

There have been number of incidences globally in the past, where the big companies have suffered a lot on account of not having a system to identify the reason for the incidence and to trace back the supply chain. The recent outbreak of E. Coli in Germany is a live example. The issue began in the second week of May, 2011 and although more than 10,000 samples were taken and analysed, E. Coli could not be detected and confirmed. On 5th July, 2011, the case was closed after identification of the food and the source of infection. This incidence gives a lesion that the only way out is to intensify the investigation on tracing back and tracing forward. Some of the other prominent incidences are: E.Coli contamination in Spinach and Lettuce in California, Milk contamination in China, Coca Cola in Belgium etc. In the incidence of Coca cola, it took 5 months to recover the sales and the crisis caused a loss of $200 million to the company. There was also one incidence of recall of 21.7 million pounds of Ground beef contamination due to E-Coli of a leading company and this resulted into closure of the company after having a business of 57 years.

There is an important connection between traceability and recalls. The traceability system provides visibility to location of food products/ consignments in supply chain and unique identification of each player in supply chain (Raw material supplier to manufacturer of finished product to intermediate distribution chain partners to retailer). It also provides unique identification of products/consignments and quantity held in supply chain and by whom. It may be said that accurate, timely and fast recalls can only be affected if traceability systems which provide accurate product identification, partner identification and location of products/consignments at all times are in place.

There are limitations in implementation of traceability too. In countries having small farm holdings, the marketable volumes are built up at the collection centres before being taken to a pack house or processing centres. In such case, traceability is possible only up to the stage of pack house or processing centres and not up to the primary level in normal course. Also in countries, where the produce/product raw material, in gradients and components are produced by SMEs or procured through the market systems in smaller volumes, the backward identification of the product becomes quite difficult.

For ideal implementation of traceability, the following approach is required:

1. Firstly, evolve national procedures and policies for quality & product standardization, co-opting all stakeholders in the supply chain from public and private sector, for each product.
2. Secondly, put in place the standards & agencies.

3. Thirdly, build centralized, national level, internet based traceability system with low cost of ownership for large number of farmers and entrepreneurs.

With the above mentioned approach, the traceability can be implemented which may act as a tool for establishment of product authenticity, reliability, identification of the problem areas for the purposes of tracking and food recall.

Traceability initiatives taken in the country

APEDA (Agricultural and Processed Food Products Export Development Authority), Ministry of Commerce & Industry , Government of India has implemented its first pilot project of traceability 'GrapeNet' for promoting exports in Indian Agriculture sector (export of fresh grapes exported from India to EU) in the year 2007. This was a web based traceability system and was used by all its main stakeholders i.e. State horticulture departments, Exporters, Laboratories, Agmark, Plant quarantine department. The farmers are the indirect stakeholders as they are registered by state horticulture departments. All the certificates required in the export supply chain i.e. Farmer registration certificate, Laboratory certificate for pesticide residue testing, Agmark certificate, Phyto sanitary certificate are issued by this system. GrapeNet is an end to end system for monitoring pesticide residue, achieve product standardization and facilitate tracing back from retail shelves to the farm of the Indian grower through the various stages of sampling, testing, certification and packing. The implementation of traceability in grapes provided following major gains:

- Self confidence among farmers
- Culture for food quality and safety
- Farmers earned approx. 40 % more value in the initial years
- Benefits to more than 40,000 farmers and 115 exporters
- FOB realization rose from 8 Euro to 11.5 Euro per carton of 3.5 Kg. in the 2007-08 , which was just after implementation of traceability
- Value addition through improved packaging

The implementation of traceability also witnessed supply chain improvements in terms of increased implementation of GAP, value addition through consumer packs, grading as per export standards, traceability throughout the supply chain and zero paper work & total accountability.

GrapeNet also received two accolades: National award for E- Governance in the year 2008 and E- Asia award in the year 2009. This showed the robustness and user friendliness of the system.

After getting the success in the first traceability system in grapes sector, APEDA got encouraged to replicate the same for Pomegranates (AnarNet), Organic products (traceNet), Groundnuts (PeaNut. Net).

AnarNet has been developed and implemented on the same lines of GrapeNet, as the process flow for both the products was same and hence all the features were same.

Tracenet was developed and implemented for export of organic products. This was a challenge, as it was to cover food and non food products such as organic cotton also.

Tracenet is the IT-enabled Certification-cum-Traceability system for Organic Sector in India, with uniform, consistent, transparent data management and certification system. This system helps to establish the traceability of export consignments of organic products from India back to the farm level.

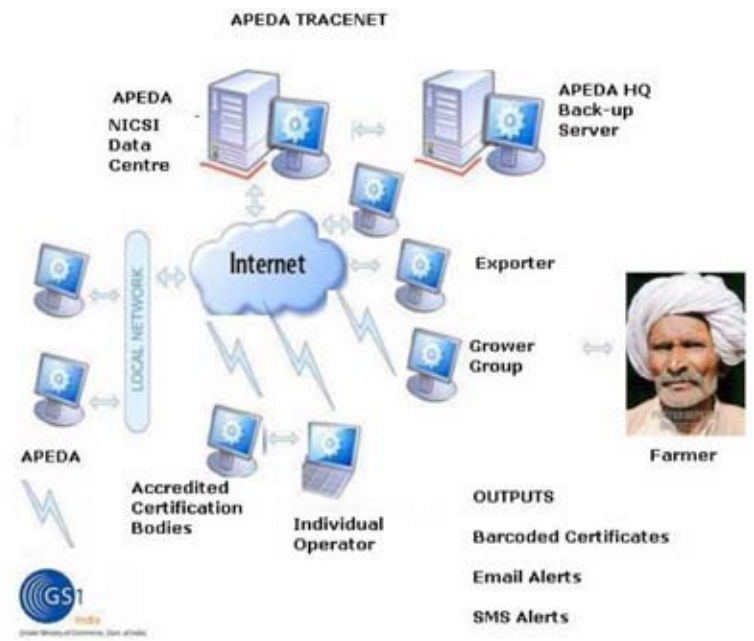
It is a major Government Intervention for providing level playing field for all stake holders in the supply chain, among farmers, processors, grower groups and certification bodies. It helps to monitor the overall growth and market access of Indian organic products.

Tracenet was conceived as an IT-enablement of the National Programme for Organic Production in India, as a Certification cum Traceability System for Organic products.

All the stakeholders involved in Organic Products in India, namely farmers, wild produce collectors, Processors, Traders, Exporters and Certification Bodies are covered by this system.

Any Official Certificate required in the compliance of Organic Production and handling is issued through this system. However, these are issued only after the requisite inputs are provided by the applicants, at various pre-determined stages and are validated.

This certification system ensures ex-



port consignment to farm traceability. Goals for developing the system are as following:

1. Uniform & Consistent Certification System of Organic Production and Handling Monitoring of Organic products in India.
2. Address concerns about food safety around the world through a system that ensures importing countries that enough measures are being undertaken by Indian authorities towards export of safer and high quality organic food products.
3. Help in establishing fork to farm traceability.
4. Provide a level playing field for all stake holders in the supply chain, among farmers, processors, grower groups and certification bodies.
5. Work towards a better value realization for Indian produce, due to the increased reliability of Indian Organic Products among the discerning consumer.

Broad objective of the system are as following:

1. Implement a consistent, uniform, transparent, IT-enabled Certification system for Organic handlers and their products.
2. Ensure compliance with the required standards and Monitor the export of Organic products from India.
3. Generate Confidence among global buyers and consumers about the genuineness of Indian Organic Produce and indirectly help the every stake holder in the supply chain, from exporter to the farmer, get the desired value for their produce.
4. Achieve farm to fork traceability.

The major challenges in development of the system were as following:

1. Organic certification has all along been driven by the credibility and branding of the Certification Bodies, with varying levels of automation and it-enabled data management & reporting. The data was generally lying with Certification Bodies and Grower Groups, leading to compliance issues.
2. Organic Certification is generally a process certification rather than a product certification. Hence the challenge is enormous, to manually go through the voluminous data of lakhs of farmers, thousands of grower groups, etc., to analyze and monitor.
3. Switching over thousands of such users into a centralized system of uniform practice was a major implementation challenge considering that Organic Production in India is all over the country and India follows a unique concept of group farming. Mapping the complete process into IT driven was a major challenge.
4. India is an agriculture dependent state. It has varied kind of agriculture crops, seasons, varieties etc. Implementing traceability at national level involved knowledge and problems of each state and region to make the necessary flexibility in the software.
5. It is also a major challenge that the system is up and running 24*7 with users' internet connection of varying speeds and extends user support to the stakeholders as and when required.

Major achievements in implementation of the system are as following:

- Stake holders Covered since a year of launch
  - 20 Certification bodies
  - 1,400 plus individual operators
  - 2,900 plus grower groups
  - 400,000 plus farmers
- Certificates issued in a year since launch
  - Scope (Registration) certificates : 3,829
  - Transaction certificates : 10,313
  - Export Transaction Certificates : 3,465
- Implementation of tracenet has enabled to achieve an approximate growth of 40 % in 2010-11 over 2009-10.
- Successfully running for more than a Year, resulting in a consolidated database of all registrations and activities related to operators within Organic world of India, including registration, inspection, production and export details.
- Tracenet has tremendously reduced time in processing of the applications of beneficiaries.
- APEDA can trace details of every export consignment right up to the farm level.
  - Every consignment that goes out of the country has a bar code printed on it with a unique 26 digit TC no. which follows international standards.
  - Using this TC No, all the lots that were used in any particular TC can be traced. Each lot No. is identified with a unique number.
  - From Lot No., system can trace the farm from which the product was sourced.

The fourth traceability system for export of groundnuts PeaNut. net has been developed and implemented taking the learning and the features of traceability system for grapes, pomegranates and organic products. The system is used by all concerned stakeholders Shellers, processors, Laboratories Exporters and IOPEPC (Indian oilseed produce export promotion council). All the required certificates such as laboratory test report, Certificate of Export and Stuffing certificate are issued by the system.

APEDA has already initiated the process of development of a traceability system for all fruits and vegetables which has been named as HortiNet. Further plans are there to explore the possibility for implementation of traceability in meat and honey sector too.

As per the requirement of developed countries for traceability for import of food products in their country, it becomes necessary to gear up for implementation of traceability in food sector for India to sustain in exports.

Deputy General Manager,
APEDA & Vice President, GS1
India

Smart Farming: A New Technique to Improve Crop Yield in Sodic Soils of Gujarat

Dr. N.C. Patel

Introduction

Land and water have been recognized as basic natural resources for overall development of a nation and also considered as the prime input vectors in the agriculture sector. India has 2.4 per cent of land on earth, 4 per cent of the world's fresh water resources with 11 per cent of the world's population and nearly 17 per cent of the world's cattle. Indian economy driven predominantly by agriculture, it is by far the largest consumptive user of water. In the past few years, the government has recognized the importance of promoting the sustainable management of India's land and water resources and has placed land and water development as one of its main priorities in the coming decades. The management of saline and alkaline soils is advocated in different perspectives by various scientists and adopted as per the suggestions in few areas for reclamation of problematic soils. Water harvesting and groundwater recharge work implemented by the Govt. of Gujarat is one of the successful models in the context as mentioned by various researchers.

Constantly faced with irrigation scheduling of when to irrigate and how long to irrigate, farmers are always left to guess instead of proactively plan and make wise irrigation decisions. Farmers have limited resources and expertise to effectively and reliably determine the current conditions in the ground, which leads to improper irrigation techniques. Manual data collection not only takes time, it also causes delays in interpreting the data properly to make accurate irrigation decisions. Many farmers rely on interpreting visual inspections of plants to make determinations whether to irrigate or not, but are not able to determine how much those soils need or retain by using this method. Scientists feel that it is time to move to real-time monitoring for irrigation scheduling. With real-time data, farmers will be better equipped to determine when and how much to irrigate their crops.

Genesis of the Problem

The Mahuva farm of Junagadh Agricultural University was covered under coconut, mango, sapota and other horticultural crops. It was famous for its greenery and was well known as "Kashmir of Saurashtra" till 1975. However, due to sea water intrusion, the area is suffered with soil salinity and sodicity problems, which have affected severely the horticultural crops in the region. In present situation, these soils in the coastal areas of arid and semi-arid climates are known for their high electrical conductivity (EC) and sodicity (high pH) and tend to become phytotoxic over years of intensive irrigation and crop production. When EC exceeds 0.4 dSm-1, the microflora in the rhizoshpere (root-zone) begin to change; in particular, the mycorrhizal fungi start to disappear and the activities of microorganisms decline, and when EC exceeds 1.0 dSm-1, harmful anaerobic microorganisms become dominant, and various disorders such as discoloration of plant leaves begin to appear. Irrigation water in these areas is also high in salt contents. With very little organic matter in the soil, sometimes less than 0.5%, and high ambient temperatures, evaporation rates are high which lead to quick salinization of soils. The dry soils mineralize and become compacted and this leads to erosion of top soil. Improper irrigation techniques without the incorporation of organic matter will also increase compaction. Over time, plants stop growing in the area and the farmland becomes unproductive.

Therefore, an integrated approach is required in which the problematic sodic soils of coastal area can be reclaimed and the saline groundwater can be treated to use for irrigating crops. Also, sensors are required which may monitor the soil moisture, EC and temperature continuously to work as decision support system to decide when to apply water and how much to apply through an automated drip irrigation/fertigation system. Further, in this era of information technology and advancement as it is difficult to manually monitor the field, a web cam (PTZ camera) is required in the field to observe everything live at the farm. The all above referred information needs to be stored in a data logger and be transferred using internet connectivity anywhere any time to keep a watch on the field from remote places so that in can become a part of decision support system from anywhere any time (24X7). Keeping above in view, a very innovative smart farming project has been undertaken with the approval of Government of Gujarat under Rashtriya Krishi Vikas Yojna (RKVY) with the objectives like reclamation of the sodic soils of coastal region of Saurashtra (Gujarat), measure and monitor the changes in soil EC, pH, temperature and moisture with the observed sensor data through farmlinc portal from anywhere any time.

Innovative Solution

The smart farming project is based on innovative research in USA from "i-Linc Technologies" ("i-Linc") along with its partners Aqua-Phyd, and AEM America. An innovative integrated approach has been developed,

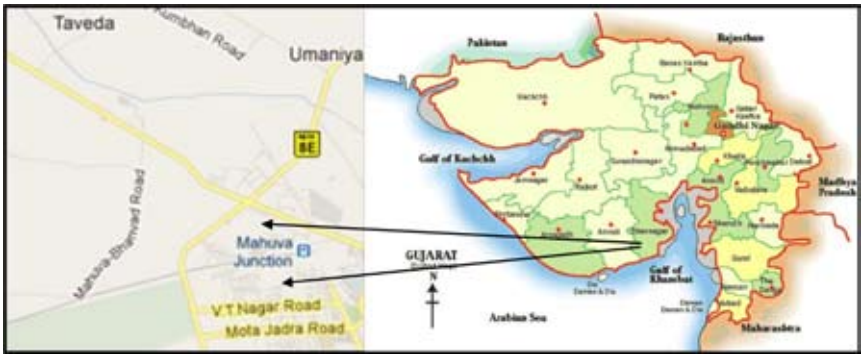


Fig 1: Location map of study area (Mahuva, Dist. Bhavnagar, Gujarat)

which reclaims sodic soil and make land suitable for crop production and allows to monitor, manage, and control resources remotely anywhere, anytime (24x7), helps conserving resources (water, energy, and labor) and improves crop yield.

Study area and major issues

The area of the project is Agricultural Research Station (Fruit Crops), Junagadh Agricultural University, Mahuva, Dist. Bhavnagar, Gujarat as shown in Fig. 1. The farm is facing problem of high electrical conductivity (EC 2.5 to 3.0 dS m-1) and high pH (8 to 8.5) and has become phytotoxic over years of intensive crop production. Earlier on this farm, several varieties of horticultural crops were grown viz., coconut, mango and high-value vegetable crops viz., onion, tomato and brinjal as well as green gram, black gram and groundnut as summer crops. At present the farm is having sodic soil conditions as well as high salt content in groundwater [EC 5 to 6.6 dS m-1, Exchangeable Sodium Percentage (ESP) 5.3 and Residual Sodium Carbonate (RSC) 57]. Due to these reasons, crops are suffering and the productivity is drastically reduced. After establishing and providing the new technology successfully on university farm located at Mahuva; it will be disseminated to the farmers of coastal area having the problem of sodic soil and saline water.

The following are the major issues being addressed under this project.

i. Reclamation of sodic soils
ii. Treatment of saline groundwater for irrigation
iii. Monitoring drip irrigation/fertigation system through wireless sensors.
iv. Observing and monitoring of field through a live PTZ camera
v. Management of whole system through internet based farmlinc portal from anywhere any time.

The above issues have been briefly described hereunder:

Reclamation of sodic soils

The sodic soils are treated with gypsum, farm yard manure (FYM) and Bokasil (a bio fertilizer) for reclamation. Apart from gypsum, FYM and Bokasil, an activated effective microorganisms (AEM) is also applied in liquid form with the irrigation water. AEM (Activated Effective Microorganism) is a liquid culture of non-GMO beneficial microorganisms from 4 genus including Lactic Acid Bacteria, Bacillus Bacteria, Yeast, and Photosynthetic Bacteria that is generally applied through an irrigation system. AEM•1 have tremendous potential in helping to improve soil structure, cation exchange capacity (CEC), balances soil pH, chelate salts, make nutrients available for plants, and increase moisture retention in soils.

Treatment of saline groundwater for irrigation by Aqua-Phyd

A device called Aqua-Phyd is used to treat the saline water. After passing through the Aqua-Phyd, the water percolation rate is increased which do not allow accumulation of salt in root zone depth. Aqua-Phyd has proven to provide a number of benefits to agriculture leading to healthier plants, increased nutrient availability, decreased salt accumulation, and greater yield. The Aqua-Phyd system enables Agriculture to

- Save water
- Prevent salt accumulation in the root zone
- Reduce effects of reclaimed poor quality water
- Increase nutrient availability
- Reduce compaction

The Aqua-Phyd, and AEM have tremendous potential in helping to improve soil structure, cation exchange capacity (CEC), balancing soil pH, chelate salts, make nutrients available for plants, and in increasing moisture retention in soils and produce crops in sodic soils with saline groundwater condition.

Fig. 2: The Aqua-Phyd system for treatment of saline water

Monitoring and control of automatic drip irrigation/fertigation system through wireless sensors

The wireless sensors (watermark) were inserted at two depths in the root zone of the crop to monitor soil moisture, electrical conductivity (EC) and temperature. Apart from this, two wire sensors were also used to compare the data observed from the radiometric sensors. The wireless monitor receiver automatically records sensor readings received from field transmitter for collection and display on a computer. Each field transmitter can read up to four sensors in specific combinations of temperature, soil moisture and pressure. The Receiver unit can also read one direct input from a switch closure sensor or rain gauge. Watermark soil moisture sensors must be

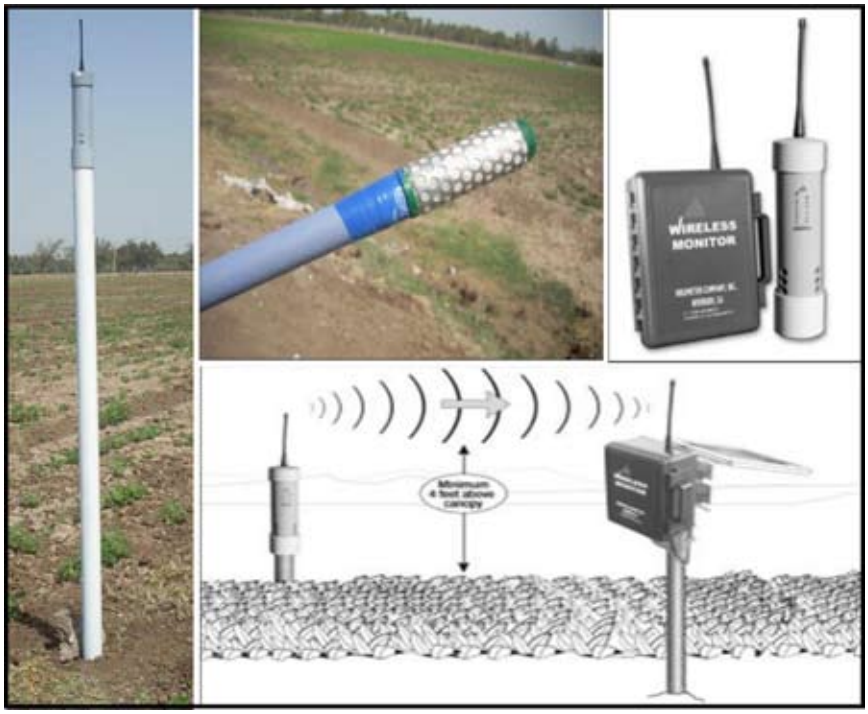


Fig. 3 wireless sensors for monitoring soil moisture content, EC and Temperature

"conditioned" prior to installation. The sensors were soaked to saturation and then dried fully, twice, and then soaked to saturation again prior to installation. This "conditioning" of the sensors ensures quick response to changing soil moisture conditions. If a sensor is only soaked and not conditioned, several irrigation cycles must pass before the sensor responds accurately. After "conditioning", sensors were installed at two depths of active portion of the root zone of the plant to monitor various parameters.

Fig 4: The receiver tower with PTZ camera and various monitoring units/devices

Observing and monitoring of field through a live PTZ camera

A PTZ camera is installed at monitoring tower on the farm. The PTZ camera is a type of web cam which may look 360º with zoom in and zoom out capabilities in the field. The camera facilitates the farmer to view his farm via a real-time video streaming data. The farmer would be able to see the crop condition, get first hand information of field activities, track assets such as equipments & livestock, manage inventory and make decisions about his overall farm management using visual information from anywhere any time. The real field installation of receiver tower with PTZ camera and various monitoring units/devices at farm study of Mahuva is presented in Fig. 4.

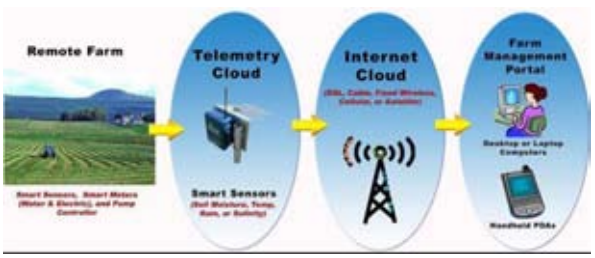


Fig.5: Remote Data Monitoring, Management, and Control with FarmLinc - Portal Solution

Management of system through internet based farmlinc portal from anywhere any time

The farm management portal (Farmlinc) provides real-time data from sensors (soil moisture, temperature, weather station, water and electric meters) located in remote farms, and provides irrigation scheduling recommendations which a farmer can use to manage/control irrigation system remotely. i-Linc's web-based portal allows a farmer to conduct his/her business remotely using a desktop/ laptop or a web-enabled Phone (iPhone) at anywhere, anytime (24x7) as shown in Fig. 5. Data from sensors and meter reading devices from remote farms is saved in a central database, specific crop models and decision support algorithms are applied, and irrigation recommendations are presented along with alerts, notifications with ability to turn on/off the irrigation systems, as well as allow fertilization and disease management remotely by a farmer. An important design factor in i-Linc's portal solution is supported for the Internet and its "ecosystem", such as Wi-Fi, WiMAX, Cellular, and Satellite.

Conclusion

The smart farming technology has been installed on the farm at Mahuva during May, 2011 as a pilot project. The successful implementation of the said project will serve as a demonstration of smart farming technology to motivate the farmers to bring problematic soils under cultivation adopting new techniques for getting better crop yields from sodic soils using saline water so that, the uncultivable problematic soils of the coastal area may be brought under cultivation.

Dr. N. C. Patel, Vice Chancellor
Junagadh Agricultural University
Junagadh

Farmers Study Tour Programs

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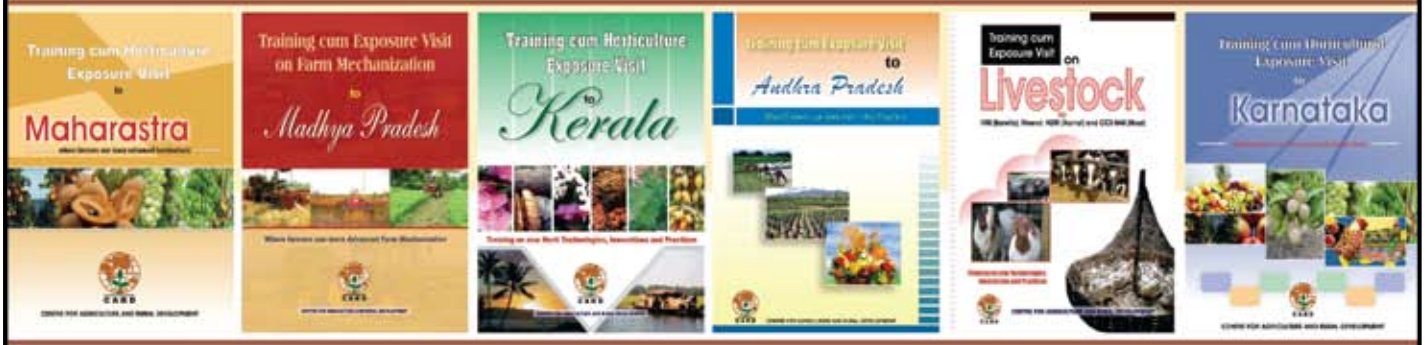

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The Technical Manager
Centre for Agriculture and Rural Development (CARD)
A-10, Second Floor, Sector - 19, Noida - 201301 (UP)
Ph: 0120-4224861, 4350888 Fax: 2519628, (M) 09311469845
E-mail: agritours@card.org.in, Website : www.card.org.in

Emerging Areas

Emerging Career Opportunities for Agriculture Graduates

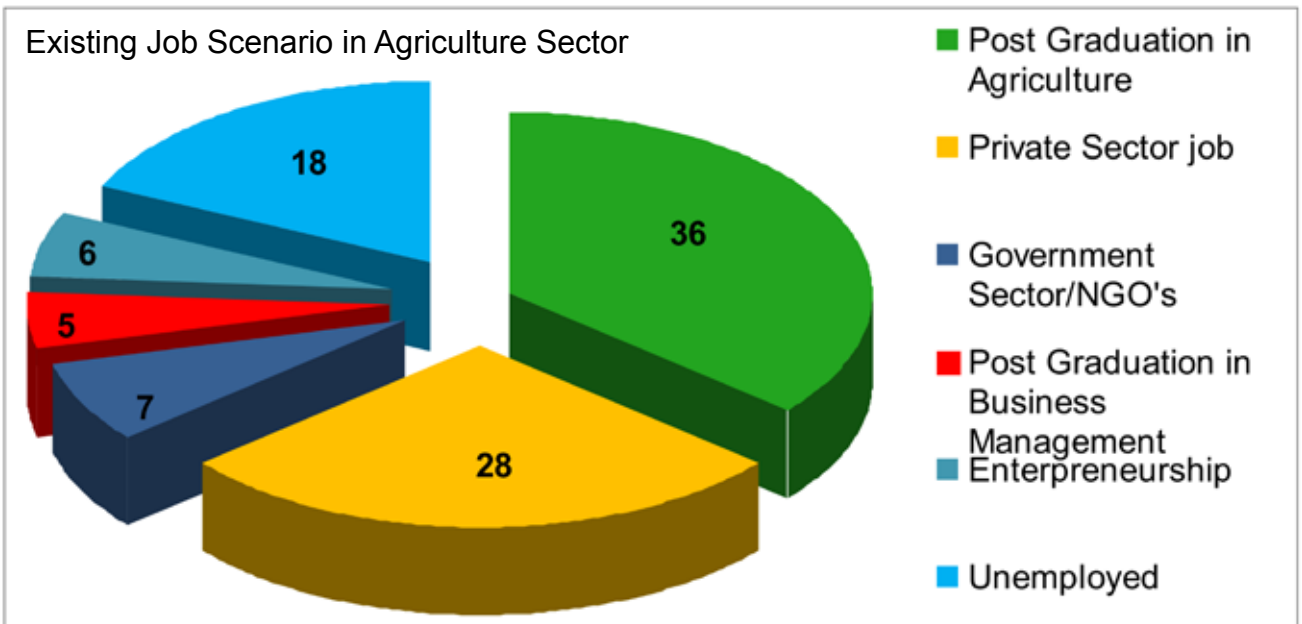
Dr. M.J. Khan

Agriculture, the vocation that had lost its dignity over the years owing to the economic indifference it has cast to its stake holders, is now slowly gaining grounds in the light of corporatisation. Bygone are the days when agriculture was a matter of mere subsistence and a mode of survival for the poor. As the world itself has opened up gates and as many nations embrace a more liberalized economy, India stands to gain its share of benefits. Though the nation is still embroiled in the unabated farmers' suicide and numerous inequities existing in this sector, this profession has transformed itself and has attained the status of an enterprise involving the leanest and the mightiest entities in its fold.

A sector which was once primarily production driven has now significantly transformed in to a market driven enterprise that has all poised to become the next driver of the Indian economy. The Indian rural market holds a great promise for the future of India and so is the agri sector. More than fifty percent of the total retail market in India is held by rural retail. The growth of rural retail market has even outpaced that of the urban market and the corporate sector which once used to shy away from investing in rural development is today vigorously competing to invest and be a part of the over all development. Players of various hues such as agri input industries, agri machinery companies, processors, exporters, retailers etc are vying for their space in rural India. Many retail chains are now opting to enter into contract farming so that they could control the flow of produce from the initial stages itself.

Though the sector is booming with opportunities, the most pertinent issue of maintaining productivity and quality remains largely unanswered and unattended to. This sector is in need of a total revamp in terms of skilled or 'learned' manpower. Unfortunately, for educated people, agriculture sector is loosing charm and is failing to attract the talent, be it research, academic, extension or production related jobs. However, the agribusiness sector and the new emerging knowledge related businesses, provide more challenging opportunities for the educated youths, particularly where MNCs or large organized sector companies are involved. The growing agribusiness sector has the potential of providing a number of job opportunities which can only be catered more efficiently by students with agriculture sciences background.

The Changing face of Agri Profes-



The National Scenario: Approx. 16,000 Agri graduates pass out every year, 10 institutes and 24 SAUs

sion

Earlier, for a graduate or a post graduate of this discipline, government was the sole employment provider. Most of the work pertained to extension activities which were in fact more productive during the early seventies with T&V systems. The golden years of agriculture following the green revolution were golden period for the agri professionals as well. But gradually with time, their effectiveness wore out and so did the profession. The number of jobs with government either remained stagnant or the number of graduates outnumbered the actual vacancies. Whatever the reason, the jobs with government showed a declining trend and the graduates faced a grim future.

The government's increasing withdrawal from the production scene and the entry of private sector has thrown open several opportunities for the agri graduates in the corporate sector. The involvement of private sector, in the beginning was mostly with the input industries, such as fertilizers, seeds, pesticides etc., which still offer good number of job openings to agriculture graduates.

Seeds Industry

Seed industry for instance, is one of the fastest growing agri-input industries, ever since the entry of major corporates in 1988, when new seeds policy was announced. And now, with the increasing application of biotechnology, the pace of growth is likely to increase. The market share of the corporates in the prolific seed industry is a whopping 70 per cent, whereas the government involvement is limited to 30 per cent. The corporate sector mostly having tie ups with global big wigs have a very impressive growth rate and better organized to handle the demand pressures of the market. More importantly, their better working culture and pay outs create more opportunities for talents in the agri sector. With a 15 per cent growth rate and a turn over of Rs. 5000 crores, this industry accounts for the largest number of new job openings. In seed industry, an agri graduate can find job in Research and Development, production, product development, sales, marketing and procurement etc. The major players are Monsanto, Mahyco, Proagro, Advanta, Syngenta, Nuziveedu, Rasi, Indo-American, JK Seeds, Namdhari, Nunhems, Bayer, Bejo Sheetal, Ankur Seeds, Vibha Agrotech etc.

Pesticide Industry

Another preferred career destination for the agriculture and agribusiness graduates is the Rs. 6000 crore strong Pesticide industry, which is dominated by MNCs and other major corporates. In terms of job openings, career growth and compensation package, this industry has been on the top during the last two decades. There are a good number of agri graduates holding top positions in the industry today. Fresh openings are mostly in the sales & marketing areas. The preferred qualification would be B.Sc (Ag) or M.Sc. (Ag.), preferably with MBA. But for more specialized avenues, this sector requires candidates to be M.Sc. (Ag) or Ph.D in disciplines like entomology, pathology, agronomy, weed sciences and agriculture chemicals. The major players are Syngenta, Bayer, BASF, Cheminova,

Monsanto, DuPont, Dow etc. among MNCs and Rallis, UPL, Excel, Dhanuka, Gharda, Pesticides India, Crystal Phosphates, NACL etc. among Indian companies.

Fertiliser Industry

The largest input industry of agriculture is the fertilizer industry with a business size of approx. Rs. 50,000 crores. The industry however operates under tight Government controls with respect to investments, gas availability, output allocations and subsidies. They are comprised of Govt. sector, cooperative sector and private sector companies, sharing almost equal size of the market. The industry is deficient of fresh investments, as in the last 15 years, no new fertilizer plant has come up in India. For the openings in marketing and agriculture services, the preferred qualification is B. Sc. (Ag.) or M.Sc. Ag. in Agronomy or Soil Science and for marketing it is agriculture graduation with M.B.A. The major players in this industry are NFL, RCF, IPL etc. in Govt. sector, IFFCO & Kribhco in Cooperative and TCL, Chambal, Indo-Gulf, Coromandal, SPIC, DSCL, NFCL etc. in private sector.

Farm Machinery Industry

Agri machinery sector is also holding up tight among other industries. Unlike other sections, this particular sector has shown a keen interest towards the agriculture engineers or mechanical engineers, although there are also some companies which have hired B.Sc. (Ag.) and agribusiness graduates. The tractor industry is comprised of some major names such as Mahindra, TAFE, Escorts, Eicher, HMT, Punjab Tractors,

Sonalika, New Holland, John Deere, Bajaj Tempo etc. Apart from tractors, other equipments such as threshers, trolleys, cultivating equipments etc. are manufactured by mostly small sector companies.

However in the irrigations systems, manufacturers include some major names like Kirloskar, Jain Irrigation, Netafim, Plastro, Premier irrigation etc.

These industries also hold promise for many job opportunities for agriculture graduates. The launch of Micro-irrigation projects by States like APMIP in Andhra Pradesh, GGRC in Gujarat, Harit Rajasthan etc. have opened up large number of job opportunities for agriculture graduates. Under these projects, companies supplying MI systems are mandated to recruit agri graduates or agri engineers for providing services to farmers.

Farm Credit Industry

Rural credit, a crucial input for agriculture is mostly catered to by nationalized banks, cooperative banks, RRBs and other govt. institutions like NABARD etc. Agriculture graduates stand a great deal of chance of getting in to these kinds of institutions. In fact in 2008 - 09, public sectors banks were the highest recruiters of agriculture and agribusiness graduates in India. Moreover, many leading private banks like ICICI have increased their share of rural banking. So did many micro finance institutions. Thus the opportunities for the candidates with agri background in this sector have been on the rise. There is likely to be good growth in rural credit industry, as now concepts like Kisan Credit Cards, Online purchase crediting systems etc. are in place as also the general growth in demand for credit due to variety of factors, like increasing commercial approach to farming, involvement of corporate, diversification to high value crops etc..

The Prospective Areas for Agri Professionals

Apart from the conventional job opportunities, now the agri graduates are more likely to encounter more challenging and demanding jobs that too in many unlikely areas such as IT, biotechnology, food processing, cold storage, agriculture supply chain management among many others, which are offering tremendous opportunities. Also, the increasing role of NGOs and other developmental organizations in the rural scene have also created many opportunities where the agri professionals can prove their mettle.

Since the specifics of jobs are changing with market dynamics, the usual curriculum in many SAUs is insufficient. The concept of marketing and management which is non existent in the college curriculum plays a huge role in any progressive career that an agri graduate embarks upon. So a MBA becomes all the more necessary if one has the ambition to excel in the job.

The opportunities for agriculture graduates to acquire the knowledge of management concepts are limited with less than 1500 seats available in agribusiness management institutes and SAUs against about an annual production of more than 16,000 ag-

riculture graduates from SAUs and affiliate colleges. A post graduate degree in agribusiness management in this scenario can be viewed as a ladder to one's corporate career growth. The industry requires no less than 2500 agribusiness management professionals annually and as already discussed, we have a supply of only about 1500 only. A huge demand supply gap is resulting in sky rocketing salaries and a need is felt for producing more number of agribusiness management professionals to sustain the growth of the industry.

Apart from this, the knowledge of agriculture, agribusiness, market, products, competition, latest development in research, policy changes, new concepts in agriculture etc. is becoming more and more important, as the nature of business keeps on changing due to technological developments, corporatisation and globalization.

R&D is yet another area, which has been attracting considerable attention both from the government bodies and private sector. Although, the positions in the existing government bodies as scientists have a limit regarding the number, the glory attached to serving in some of the nation's premier institutions has never subsided. There is still breathtakingly high attendance to the examinations held for these coveted posts. The scenario is quite different in the case of the private sector where the close competition demands innovation, which can only be rendered by a sound R&D. So now, most of the input companies especially those in seed sector are giving impetus to the R&D. Hence those with research in their mind can try in the private sector as well. When research is the priority, the candidates have to expand their résumé with more qualification going beyond post graduation. A PhD and sometimes a post doctoral fellowship may come in handy to serve as a scientist.

Agriculture as a sector itself has undergone many changes and so are the opportunities associated with it. The near future will see more educational institutes in the agribusiness sector coming up to cater to the increasing demand for trained professionals for private sector. The corporates are also expected to step in with their participation to produce sufficient number of skilled and employable manpower in agribusiness. Various short term and long term courses, distance learning courses and skill enhancement training programmes are a definite yes in the days to come. The student community in agriculture has to look ahead and gear up to take the challenges of the unfolding world of agriculture and contribute to the larger growth and development of the nation. With trade and agriculture getting globally integrated and in post WTO scenario, the global opportunities are awaiting Indian agri professionals. There are also strong opportunities emerging for them to serve the millions of people living in the rural areas by participating in rural growth phenomenon, where corporates and institutions are aggressively involved.

President & CEO, Institute of Agribusiness Management, Noida
Centre for Agriculture and Rural Development

Biofuels and Agriculture : An Overview

Pooran Chand

Globally, biofuels are most commonly used to power vehicles, heat homes, and for cooking. Biofuel industries are expanding in Europe, Asia and the Americas. Biofuels can be produced from high sugar crops (sugar cane, sugar beet, and sweet sorghum or starch (corn/maize), and crops plants that contain high amounts of vegetable oil, such as oil palm, soybean, algae, jatropha, or pongamia pinnata. China and India are well positioned to become world leaders in biofuel production within a decade. The vehicle population continues to increase exponentially and by the year 2020 about 1.5 billion vehicles are expected to be in use in the world. Unregulated carbon dioxide emissions, a prominent green house gas, will increase by 65% over the current levels due to large scale use of fossil fuels. The Supreme Court of India informed the Government of India (GOI) to use Compressed Natural Gas (CNG) as an alternative to petrol and diesel for fuelling automobiles to reduce environmental pollution. According to the Federation of Indian Chambers of Commerce and Industry (FICCI), India could save nearly 80 million L of petrol annually if petrol is blended with alcohol by 10%.

Introduction

Self sufficiency in energy requirement is critical to the success of any growing economy. With increasing energy consumption, dependence on fossil fuels will necessarily have to be reduced. Attempts are being made at international level to address these issues and among other possible solutions, the use of biomass ethanol needs special attention especially for a tropical and agricultural based country like India. Its use as transportation fuel has been wide spread in Brazil, and is becoming popular in USA. Ethanol can be derived from different sources of biomass such as sugarcane molasses, corn, sorghum, potatoes, and others. The effective use of ethanol either as a neat fuel or as a mixture with gasoline has been proved to be technically feasible and environmentally acceptable.

Biofuel is defined as solid, liquid or gaseous fuel obtained from relatively recently lifeless biological material and is different from relic fuels, which are derived from long dead biological material. Also, various plants and plant-derived materials are used for biofuels manufacturing. Globally, biofuels are most commonly used to power vehicles, heat homes, and for cooking. Biofuels industries are expanding in Europe, Asia and the Americas. Agro fuels are biofuels which are produced from specific crops, rather than from waste processes such as landfill off-gassing or recycled vegetable oil. There are two common strategies of producing liquid and gaseous agro fuels. The first is to grow crops with high sugar content (sugar cane, sugar beet, and sweet sorghum or starch (corn/maize), and then use yeast fermentation to produce ethyl alcohol (ethanol). The second is to grow plants that contain high amounts of vegetable oil, such as oil palm, soybean, algae, jatropha, or pongamia pinnata. When these oils are heated, their viscosity is reduced, and they can be burned directly in a diesel engine, or they can be chemically processed to produce fuels such as biodiesel. Wood and its byproducts can also be converted into biofuels such as wood gas, methanol or ethanol fuel.

It is also possible to make cellulosic ethanol from non-edible plant parts, but this can be difficult to accomplish economically.

Types of biofuel

Biofuels are energy carriers that store the energy derived from biomass. A wide range of biomass sources can be used to produce bioenergy in a variety of forms. For example, food, fibre and wood process residues from the industrial sector; energy crops, short rotation crops and agricultural wastes from the agriculture sector and residues from the forestry sector can all be used to generate electricity, heat, combined heat and power, and other forms of bio energy. Biofuels may be referred to as renewable energy because they are a form of transformed solar energy. Biofuels can be classified according to source and type.

First generation biofuel

First-generation biofuels are made from sugar, starch, vegetable oil, or animal fats using conventional technology. The basic feedstocks for the production of first generation biofuels are often seeds or grains such as wheat, which yields starch that is fermented into bio ethanol, or sunflower seeds, which are pressed to yield vegetable oil that, can be used in biodiesel. These feedstocks could instead enter the animal or human food chain, and as the global population has raised, their use in producing biofuels has been criticized for diverting food away from the human food chain, leading to food shortages and price rises.

Second generation biofuels

Supporters of biofuels claim that a more viable solution is to increase political and industrial support for and rapidity of second generation biofuels implementation from non food crops, including cellulosic biofuels. Second generation biofuels production processes can use a variety of non-food crops. These include waste biomass, the stalks of wheat, corn, sweet sorghum, wood, and special energy or biomass crops (e.g. Miscanthus).

Table-1: Main energy crops worldwide

Country	Bioethanol	Biodiesel
Brazil	sugar cane	---
United States	maize	soybean
China	sweet sorghum	rapeseed, sunflower seed
Germany	sugar beet	rapeseed, sunflower seed
France	sugar beet	rapeseed, sunflower seed
India	sugarcane	jatropha
Italy	---	rapeseed, sunflower seed
Canada	cereals	---
Thailand	cassava	---
Spain	sugar beet	---
Denmark	---	rapeseed, sunflower seed
Czech Republic	---	rapeseed, sunflower seed
Australia	cereals, sugar cane	---

Sources: United States Department of Agriculture, United States Department of Energy, the European Commission.

Second generation biofuels use biomass to liquid technology, including cellulosic biofuels from non-food crops.

Third generation biofuels

Algae fuel, also called oilgae or third generation biofuel, is a biofuel from algae. Algae are low input, high yield feed stocks to produce biofuels. It produces 30 times more energy per acre than land crops such as soybeans. With the higher prices of fossil fuels (petroleum), there is much interest in alga culture (farming algae). One advantage of many biofuels over most other fuel types is that they are biodegradable, and so relatively harmless to the environment if spilled. The United States Department of Energy estimates that if algae fuel replaced all the petroleum fuel in the United States, it would require 15,000 square miles (38,849 square kilometers), which is roughly the size of Maryland. Algae, such as Botryococcus braunii and Chlorella vulgaris are relatively easy to grow, but the algal oil is hard to extract. There are several approaches, some of which work better than others.

Second and third generation biofuels are also called advanced biofuels.

China and India are well positioned to become world leaders in biofuel production within a decade. Similarly, other countries have plans to more than double their biofuel production within next 15 years. Brazil currently produces 37% of the world's ethanol supply, almost entirely from sugarcane. Large commitments to ethanol as a partial petroleum substitute have been set by:

- India: 8 billion liters for blending at 10% rate with petrol (gasoline)
- China: 14 billion liters at 10%
- Brazil: 16 billion liters at about 22 to 24%
- USA: 30 billion liters at 10%

Brazil, the current number one ethanol producer in the world, mainly uses sugarcane as the feedstock for ethanol production. In the USA most ethanol is produced from maize. These targets are generally supported by subsidies deemed to be serving national interests in energy self-sufficiency, pollution control, and strengthening the rural economy. The main energy crops used worldwide for the production of bioethanol and biodiesel are represented in table-1.

Ethanol

Any feedstock containing significant amounts of sugar, or materials that can be converted into sugar such as starch or cellulose, can be used to produce ethanol. Ethanol available in

the biofuel market today is based on either sugar or starch. Common sugar crops used as feedstocks are sugar cane, sugar beet and, to a lesser extent, sweet sorghum. Common starchy feedstocks include maize, wheat and cassava. The use of biomass containing sugars that can be fermented directly to ethanol is the simplest way of producing ethanol. In Brazil and other tropical countries currently producing ethanol, sugar cane is the most widely used feedstock. However, these starchy products represent only a small percentage of the total plant mass. Most plant matter is composed of cellulose, hemicellulose and lignin; the first two can be converted into alcohol after they have first been converted into sugar, but the process is more difficult than the one for starch.

Ethanol can be blended with petrol or burned in its pure form in slightly modified spark-ignition engines. A litre of ethanol contains approximately 66 percent of the energy provided by a litre of petrol, but has a higher octane level and when mixed with petrol for transportation it improves the performance of the latter. It also improves fuel combustion in vehicles, thereby reducing the emission of carbon monoxide, unburned hydrocarbons and carcinogens. However, the combustion of ethanol also causes a heightened reaction with nitrogen in the atmosphere, which can result in a marginal increase in nitrogen oxide gases. In comparison with petrol, ethanol contains only a trace amount of sulphur. Mixing ethanol with petrol, therefore, helps to reduce the fuel's sulphur content and thereby lowers the emissions of sulphur oxide, a component of acid rain and a carcinogen.

Biodiesel

Biodiesel is produced by combining vegetable oil or animal fat with an alcohol and a catalyst through a chemical process known as transesterification. Oil for biodiesel production can be extracted from almost any oilseed crop; globally, the most popular sources are rapeseed in Europe and soybean in Brazil and the United States of America. In tropical and subtropical countries, biodiesel is produced from palm, coconut and jatropha oils. Small amounts of animal fat, from fish- and animal-processing operations, are also used for biodiesel production. The production process typically yields additional by-products such as crushed bean "cake" (an animal feed) and glycerine. Biodiesel can be blended with traditional diesel fuel or burned in its pure form in compression ignition engines. Its energy content is 88–95 percent of that of diesel, but it improves the lubricity of diesel and raises the cetane value, making the fuel economy of both generally comparable. The higher oxygen content of biodiesel aids in the completion of fuel combustion, reducing emissions of particulate air pollutants, carbon monoxide and hydrocarbons. As with ethanol, biodiesel also contains only a negligible amount of sulphur, thus reducing sulphur oxide emissions from vehicles. A range of different crops can be used as feedstock for ethanol and biodiesel production. However, most global ethanol production is derived from sugar cane or maize in Brazil, the bulk of ethanol is produced from sugar cane and in the United States of America from maize. Other significant crops include cassava, rice, sugar beet and wheat (Figure-1).

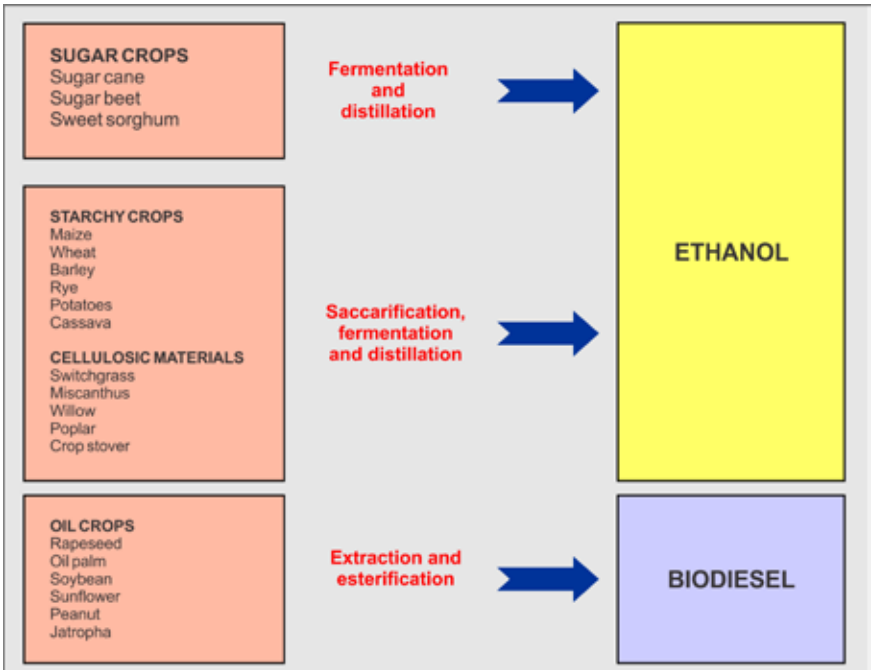


Figure-1: Conversion of agricultural feedstocks into liquid biofuels (Source: FAO)

Environmental advantages of biofuels

The main environmental advantage of biofuels stems from the fact that they are carbon-neutral: the carbon dioxide they release upon combustion is initially extracted from the atmosphere during biomass production, resulting in zero net greenhouse gas emissions. Biofuels also reduce the release of volatile organic compounds, as the addition of ethanol to gasoline oxygenates the fuel mixture so it burns more completely. Ethanol also eliminates the need to add lead. In addition, biofuels are biodegradable and non-toxic, meaning spillages represent far less of a risk than fossil diesel spillages.

Optimizing the chemical and physical attributes of biofuel sources

The switch to renewable biomass sources will also require the development of a suite of energy crops tailored with the desired chemical and physical characteristics.

For bio ethanol production, attention must shift from plant grains toward corn stovers (dried leaves and

stems), trees and perennial grasses, and low-cost agricultural and municipal wastes. Several approaches would improve the efficiency of energy production from biomass sources. As the biosyntheses of cellulose and of lignin are co-regulated, reducing the proportion of lignin in a plant will also increase the proportion of cellulose (13). An alteration of the properties of the cell wall could also be a strategy to facilitate access by key hydrolysing agents for a more efficient release of sugars for fermentation. In addition, research is required to identify new potential biomass sources.

The Planning Commission, Govt. of India, has launched an ambitious National Mission on Biodiesel to be implemented by a number of government agencies and coordinated by the Ministry of Rural Development. The Mission focuses on the cultivation of the physic nut, Jatropha curcas, a shrubby plant of the castor family. The seed contains 30-40% oil and can be mixed with diesel after transesterification. The Government is also discussing a National Biofuel Policy.

Few highlights on biofuels production

- Bioenergy covers approximately 10 percent of total world energy supply. Traditional unprocessed biomass accounts for most of this, but commercial bioenergy is assuming greater importance.
- Liquid biofuels for transport are generating the most attention and have seen a rapid expansion in production. However, quantitatively their role is only marginal: they cover 1 percent of total transport fuel consumption and 0.2– 0.3 percent of total energy consumption worldwide.
- The main liquid biofuels are ethanol and biodiesel. Both can be produced from a wide range of different feedstocks. The most important producers are Brazil and the United States of America for ethanol and the EU for biodiesel.
- Current technologies for liquid biofuels rely on agricultural commodities as feedstock. Ethanol is based on sugar or starchy crops, with sugar cane in Brazil and maize in the United States of America being the most significant in terms of volume.
- Large-scale production of biofuels implies large land requirements for feedstock production.
- Even though liquid biofuels supply only a small share of global energy needs, they still have the potential to have a significant effect on global agriculture and agricultural markets because of the volume of feed stocks and the relative land areas needed for their production.
- The contribution of different biofuels to reducing fossil-fuel consumption varies widely when the fossil energy used as an input in their production is also taken into account. The fossil energy balance of a biofuels depends on factors such as feedstock characteristics, production location, agricultural practices and the source of energy used for the conversion process. Different biofuels also perform very differently in terms of their contribution to reducing greenhouse gas emissions.
- The marketing arrangements like contract farming with buy-back arrangement where industry is actively linking up with farmers on agreed terms, and support from technologists for development of suitable technology is need of the hour.
- Government intervention in achieving the agreement agreeable to both parties is also sought.

Concluding remarks: the road to biofuels

- Biofuels can replace 30% of current transportation energy needs in an environmentally responsible way without affecting global food production with plausible technology developments.
- Current practices, however, do not make biofuels economically competitive, nor optimize energy use and emission characteristics.
- For biofuels to play an important role in meeting future energy needs, a multidisciplinary approach is required, in which the activities of biologists, agronomists, engineers, energy experts and policy specialists are integrated. In addition to developing specific high-yielding energy crops, the impact, efficiency and sustainability of biorefinery facilities need to be improved.
- Research is required to enhance the infrastructure for the development of biofuels (including transport, distribution, and production chain), in order make the production of biofuels economically sustainable. Commercialization and policy support are critical for success.
- Socio-economic concerns, such as land management practices and the choice of biomass source, should be carefully addressed so that biofuels production does not negatively impact either food production or the preservation of biodiversity.
- Equally important are studies to obtain a clear diagnosis of the environmental impact of specific biofuels, in terms of i) combustion emissions, which vary according to the specific biofuels used, ii) energy inputs required for the manufacture of biofuels and iii) the environmental footprint of fertilizers and herbicides used during the production of energy crops.

"With continued policy support and vigorous technology, biofuels could very soon be breathing new fire."

"Biofuels can be used on all aircraft and engines don't need to be modified"

Paul Nash - Head of New Energies at the Toulouse Based Air Bus Industries (Times of India, July 4, 2011)

Professor & Head, Department of Genetics & Plant Breeding, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut

Seafood: A Viable Source of Health and Wealth

*W.S. Lakra**

*G. Venkateshwarlu***

The term 'seafood' refers to any sea animal or plant (seaweed) that is served as food for humans. Seafood includes not only seawater animals, such as fish and shellfish (crustaceans and mollusks) but also similar animals from freshwater and brackishwater. The crustaceans include shrimp, lobster, crab and crayfish, while the mollusks comprise of mussel, oyster, squid and cuttlefish. Fisheries provide a vital source of food, employment, trade and fiscal well being for people throughout the world and particularly in developing countries.

Fish as a health food

Currently, seafood has gained importance as a health-food for many reasons and has been an important part of the human diet. Fish is one of the rich sources of easily digestible animal proteins containing all the essential amino acids and is playing an important role in preventing protein-calorie malnutrition. Besides being an important source of proteins, fish and fish products are rich sources of micronutrients and human health beneficial omega-3 poly unsaturated fatty acids (PUFA). Aquatic ecosystems are known to be the main source of PUFAs in biosphere; thereby humans obtain principal part of omega-3 fatty acids (especially EPA and DHA) by consuming fish, aquatic invertebrates and micro algae. The physiological benefits of omega-3 fatty acids have mainly been associated with a reduced risk of cardiovascular diseases and with significant reduction in the extent of atherosclerosis. Their beneficial effects have also been well established with the visual and neural development of the infants.

Aquatic nutraceuticals and functional foods

Deficiency of omega-3 fatty acids in modern diet has been shown to be positively correlated with several degenerative diseases like cardiovascular diseases, arthritis, etc. As the intake of fish and fishery

products is lower compared to the human body requirements, efforts are in progress to produce nutraceuticals and functional foods enriched with omega-3 PUFA and these products are currently available in the markets. Several marine based (fish oils such as cod-liver oil, menhaden oil and herring oil and lipid extracts from fungi and algae) nutraceuticals are available in the form of dietary supplements. A number of functional foods have entered into the market shelves to increase the consumption of PUFA by incorporating fish oil into different products such as milk, bread, soft drinks, yogurt, mayonnaise etc.

Exponential growth in Indian seafood exports

The Indian fish Industry has come a long way and today seafood is being exported to more than 100 countries from India. Before 1960, the markets of Indian seafood were largely confined to neighbouring countries like Sri Lanka, Myanmar, Singapore etc. when our exports were mainly of dried items. This situation changed with the development of technologies and modernization of processing plants; dried products gave way to processed and frozen products. The product shift also resulted in market shift making inroads into the developed markets viz. Japan, USA, Europe, Australia, etc. Several seafood processing units with modern machinery for freezing were set up at all important centers in the country for export processing. The export of marine products has steadily grown over the years - from a mere Rs.3.92 crore in 1961-62 to Rs.12,826 crore in 2010-11. During last financial year, export of fish products has crossed all previous records in quantity and achieved the US$ 2.84 billion mark by registering a growth of 33.17% in US$ realization compared to the same period of last year. As per the figures released by the MPEDA, there is a considerable increase in export of frozen shrimp and frozen squid during the period because of the large-scale production of white shrimp (Litopenaeus vannamei), high productivity of Black Tiger Shrimp and increased landing of Squid.

Raft cultivation of **Kappaphycus**

Diversification is need of the hour

Though we have achieved significant growth in terms of export earnings, the major export item is only frozen seafood for the past so many years. Frozen shrimp continued to be the major export item accounting for 41.4% of the total earnings. Hence, the diversity in the products should be given focus in species wise as well as product wise. Varieties of seafood including cephalopods and molluscan shellfishes can be processed in different forms into different products to ensure the diversification. Diversification can also be successfully achieved by value addition. A number of products and market opportunities are available particularly for value-added products. Fish mince offers immense scope for development of diverse products such as surimi-based seafood analogs, sausages, battered and breaded products, restructured, dried and formulated products. Further, development of minced fish and mince-based products provides dual opportunities for utilization of low value fish for human consumption as well as diversification of fish processing industries for international trade in value-added products. Market expansion for mince based products depends on design of appealing products, careful process development, identification of consumer preferences varying in considerable cultural backgrounds and adherence to strict quality standards. India and other Asian developing countries can benefit the most from better management of the low cost fishery resources because of advantages such as abundant resources and cheap labour.

Bridging the gap between fish production and processing

There is a huge gap between the total fish production in the country and its processing capacity for domestic consumption and export. Post harvest, pre-processing, processing and marketing sectors are currently very much export oriented and the domestic market is not given adequate thrust. Keeping in view the vast potential of domestic market for fish products, necessary steps need to be taken immediately.

Need for enhancing fish consumption

The nutritional value of fish is well understood and people are aware of the health benefits of PUFA. However, the present consumption rate is only 4.7 kg against Indian government's objective of achieving the per capita fish consumption of 11 kg/year as per the WHO recommendation. Hence, there is a need of promoting fish consumption

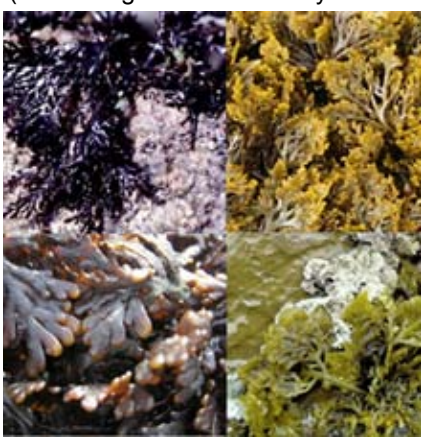
Rope cultivation of *Gracilaria*

by creating awareness regarding medicinal and nutritional value of the fish throughout the country. Further, there is a wide range of variation in the fish consumption pattern in our country. People in coastal areas have more accessibility than those in inland areas. This scenario can be changed by establishment of cold chains, value addition, improved processing and preservation methods. It was also observed that there is an urgent need to address hygienic landing and quality control.

Sea Vegetables – Untapped Resource for Vegetarians

Sea vegetables or commonly known seaweeds or marine macro-algae are large benthic algae that are multicellular, macrothallic, and thus differentiated from most algae that are of microscopic size. These plants form an important renewable resource in the marine environment and have been a part of human civilization from time immemorial. Chinese literature says that as early as 2500 years ago, foods prepared from these plants were served for the Royals with a great extravaganza. It was only after the Second World War that many countries including India, paid attention to these resources. The global production of seaweed is about 4 mmt; out of which Kelps are of 66% and red seaweeds (mainly Kappaphycus) are of 33%. Interestingly, 80% of total global production is produced in Asia-Pacific region with Kelps mainly from China and Japan and Kappaphycus from Philippines. In India, out of 844 species, only 4 are being cultivated with the total production of 0.2 mmt indicating vast potential for their cultivation.

It has been estimated that about 100 gm of Sea vegetables are equivalent to 1 kg of vegetables, which can provide: 30-40 g protein; Amino acids (alanine, aspartic acid, glutamic acid, free amino acid, taurine); Poly Unsaturated Fatty Acids (PUFA); Vitamins (Vitamin A, B2, B12, C and E); Minerals (Na, K, Ca, Mg, P, Fe, Zn, Mn, Co) and Iodine (brown algae are the only natural source of iodine and are used in diet of to fight goiter). The increasing demand of the raw material required for phycocolloid production such as agar, alginate and carrageenans leads to only one direction and that is large scale cultivation of these species. So far, in many places, the natural harvest used to be the source. Economically, they are the only source for phycocolloids such Agar (Source- Gracilaria), Alginic acid (Sargassum) and Carrageen (Hypnea). Apart from this, they are used for medicine, aqua-feed, poultry feed and as fertilizer for agriculture as well. The sea vegetables are staple item of diet in Korea, Japan and China. Out of 20,000 species; about 200 species are commercially used for food and phycocolloids.



Seaweeds are untapped source of income from the seas, which has been ignored. In India, with the advent of Kappaphycus cultivation along the Tamilnadu coast, some awareness has been created. However, the local communities, though little importance is known traditionally, remain oblivious to this treasure in their vicinity. The harvesting of seaweeds will be additional income for poor artisans. The cultivation of seaweeds involves simple protocols such as site selection, seeding, laying out nets in the field etc. Among all the cultivation methods developed for G. acerosa, bottom-culture method using coral stone as a substratum is found to be the best-suited for cultivation. A crop yield of 4 tons (dry weight)/ha/yr was achieved in two harvests over 0.5 ha area by the above mentioned method using coral stone as substrata. Based on the pilot-scale experiments, 20 tons (dry weight)/ha/yr in three harvests was obtained for G. edulis using longline rope method, in which a coir rope was used as substrate and 30 tons (dry weight)/ha/yr in five harvests was obtained for the same seaweed using Single Rope Floating Raft Technique (SRFT).

Director / Vice-Chancellor, Central Institute of Fisheries Education, Mumbai, **Principal Scientist, Central Institute of Fisheries Education, Mumbai

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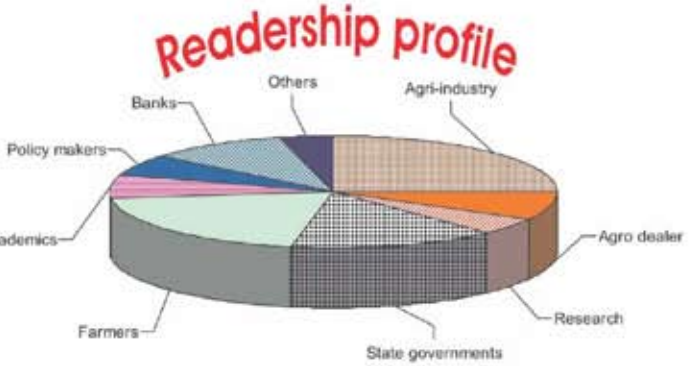

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Future outlook

Beyond Green Revolution

Vibha Dhawan

Impact of Green Revolution

Global agriculture had witnessed a major transformation during the 20th century which was largely driven by rapid advances in the sciences, substantial public investments and enormous policy support from the governments. These advances were possible largely due to modernization of plant breeding technology, improved agronomy, development of inorganic fertilizers, chemicals for pest and disease control and free exchange of germplasm across international boundaries. Most developing countries, including India thus achieved sustained food surpluses during the second half of 20th Century and emerged from their long dependence on food aid from developed part of the world. One must also acknowledge initiatives of Rockefeller and Ford Foundation in establishing an international agriculture research programme to help transfer and adapt scientific advances already available around the world to the conditions of the developing countries. The first investments were made in two cereal crops i.e. rice and wheat, which included breeding of improved varieties combined with extensive use of fertilizers, other chemicals, chemical inputs and irrigation. USAID Administrator, W.S. Gaud, coined the term Green Revolution which actually is a continuing process of change rather than a single event which even today is leading to continual improvement of cereal varieties thus helping in increasing productivity. Another key element of success was development of draft varieties of wheat by the Noble Prize winner Norman Borlaug. Dr Borlaug himself had travelled to the major wheat growing countries of the world, convinced scientists to incorporate draft trait in the conventional varieties grown in their respective countries. This gave a major push to the cereal breeding programmes. The Green Revolution rapidly spread across the entire globe thus helping in increasing food productivity and pulled many regions back from the edge of an abyss of famine and led to regional food surpluses within a short span of 25 years. The self-sufficiency in food actually changed the entire fabric of rural India lifting many people out of poverty thus making an important contribution to social and economic growth. It also saved large areas of forests and other fragile lands from conversion to cropping. The policies of Government of India at that time were very conducive thus leading to achieving the goal of meeting food security. However, there are still some lingering social and environmental problems that are being raised against the technology. The most important is the increasing disparity between rich and poor farmers; and excessive use of water and fertilizers which is leading to declining of soil health and receding of water tables. While some of these criticisms are valid, a holistic audit will surely suggest that Green Revolution was an important step for intensifying food production systems and saving millions from poverty and hunger.

At the time of Green Revolution, the major goal was to increase productivity. Thus, the high yielding cereal varieties that were developed were suitable for higher yields in favourable environment such as irrigated areas with high fertilizer usage. Unfortunately, some of these varieties are more vulnerable to pests and diseases compared to the traditional varieties thus increasing the risk of major yields and food production short falls in unfavourable years. Most of these varieties cannot tolerate temperature fluctuations that are

becoming norm of the day due of the climate change. Couple of degrees increase in temperature at grain filling stage of wheat can drastically reduce wheat production and quality of the grains. Another concern that has been voiced is that large areas where major cereals are planted with few modern varieties are increasing the risk of loss of biodiversity and that genetic uniformity might make crop vulnerable to catastrophic losses from changes in pest diseases and the climate. Also, improvement in cereal crops leading to increased productivity has detracted farmers from growing millets and other minor crops that were extremely important for nutritional security. But one must ask these questions: who are responsible for maintaining biodiversity of crops? Is it the resource poor farmer? How to ensure long term sustainability of agriculture? Are we doing adequate capacity building through the existing extension system? Who is responsible for nutritional security of the poor people? Fortunately, some of these questions are adequately addressed by the Governments and International agricultural research systems. Gene banks have been established by the national governments (National Bureau of Plant Genetic Resources in India) and by CGIAR (Consultative Group on International Agricultural Research) as Biodiversity International. These gene banks are making germplasm available both to public and private sector for breeding purposes. With active participation of the private sector in seed businesses, fortunately varieties are changed more frequently from broad genetic base of varieties. Recently, some issues have been raised on how germplasm may be shared especially with the private sector organizations that pay for the high cost of maintaining germplasm banks. The awareness programmes on balanced food are also being addressed through horticultural mission programs. Efforts are also being made for revamping the extension system in which apart from public sector institutions (most importantly Indian Council of Agricultural Research), private seed companies are also actively participating.

Way Forward

No technology is perfect and each technology has a certain life. One must realize that the benefits from green revolution have gradually plateaued and in India, in spite of repeated requests made by the Hon'ble Prime Minister, we are unable to attain growth of 4% in the agriculture sector. In fact, our growth has been even lower than the population growth. This essentially means that if we continue on the existing path, in the years to come, per capita food availability will decline further forcing us either to import food or that many more will go to bed hungry. Therefore, we must look at other technological options including using biotechnological tools be it traditional or advanced technology of genetic manipulation.

Discovery of DNA as double helical structure and further genes as the basic hereditary unit has opened enormous opportunities. While in plant breeding, to incorporate a trait of interest, one has to do series of back crosses but in case of genetic engineering, it is possible to identify a gene of interest, clone it (make multiple copies) and insert into the genome of otherwise desirable plant. The gene has no boundaries and therefore, it is possible to incorporate genes of bacterial origin to higher plant. It is important to understand that gene is nothing but a small portion of DNA consisting of four nucleotides, ATGC (Adenine, Thymine, Guanine, & Cytosine) organized in a particular fashion. Thus, there is no difference in a gene of animal origin and that of plant origin.

The crop varieties researched/ produced by genetic engineering are regulated through a set of rules and regulations. Even to initiate research, the institutions must convene regular meetings of the Institutional Biosafety Committee (IBSC) in which nominees from Department of Biotechnology, Government of India are present. At the next level, when plants are to be tested in containment, a much larger regulatory body RCGM (Review Committee on Genetic Manipulation) under the Department of Biotechnology, reviews the application ensuring that all aspects of biosafety, are duly considered. There are suggested rules and guidelines and if applicant fulfills those criteria and committee is satisfied, approval for field trials under containment is granted. Further, it is ensured that nothing is leaked out of the premises and even remains of the test plants are carefully destroyed. The applicant also develops procedures for testing the product meeting the criteria of substantial equivalence (GM food should be considered the same and as safe as conventional food if it demonstrates the same characteristics and composition as the conventional food), with proper testing for any possible

allergenicity and toxicity. The approving body for commercial release is GEAC (Genetic Engineering Approval Committee) under the Ministry of Environment and Forests.

In India, approval has so far been granted only for one GM crop and that is cotton. The trait is for conferring resistance through Bt Bacillus thuringiensis protein to important insect pests of cotton which was adopted in 2002 with approximately 54000 farmers and was planted in 50,000 hectares area. By 2010, 6.3 million farmers adopted the technology covering an area of 9.4 million hectares representing an unprecedented increase of 188 fold in nine years. According to the recent ISAAA Brief (No 42 of 2010), yield gains are approximately 31%, a significant 39% reduction in insecticide sprays, leading to 88% increase in profitability (US$ 250 per hectare). It is interesting to see that a total of 780 Bt cotton introduction (779 hybrids and one variety) were approved for planting in 2010, indicating that there is no fear of loss of biodiversity. The deployment of Bt cotton has helped India attaining number one position as exporter of cotton and only next to China in terms of producer. While due to increased production, there has been some decline in international prices, but due to productivity gains, the individual farmer's income has still gone up.

We must realize that there is an opportunity cost – what would have been the plight of the cotton farmer in India if we have not adopted the technology!

The next crop to get approval for commercial release was Bt Brinjal. GEAC in October 2009 allowed the release of Bt eggplant but immediately had put a moratorium. The then Minister of State for Environment and Forests, Shri Jairam Ramesh has called public consultations in different parts of the country and based on the public opinion has put a hold on its commercial release. Public has voiced number of concerns such as lack of long term studies on the safety of the crop; biosafety concerns due to large number of existing varieties of Brinjal; authority of food safety tests as they were largely done by the developer of the technology and difficulty in labeling as consumer has right to know what they are consuming.

The issue is not restricted to the introduction of Bt Brinjal alone, but is a much larger one. Today, we are living in a global village. Thus, we cannot expect to be untouched by the developments in other parts of the world. 15.5 million farmers have grown biotech crops in the year 2010 in 29 countries. Over 30 countries are importing products of biotech crops thus making total of 59 countries using biotech crops either for planting

or as products. Globally, we are also witnessing rise in food prices at a rate which is consistently higher than the consumer price index. This is definitely a departure from past many years when the increase in food prices was in line with CPI. It is quite depressing for developing part of the world, where people are spending substantial part of their income on food. Large percentage of our population today is making hard decisions on relying on cereals alone resulting in nutritional insecurity. The prices of pulses, vegetables and fruits have gone skyrocketing making them a luxury item for the poor rather than a part of their routine food. Thus, if globally any technology is adapted which improves productivity without compromising on food or environmental safety, the products of that will reach to other parts of the globe. To ensure that India does not reach to a situation where importing food will become cheaper than producing its own, we must carefully evaluate all technological options that are available for meeting food and nutritional security.

The technology is evolving and as we move, we will be learning new lessons be it extension or its regulation. We do not have to rush and proper risk assessment and management practices must be evolved. But at the same time we should not be doing analysis to an extent that it kills the technology. We should have faith in our farmer who is the best judge to decide how to increase land productivity.

Biotechnologies: Gap Analysis for Adaptation

Genetic engineering is not the only technology which can help in increasing land productivity. There are number of other biotechnologies which have enormous potential for improving land productivity, be it tissue culture for cloning of disease free elite genotypes; biofertilizers for small and marginal farmer that can be produced locally, help in replacing inorganic fertilizers and improve soil health; biopesticides that are much safer for environment and humans etc. While the benefits of these technologies have been proved beyond doubt, they are yet to be adopted on large scale. The reasons are many, such as lack of awareness due to lack of proper extension; inadequate microfinancing avenues; inadequate crop insurance, lack of entrepreneurship development for marketing of agro-inputs; inadequate value addition of farm produce so that farmer is compensated adequately; lack of certification of biofertilizers and biopestcides, organic certification of food etc. Agriculture requires much serious investment be it of human resources or of finances to ensure that every citizen on this planet have access to adequate and safe food.

Executive Director, The Energy & Resources Institute (TERI), New Delhi

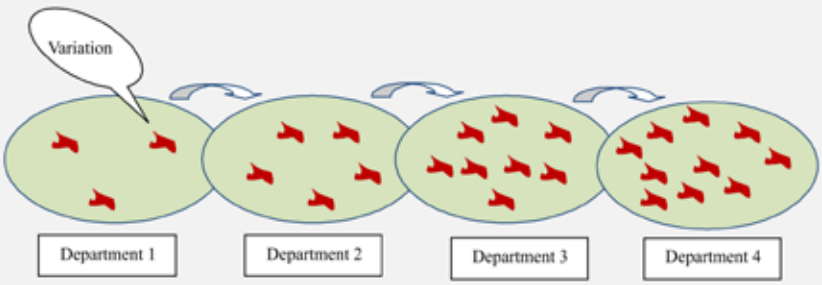
Leadership in Present Day Indian Agriculture Sector vis-à-vis the Germ Theory Management

Pinaki R. Dey

Indian agriculture has no doubt come a long way since the first green revolution. Productivity has increased, new crops have been introduced, various indigenous and international technologies have been embraced, sectors like food processing, food-retailing and few others have attracted greater corporate focus than before. However, the sector is plugged with quite a few pertinent problems. Even after 64 years of independence, there are regional inequalities in agriculture sector, within a region there are individual inequalities, a large number of farmers still do not get the deserved farm gate price, tonnes of food grains are brutally getting wasted due to bad warehousing infrastructure, prices of basic agricultural commodities are increasing unabated. It's not that these issues are ignored, brushed aside or not being acted upon by the policy makers, government and civil servants related to the agriculture sector of the country. Several reforms have been made, new measures being taken, various financial and non financial incentives have been provided to the sector as a whole and to the farmers in particular. However, what appears to be the need of the hour is a strong leadership in the agriculture sector, whether collective or individual, based on a pragmatic and futuristic approach, a dynamic leadership based on ``profound knowledge``.

This article tries to define the leadership that is so critically required in the present day agricultural sector of the country from the perspective of the germ theory of management, which still holds very effective in today's global scenario and gaining increasing relevance day by day. Once we start viewing the agriculture sector like any other organized sector and the farmers as social entrepreneurs feeding the whole nation, we go one step ahead in embracing effective, egalitarian and futuristic leadership and management based on latest management principles.

Fig 1: The virus of variation keeps on increasingacross various departments within a particular sector

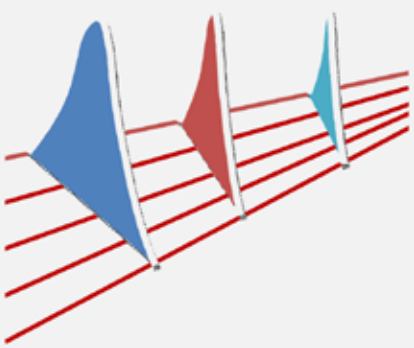


The Backdrop

The year was 1870. Until this time, medical doctors were the demigods who were helping people to live longer and live healthy. Unfortunately, these doctors had the knowledge of medical science but they were not having the `profound knowledge`. The profound knowledge was told by Luis Pasteur. He suggested that there are invisible micro organisms called germs which travel from one patient to another or from the contaminated hands of the `savior` doctor or through the air and infect the wounds of another patient. The invisible germs infect the wound of a person and cause infection. It was then understood that the treatment of the doctors were causing some patients to get better, some to remain the same and some others to get even worse (Interestingly, doesn't the same happen with various reforms and policy measures that help some farmers, does not affect some other fellow farmers and some get adversely affected). This theory of the invisibly infecting germs was termed as the `Germ Theory of Medicine`.

In the year 1992, Myron Tribus extrapolated the germ theory of medicine to modern day management. He proposed that the virus of variability or poor quality in any sector or business process is like the invisible germ which keeps on infecting one process to another with multiplying magnitude. It was suggested that the variation in a process is either due to common cause variation (`noise`,

Fig 2: Reducing variation on a continuous basis



arising from within the system) or a special cause variation (`signals`, arising from outside the system). Problems arise when we fail to detect the right cause of variation and as a result fail to increase the quality of a system despite our best of efforts. Variations in a process are many a time within the systems and failing to detect variations in a process is a result of bad management practice and leadership of any sector (Fig 1). Whatever measure is taken to improve the system without identifying the root cause might show temporary positive results in the short time but would turn futile in the long run.

Any leadership and management process should actually concentrate on improving the system for better results rather than adopting window dressing techniques, short term measures, judging performance based on targets and numbers, trying to improve performance by merely on the basis of instruments like financial incentives, rewards, punishments, warnings etc. The leadership in the present agricultural sector of the country should aim at controlling variation continuously and consistently, compressing on a continuous basis (Fig 2). Like any other sector, agricultural sector too has got its stakeholder groups like the farmers, government authorities, corporate sector in agribusiness, credit institutions and others. It is essential that leaders of these respective stakeholder groups find the real cause of inefficiency or variation in their respective arenas. It is also very necessary that the leaders of these sub sectors are in constant communication with each other.

Why the Germs of Variations in a Process Amplifies Due to Bad Leadership

What it should be	What is usually seen
Inclusive approach (`together we work`)	Usually top to down approach
Mentoring and acting as a true guide to the stakeholders of the sector	Believe in `getting the work done`
Leading from the front, be a role model	Often escapist, ready to share team success but abandons failures
Believes in `for whom am I dependent on and who depends on me`	Believes in `who is responsible and whom should I please`
Looks for long terms solutions and always has the long term interest of the sector in mind	Looks for quick fixes just to stay in power disregarding long term interest of the sector
Accepts team failure with grace and counts himself responsible too	Does not have the courage to accept failure and indulges in blame game

Germ of Variation Breeds Faster with Myopic Leadership

Many of the present day functions are run on the basis of a leadership that is myopic in its view. The cause of failures or variations is wrongly interpreted and the real cause is never found out. Leaders often forget to notice that the germs of variability are within the system and try to find a quick fix for the problem. In doing so, they overlook the mistakes in the leadership or the system and instead indulge in blame game, judge everything on the basis of artbitrary numbers or targets and passes on the responsibility to others. Same is applicable for the agriculture sector too. Instead of asking the question ``who am I dependent on and who depends on me?``, leaders often tend to ask the question ``Who is responsible and whom can I please?``. The result of this attitude causes a variation to continue in a system and as it passes from one unit to another, the magnitude of variation increases. As a result, performance and quality of the sector doesn't improve on a permanent basis and individuals are either castigated or terminated from jobs based on wrong and random interpretation of bad performance.

Many a times, it happens that in the pursuit of short term rectification and improvement of the sector on the basis of mere numbers and targets, leadership forgets the long term perspective and the point of continuous improvement. Most of the leaders become escapists, look for scapegoats and does nothing to fundamentally improve the system. We cannot let that happen in the agribusiness sector at this crucial juncture when the country is marching towards being an economic superpower.

Agricultural Supply Chain Management- Is It Not about Controlling Variations in each stage?

Various business organisation

practice it, B-schools teach it, but still supply chain management in todays agribusiness remains one of the most challengeing aspect of the management. Perhaps, recognising the concept of Germ theory and believing in true leadership would have made the task more easy. The barriers between various departments, each department thinking in isolation, creation of the `Bullwhip Effect` within an agriculture supply chain and all such chaos lead to a greater multiplication of variations. The leaders of the related entities in the value chain of supply chain management should really belive in `for whom am I dependent on and who depends on me? ` rather than trying to evade responsibilties by believing in ``who is responsible and whom can I please?``. It is time to think deeply the inherent reasons of problems in supply chain management in agribusiness in any organisation from the point of view of the Germ theory and true leadership. A small and seemingly insignificant variation in protocol right from the procurement stage keeps on multiplying in each stage of the supply chain, along with the additional variations in the other stages, making the whole supply chain look inefficient, unprofitable and challenging to manage. As a result, the price escalates, great deal of produce is wasted and neither the producer nor the ultimate consumer is benefitted.

India being on the road to being a developed country- More need of systemic changes in Agriculture Sector

As India rapidly progresses towards transforming herself into a developed nation in the coming decades as opined by many, it is natural that the share of industry in the national economy would be increasing and the share of agriculture would get reduced. What we are witnessing today as so called ``transferring of farming land to other industry (mainly the manufacturing) sectors``, is a natural phenomenon obeying one of the basic laws in economics just mentioned in the preceeding lines about small share of agriculture in the economy of a developed world. There would be a natural pressure on cultivable land as industry expands and the country moves on the path of becoming a developed nation. This really nessecitates that its hightime that the efficiency of the agriculture sector is enhanced dramatically, all the anomalies inherent in the system is identified, effective measures helping in minimising these anomalies or variations are developed and the various stakeholders of the sector act as a cohesive unit. This would only be possible from a pragmatic leadership, a leadership based on profound knowledge.

It is high time to consider the current scenario of agriculture sector in general and agribusiness in particular from the perspective of the Germ theory. It is time to rethink and remodel many management styles of the sector from this perspective. The germ theory goads each of us to realize that it is always better to look within our own selves and change ourselves as leaders. The anomalies in the system should first be corrected before trying to find faults in others and search for scapegoats. We are wasting millions of money, huge time and energy in mere short term stop gap arrangements to control variations or problems in the sector. Perhaps, we are committing huge mistakes as leaders when we are trying to analyse the performance or non performance of the sector and the people involved only on the basis of tools like targets, incentives, punishments etc.

Conclusion

The Germ theory of Management helps us to think further and deep inside ourselves about the real cause of non performance and variation within a system. Perhaps, it is time to think beyond tools like subsidies, loan waivers and other populist measures and revive the whole system in its true sense, even if it means working from the scratch and taking each step at a time. Finding the root cause or causes of inefficiency in the agriculture sector is perhaps easier said than done, but definitely not an impossible task if all the heads come together, discuss the issues thread bare and think of the total sector as a whole. Managing a system is complex and managing complexities requires leadership based on profound knowledge, futuristic ideas, seamless communication between different entities, sacrifice, integrity and effort towards controlling variations on a continuous basis.

Consultant,
Evaplan GMBH, Germany

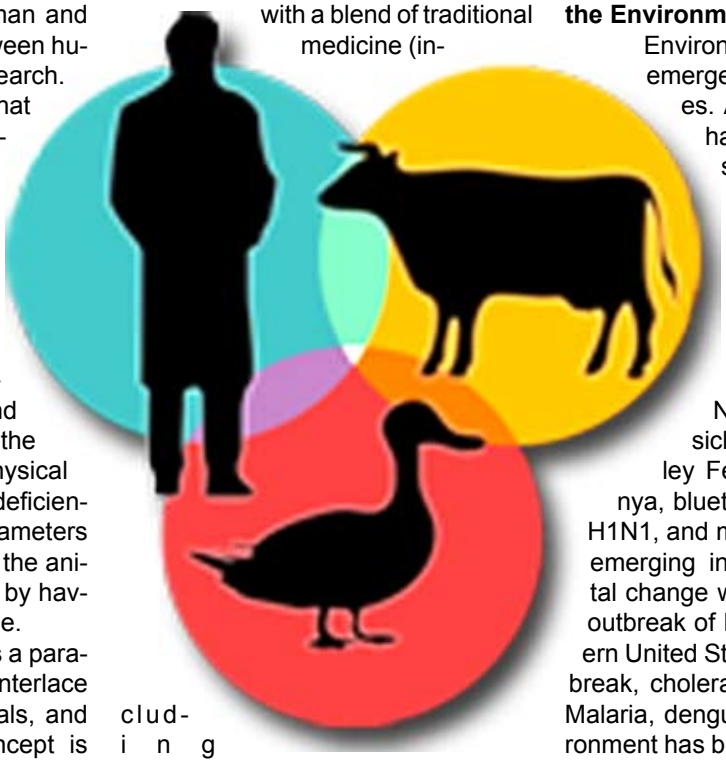
"One Health" Paradigm: Synchronizing Health for Humans, Animals, and the Ecosystem

R.K. Singh

What is "One Health" approach?

The concept of "One Health" dates back to 19th century when the union of veterinary and human health was both understood and widely accepted as has been exemplified by Sir William Osler - a physician considered to be the father of modern medicine – who taught in both medical and veterinary schools. However, the specialization in veterinary and medical sciences during 20th century led to distancing of human and veterinary medicine and between human and animal disease research. While we know for sure that animal and human pathogens are changing and will continue to do so in future as well; we concentrate mainly only on pathogens and their natural hosts, with least emphasis on role which environment plays as the environmental factors affect not only the pathogen and their natural hosts but also the incidental hosts, and the physical parameters like nutritional deficiency, stress, and climatic parameters which might adversely affect the animal/human health especially by having lowered immune response.

"One Health" approach is a paradigm that encompasses and interlace the health of humans, animals, and their environment, This concept is only possible through inter/multi-disciplinary action among public health, clinical medicine, microbiology, ecology, and geography, as well as public outreach, for sustainable development of the ecosystem. "One Health" approach has more relevance for infectious diseases of animal and humans, especially zoonoses. The current scenario of the emerging zoonoses (60% of emerging diseases are zoonoses - with 75% of these originating from wildlife) entails a unifying discipline that connects health among humans, animals, and the environment, for reducing threats to global health from infectious diseases. The One Health approach has all the elements – and therefore – potential to advance healthcare during the 21st century and beyond by accelerating biomedical research, enhancing public health efficacy, expeditiously expanding the scientific knowledge base, improving medical education and clinical care with a blend of traditional medicine (including alternative medicine streams like Ayurveda, Unani, and Homoeopathy systems) and modern medicine. Further, linking animal and human medicine (from basic public health measures – to – surveillance – to – control and prevention) with environmental management is very important in view of the zoonoses. However, it is very crucial to consider the environment as one of the equally important determinant of animal and human health. When we mention about the environment; it is not only the climatic parameters but also the pollutants, the agriculture/horticulture, livestock husbandry, forests, the soil, the water, and the air quality, etc. [source: http://www.thedailybeast.com/newsweek/ 2010/04/27/animal-instincts.print.html; retrieved August 1, 2011; by Claudia Kalb, April 26, 2010 8:0 PM EDT].



The "One Health" Concept and "Conservation Medicine" embrace the Environment as a Component

Environment impacts the emergence of many diseases. A number of diseases have already been observed with increased frequency of emergence with varied pathogenicity, and increased/changed geography. Some of them include hantavirues, cholera, West Nile, African horse sickness (AHS), Rift Valley Fever (RVF), chikungunya, bluetongue, plague, H5N1, H1N1, and many more. As in other emerging infections, environmental change was a key factor in the outbreak of HPS in the southwestern United States in 1993; AHS outbreak, cholera, plague, bluetongue. Malaria, dengue, etc. As such, environment has been a key driving force in emergence and course of many diseases in the past and will continue to influence disease emergence and pathogenesis in future as well.

Why "One Health" Approach?

For most of the newly emerged or emerging diseases; the ecology of the pathogen is not known. The "One Health" approach addresses the microbial evolution by taking into account the pathogen-host-environment interface and, therefore, this paradigm is essential in reduc-

ing the global health risk [source: http://www.thedailybeast.com/newsweek/2010/04/27/animal-instincts.print.html; retrieved August 1, 2011; by Claudia Kalb; April 26, 2010].



Disease epidemics such as those which have been observed in recent past due to emergence of deadly pathogens like plague, SARS-Corona Virus, H5N1, H1N1, Crimean Congo Haemorrhagic Fever (CCHF) virus – even if not lethal – do hijack public-health attention and critical resources. For most of the newly emerged or emerging diseases; the ecology of the pathogen is not known. In most of such cases, it has been observed that pathogen was circulating somewhere and – on finding congenial atmosphere – led to extensive replication and transmission leading to disease epidemic. Such situations could have been avoided, provided an appropriate surveillance strategy was in place because such a mechanism helps in immediate recognition and launch of control programmes without losing any time.

The loss of life, economic loss, psycho-social stress, market disruption, and sense of insecurity in human population, etc. due to disease epidemics have adverse impacts. The economic aspects of disease epidemics drain the resources to meet the challenges due to health risks. Economic consequences due to many disease epidemics are well known and extent of overall economic loss which could be too much for even a single epidemic has already been appreciated. Thus, the economic burden of disease epidemics is too much and justifies implementation of "One Health" or "Ecosystem Health" approach in disease prevention and control at national, regional, and global level. United Kingdom experienced an outbreak of FMD in 2001. Overall economic loss to UK due to this FMD epidemic was estimated to the tune of £2.4 - £4.1bn which constitutes to approximately 0.5% of the GDP of UK. Many similar disease outbreaks have been experienced by many countries and regions in the world with similar economic consequences.

Moving from "One Health" paradigm to "Ecosystem Health" paradigm

The concept "One World-One Medicine" was given by Edward Jenner in view of the poxvirus infection in humans and animals and subsequent success of cowpox (vaccinia virus) vaccine in eradicating smallpox (variola virus). However, this concept could not pick up and remained in academia only till 19th century when importance of comparative medicine was realized by researcher communities in human medicine and veterinary medicine. Since then, the realization of intricacies of microbial evolution and role of environment in microbial pathogenesis led to building of newer concepts which led to successive transition from "One World – One Medicine" to "One Medicine" to "One Health", and finally to "Ecosystem Health" paradigm. The "Ecosystem Health" paradigm considers the plant-animal-human-environment interface in microbial evolution, pathogenesis, spill-over from wild-life, inter-species transmission, species cross-over (or species-jumping), and addresses the intricate issues in disease causation, disease control and prevention in a holistic manner.

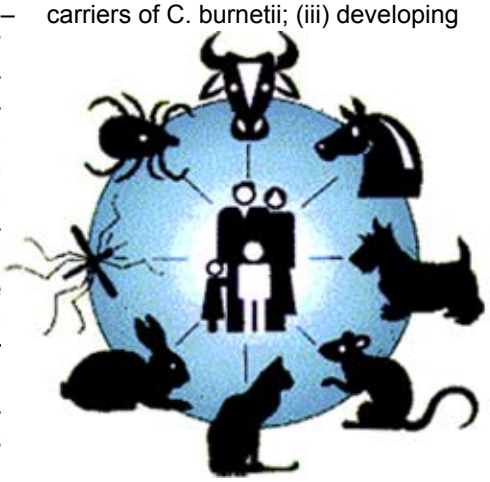
Emergence of diseases and pathogens (Q fever, hantaviruses, SARS, West Nile virus, Nipah virus, cholera, malaria, and dengue, H5N1, H1N1, CCHF) in recent past highlight the significance of the "One Health" perspective. Blending of molecular technologies with conventional technologies provides better understanding of the disease. The new technologies like sequencing – including whole genome sequencing and metagenomics – are providing much insight into the microbial evolution, and the intricacies in the relationships between host-pathogen-environment which is the essence of the "One Health" or "Ecosystem Health" approach. As such, adopt-

ing the "One Health" or "Ecosystem Health" paradigm is crucial for understanding emerging diseases and meeting future challenges in global health due to infectious diseases, as the "One Health" approach will help in advancing the animal and human health care for the 21st century and beyond by accelerating biomedical research, enhancing public health efficacy, expeditiously expanding the scientific knowledge base, and improving medical education and clinical care (source: http://www.microbemagazine.org/index.php/09-2010-home/2760-one-health-attaining-optimal-health-for-people-animals-and-the-environment; retrieved August 1, 2011].

The "One Health" approach – since its formal inception in 2007 after approval by American Medical Association (AMA) and American Veterinary Medical Association (AVMA) – has been receiving much attention and focus worldwide. In 2008, three major international organizations charged with animal health and human health, viz., the Food and Agriculture Organization (FAO), the World Organization for Animal Health (OIE), and the World Health Organization (WHO) - in collaboration with the United Nations Children's Education Fund, the UN System for Influenza Coordination, and the World Bank – developed a joint strategic framework entitled "Contributing to One World, One Health-A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystems Interface" in response to the evolving risk of emerging and re-emerging infectious diseases. This strategic document set out specific interlinked objectives for countries to consider in their approach to infectious disease control at the animal–human–ecosystem interface [http://www.microbemagazine.org/index.php/09-2010-home/2760-one-health-attaining-optimal-health-for-people-animals-and-the-environment; retrieved August 1, 2011].

Challenges to "One Health" approach

It is worthwhile to recognize that there are many barriers - which ought to be overcome - towards achieving a "One Health" paradigm shift. These barriers include (i) overcoming inertia associated with change which requires change of mind-set; (ii) building lines of communication between disciplines that do not currently have well-established systems for sharing information – the disconnect between veterinary and human health sectors – a key challenge in unified "One Health" approach – has been evident during 2009 "Q" Fever outbreak in Netherlands, which is an infrequent bacterial zoonoses caused by Coxiella burnetii, with cattle, sheep, and goats as primary carriers of C. burnetii; (iii) developing



professional respect among various participating disciplines and departments/agencies; (iv) making people to agree on "common Action Points (CAPs)" within the differing mandates across agencies responsible for human, animal, and environmental health; and (v) simultaneously being generalists and specialists. Such change requires new paradigms for trusting each other, confidence building, communication, cooperation, and funding that crosses traditional agency and organizational lines; and reorienting veterinary education to meet the challenges in efficient implementation of the concept of "One Health" at ground level. Various agencies (scientific societies and national/international agencies like FAO, OIE, WHO, etc.) are now exploring the ways and means of increasing communication and participation amongst medical, public health, animal health, and environmental researchers and practitioners. Integration is one of the most important CAPs which will be a key element for success of the "One Health" paradigm where it is necessary to connect subject matter experts from different disciplines; ensuring the participation of various stakeholders in integrated national and global human and animal surveillance systems; extensive collaboration in identifying diagnostic platforms for use in assessing the human, animal, and the environmental health status; and facilitate sharing of pathogen samples and information, a problem which is sometimes difficult because of fear of biopiracy. It will also be necessary to develop improved tools and models to predict where and when outbreaks are most likely to occur. It will be necessary to develop "Point-of-Care" diagnostic techniques for diagnosing and treating the endemic diseases, and to ensure that the appropriate biologic samples are transferred to reference laboratories in a timely manner. Systems analysis will also need to be developed and applied to improve identification and movement of samples. Predictive models using human and animal biologic samples will have to be tested if we are to properly identify risk factors for zoonotic disease spread and ways to combat emerging infectious diseases (source: http://www.microbemagazine.org/index.php/09-2010-home/2760-one-health-attaining-optimal-health-for-people-animals-and-the-environment; retrieved August 1, 2011).

Collaborative participation amongst stakeholders is necessary

Various stakeholders in conservation medicine – like in "One Health" approach – comprise of physicians, veterinarians, researchers, clinicians, microbiologists, pathologists, marine biologists, toxicologists, epidemiologists, anthropologists, economists, parasitologists, political scientists, and public health professionals. An intricate network of all the stakeholders, with strategic smooth functioning

with clear cut roles, is the essence of this approach. The very critical arms of conservation medicine or "One Health" approach are the researchers and practitioners in human medicine and veterinary medicine who need to stretch beyond classic approach to disease control and prevention and must (i) build synergies between functioning of public health experts, and researchers in human and veterinary medicine, ecology, conservation biology, and disease modeling and forecasting to identify factors that allow diseases to cross species barrier and improve surveillance; (ii) promote multidisciplinary research to examine links between disruption of environment, changing weather patterns and emergence of zoonoses; and (iii) strengthen capacities and recognize emerging zoonoses.

Way forward

In case of zoonoses, the integrated surveillance system for both animal and human diseases is a must which has now been fulfilled with the launch of a programme known as "Predict" which is a component of a $400 million, five-year programme "Emerging Pandemic Threats Program" of United States Agency for International Development (USAID) [www.usaid.gov], with the goal of preempting or combating newly emerging animal diseases that pose a risk to human health. Predict focuses on improving wildlife surveillance, a component which has not been given due credit in the past. Since we do not understand the ecology of these diseases and the magnitude of possibilities; launch of Predict begins the fulfillment of a longstanding dream, which is to better understand what's out there and how we can identify and anticipate the next epidemic or pandemic before it happens" [modified from http://www.thedailybeast.com/newsweek/2010/04/27/ animal-instincts.print.html; retrieved August 1, 2011; by Claudia Kalb, April 26, 2010]. The emergence of new diseases; re-emergence of existing diseases; cross-species transmission; species-jumping; anti-microbial resistance; pollutants and drug residues in food chain; low-grade health of humans, animals, plants, soil, water, etc.; and adverse effects of climate change on animal and human health as well as on production and productivity of agriculture and livestock have recently been appreciated with serious concerns. This should not be surprising as we have been exploiting the natural resources to the maximum without any thought about sustainability. The recent appreciations as mentioned above have led to realization of importance of conventional (conservation) agriculture, conservation medicine, organic farming, mixed farming, water conservation, indigenous traditional knowledge in agriculture, animal and human health, and about techniques, technologies, and efforts which can help in mitigating the adverse effects of climate change. In agricultural practices, blends of conventional and new technologies are now increasingly being used. On the similar lines, the importance of "One-Health" (www.oneworldonehealth.org) approach has, of late, been realized in view of the increasing zoonoses.

The world community is now faced with a challenge of maintaining the "continuum from agriculture to food to nutrition to health to employment in rural settings" which Secretary (DARE) and Director General (ICAR) echoed while delivering his message during the X Agricultural Science Congress on "Soil, Plant and Animal Health for Enhanced and Sustained Agricultural Productivity" at Lucknow on February 10, 2011 (Ayyappan, 2011). The way forward is challenging to us as health professionals, livestock and plant researchers, ecosystem researchers, administrators, and policy makers in respective sectors will need insightful leadership from government agencies, research institutions, academic institutions, NGOs, and international agencies (CDC, WHO, FAO, OIE and professional societies). Currently, we are at a crossroads between talking about "One Health" and truly embracing the new paradigm. Implementing the "One Health" approach, "Conservation Medicine", and "Conservation Agriculture" in right earnest with real integration only can keep the health of humans, animals, and the environment in the balance (source: http://www.microbemagazine.org/index.php/ 09-2010-home/2760-one-health-attaining-optimal-health-for-people-animals-and-the-environment; retrieved August 1, 2011).

Director, National Research Centre on Equines

A Second Green Revolution

Rita Sharma

In his Independence Day speech this year, the Prime Minister called for a Second Green Revolution. Producing more food for a large and growing population in the coming decades is a major challenge for the country. A national food security legislation on the anvil lends greater urgency to the subject.

The Second Green Revolution will need to be based on a new paradigm for sustainable intensification of agriculture as contrasted with the mere intensification of agriculture which characterized the first one.

Cornucopia and Pandora's Box

It is now widely accepted that the Green Revolution of the 1960s and 1970s proved to be a double-edged sword, a cornucopia and a Pandora's Box. The intensification of agriculture through adoption of modern science-based technologies doubled foodgrain production from around 117 million tons in the mid-1960s to a record output of over 240 million tons in 2010-11. In Punjab, Haryana and western Uttar Pradesh, the bastions of the Green Revolution, yields quadrupled, contributing majorly to national food security.

Success of this Green Revolution, however, spawned a new and stickier set of environmental problems leading to rapidly falling groundwater-tables, declining soil health, and loss of biodiversity. Modern varieties of wheat and rice required heavy doses of external inputs involving assured irrigation, fertilizers, agro-chemicals for pests, weeds and insect control, fossil fuels for agricultural operations. In doubling foodgrain production, nitrogenous fertilizer application increased eight-fold. Further increases in foodgrain output will require even larger increases in fertilizer use, with comparable or greater increases needed in the application of pesticides, fungicides and other agrochemicals. These modern agricultural practices are adversely affecting soil fertility through erosion, acidification, salinization, multiple nutrient deficiencies, declining soil carbon, loss of organic matter and reduction of biological activity.

To extract groundwater for irrigation from receding underground aquifers, shallow gravity tube wells are being replaced with submersible pumps at higher costs affecting the overall ecology of the region. As the supply of fossil fuels declines, their prices rise, driving up input prices, principally fertilizer and diesel needed for farm operations. Alternate energy sources are not yet a viable option. Inefficient input use and management practices are leading to decline in soil health, pesticide residues in farm produce and widespread contamination of surface and groundwater with connected health hazards.

Can the environment and human health tolerate indiscriminate increases? Can this model of intensive agriculture be sustainable?

Future Productivity Jeopardized

The earlier Green Revolution is running out of steam. During the 10 year period 1997-98 to 2006-07, foodgrain production grew at an average annual rate of only 1 per cent; wheat and rice yields are plateauing off. Returns to application of inputs have diminished. Intensive crop production is depleting agriculture's natural resource base jeopardizing future productivity. The challenge is made even more daunting by the added effects of climate change and energy scarcity.

To ensure adequate foodgrains for a growing and increasingly affluent population, the total demand for foodgrains is projected to touch 281 million tons by 2020-21. Meeting this demand will necessitate a growth rate of 2% per annum in foodgrain production. If the goals of national food security have to be met, is it possible to sustainably revive agricultural growth through a Second Green Revolution? Can the tripartite goals of national food security, agricultural profitability and environmental quality be simultaneously achieved? There are grounds for optimism.

A Paradigm Shift: "Save and Grow"

It is now widely recognized that an ecosystem approach must underpin intensification of agriculture. A Second Green Revolution would be characterized by sustainable intensification of agriculture (SIA). This would imply practice of both intensification and conservation.

The FAO in its recent publication Save and Grow calls for a new approach exhorting smallholder farmers to economize on cost of production and build healthy agro-ecosystems which will enable them to maximize

yields and invest the savings in their health and education. It cautions that while the Green Revolution technology saved an estimated one billion people from famine and produced more than enough food for a world population that doubled from three to six billion between 1960 and 2000, the present paradigm of intensive crop production cannot meet the challenges of the new millennium. In order to grow, agriculture must learn to save.

The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), a major study of the future of food and farming up to 2050 has called for substantial changes throughout the world's food system, including sustainable intensification to simultaneously raise yields, increase the use efficiency of inputs and reduce the negative environmental effects of food production.

Sustainable Intensification of Agriculture appears to be the pathway for convergence of production and ecological concerns. Embedded in the SIA is the recognition that technologies of the earlier Green Revolution cannot be done away with and will continue to be used in the foreseeable future. The Second Green Revolution, different from the first, will use modern plant varieties but with much greater attention to sustainable use of natural resources and more efficient and judicious use of external inputs. Productivity enhancing programmes and schemes will be so designed that adaptation and mitigation to climate change emerge as co-benefits in this new regime.

A Regional Tripartite Approach

It may be recalled that the earlier Green Revolution spread differentially across the country. In the north-western region, characterized by irrigation infrastructure, appropriate resource endowment and conducive agrarian, land-ownership systems, it has had its longest gestation. The rainfed regions, on the other hand, were by-passed.

The Second Green Revolution through SIA will need to be based on a tripartite approach of (i) building on the gains in the north-western region, the original constituency of the Green Revolution, while repairing the damage of the earlier era; (ii) extending the technologies of the first Green Revolution, eastward where due to a favourable water regime, potential exists but has not yet been optimally utilized, yet avoiding the pitfalls of the earlier experience; and (iii) applying different technologies and practices for the remaining rainfed regions of the country. Underpinning all the three approaches is the environmental sustainability issues – terrestrial, aquatic and climatic. SIA will need to address a range of farming systems, and adapt to specific agro-ecological and socio-economic contexts in a way that any negative impact of the Green Revolution is countered by the ecosystem services built into the production strategy.

At the core of the SIA approach is resource conservation without compromising on productivity growth. This can be achieved in multiple ways as is being demonstrated by various technologies and management practices. The special trait about these conservation technologies and practices is that they have been developed as much "bottom-up" as they are "top-down". While drought resistant varieties are bred in Universities and research establishments, the Systems of Rice Intensification (SRI) has originated in farmers' fields. These are climate resilient practices and technologies and they lead to better adaptation to climate variability and change.

Technologies and Practices for Sustainable Intensification of Agriculture

Current levels of water and fertilizer efficiency use are woefully low. Presently, irrigation efficiency is a mere 30 percent. Fertilizer use efficiency ranges from 2 to 50 percent. The enormous wastage of resources not only increases cultivation costs but inflicts severe environmental damage. It is estimated that a 10 percent increase in water use efficiency can give dividends of 50 million tons of additional foodgrain from the existing irrigated area. A 10 percent rise in nutrient use efficiency would result in a saving of almost 20 million hectares of land.

Technologies and management practices are being developed that lead to resource conservation. They need to be more aggressively promoted and disseminated. These include (i) zero tillage, (ii) retention of crop residues, (iii) integrated pest and nutrient management, (iv) suitable crop rotations, (v) breeding suitable plant varieties both through conventional means as well as through bio-technology which are resource conserving (drought, pest and disease resistant) and efficient on nutrient uptake, (vi) controlled-release of nitrogen through the deep placement of super granules of fertilizer, (vii) addition of biological inhibitors to fertilizers, (viii) nitrogen-fixing trees. (ix) use of animal manure, (x) compost, (xi) laser leveling, (xii) fertigation, (xiii) drip and mini-sprinkler systems, (xiv) reuse of urban waste water, (xv) improved water conveyance innovations, (xvi) watershed management units, (xvii) raised seedbeds, (xviii) precision timing in plant watering, (xix) improved water harvesting and retention, (xx) Systems of Rice Intensification (SRI), (xxi) Evergreen Agriculture, (xxii) reduction of crop wastage, etc. Four illustrative examples are discussed:

- Zero-tillage reduces soil erosion and increases the soil's capacity to hold water and sequester CO2, sustains soil fertility, improves water management and reduces production costs through energy savings. It simultaneously promotes resource - conservation and high production levels. During the past decade, its adoption has increased from 0.02 to 3 million hectares. The zero-till drill saved 70-80 percent of diesel and Rs. 2500 to Rs. 3000 per hectare in cultivation costs.
- Systems of Rice Intensification (SRI) is a grassroots innovation which works by changing the management of rice cultivation. SRI has demonstrated yield ad-

vantage of 1.5 to 2 times together with savings in seed requirement of 65-70 percent, water savings of 35-40 percent and significantly less fertilizer use. Under the National Food Security Mission, it is proposed to bring 5 million hectares under SRI. In Tamil Nadu 20 percent paddy area is already converted to SRI.

- Evergreen Agriculture combines agroforestry with the principles of conservation farming. The addition of trees on farms offers multiple livelihood benefits to farmers, including sources of green fertilizer to build healthier soils and enhance crop production, and providing fruits, medicines, livestock fodder, timber and fuel wood. There are environmental benefits too, in the form of shelter, erosion control, more effective water cycles and watershed protection, increased biodiversity, greater resilience to climate change, and carbon storage and accumulation. In fact, one tropical tree can sequester at least 22.6 kg of carbon from the atmosphere each year.
- Reduction of food losses and wastage is an important conservation exercise. It is estimated that the total preventable post-harvest losses of foodgrains is 10 percent of the total production or about 24 million tons. The losses occur in threshing, transportation, processing and storage. Wastage and spoilage in horticultural produce is even higher at over 30 percent. Creation of additional scientific storage capacity of over 15 million tons over and above the existing 43 million tons in the public sector is to be added by 2013. Efforts are underway for capacity building, R&D and marketing reforms to reduce losses.

Science and technology are necessary but not sufficient on their own. They require appropriate policies and incentives for changing farming practices -- use of water and nutrient saving systems -- without compromising on farm productivity. Recognizing that imbalanced fertilizer use is one of the main factors of poor fertilizer efficiency, the "nutrient based pricing subsidy policy" is expected to diversify the products on offer and enable balanced fertilizer use as per soil tests. Similarly, policies that create water entitlements and rational pricing of water, can improve water use efficiency. Subsidies on drip and sprinkler irrigation have helped in the adoption of these water-saving technologies. The time has come to incorporate the value of natural resources and ecosystem services into agricultural input and output price policies.

Investment in Sustainable Intensification of Agriculture has been enhanced through a slew of

schemes. Foremost among them is the National Initiative on Climate Resilient Agriculture. The National Food Security Mission with a focus on intensification has a significant component of SRI. It aims to extend the Green Revolution technologies in the eastern region as does the Rashtriya Krishi Vikas Yojana. Several productivity enhancing schemes factor-in incentives for resource conserving technologies through subsidies and front-line demonstrations. The National Mission for Sustainable Agriculture, which is one of the eight Missions under the National Action Plan on Climate Change, also seeks to devise appropriate climate resilience in agricultural operations. The emphasis on the Watershed-based approach to farming is central to the promotion of eco-agriculture. Major investments are also being made through Mahatma Gandhi National Rural Employment Guarantee Scheme for natural resource rejuvenation. With an annual investment of Rs. 40,000 crores, MGNREGS is a powerful rights'-based instrument for green employment generation which has co-benefits for adaptation to climate change as over 80 percent of the works taken up under the scheme relate to water conservation, land development and afforestation. The Forest Dwellers Rights Act is another legislation expected to lead to sustainable resource use. Both these Acts need to be further aligned with SIA.

The Way Forward

To bring about a Second Green Revolution requires changes in attitudes and mindsets of stakeholders – farmers, researchers, bankers and policy makers. The transformation from a mere intensification of agriculture to a sustainable intensification of agriculture is a paradigm shift which calls for new and innovative institutions and partnerships. The entire range of farm operations from planting and harvesting to water and nutrient management, to disease and pest control will be more knowledge and skill intensive and will need a different kind of stewardship to foster its expansion. A Second Green Revolution will require creation of dynamic learning networks for sharing of experiences, multiple extension and delivery systems, supported by information and communication technology to provide farmers with better access to knowledge and innovation, markets and weather forecasts.

Necessity drives change. In an era of technological optimism, a Second Green Revolution can become a reality leading to sustainable food security and transforming the lives of millions of small farming households who were by-passed by the earlier green revolution. It is time to adopt these higher aspirations.

Secretary, National Advisory Council. The views expressed are personal.

A Thought

Rescuing Agriculture from Present Penury

Sharad Joshi

Indian agricultural policy in a nutshell

A large number of researchers and scholars who wish to study agriculture in India are intrigued by the extreme penury of the farmers and the low levels of productivity. It surprises them that the peasantry of a country so well endowed in water resources and sunlight should be so miserably placed.

It was only as late as in 1990 that the documentation of the World Trade Organization (WTO) clearly established that the government of India imposed a negative subsidy on Indian farmers. In the WTO parlance, the term 'negative subsidy' has a specific meaning. It refers to cases where the income received by the farmer by the sale of his proceeds is less than the income he would have received in a hypothetically free market where the government does not intervene in any manner.

On the other hand, 'positive subsidy' refers to cases where the farmers receive an income that is higher than what they would have received in a hypothetically free market, thanks to the intervention of the government.

The central and the most essential fact about Indian agriculture is that it suffers from either the caprices of nature or, when the nature is benign, by the tyranny of governmental interventions.

It is astonishing that most learned reports and books on Indian agriculture skillfully avoid referring to this central fact.

For years, all economists and agronomists have held that the poverty of the farmers and the low productivity of agriculture in India are interconnected and are both caused by the illiteracy, wasteful expenditure and large incidence of alcohol and other vices amongst the farmers. It is strange that this calumny persisted for long decades of the British Rule as also the first five decades after independence.

The farmers and the agriculture are the source of all wealth and multiplication thereof, at least in the physiocratic sense. In the peasant idiom, 'if a farmer sows one seed the crop is hundred- or even a thousand-fold.'

How come the one industry where there is an actual physical multiplication suffers from the most serious deprivations?

Practically every regional language in India has a proverb that maintains that agriculture is the best of all vocations; the trade comes only second and the service is the least honourable of all. The proverb persists even though the reality has turned upside down, particularly after the independence. Now a job, particularly the government service is the most prestigious and agriculture almost the passage to poverty, indebtedness and suicide.

Even though the learned economists and the erudite scholars refuse to recognize the fact of the negative subsidy in agriculture, there was abundant evidence of the social recognition that agriculture was the most arduous of all vocations.

Children of farmers, who had the good fortune of getting higher education, systematically preferred jobs and turned their backs on the parental lands. Daughters of non-agrarians have, for decades, clearly expressed their reluctance to be married into agricultural families. The life of a farmer housewife is a continuous misery comparable to life imprisonment. Now, even the farmers' daughters indicate a clear preference for grooms in non-agricultural vocations, be they even menial.

The instruments of intervention that the government of India used were simple but lethal.

Until as late as 1960s, government imposed a compulsory levy on the food grains produced by the farmers. If a farmer had produced less quantity than was required to be given as 'levy' he was required to make up the difference by purchasing the food grains in the open market at higher prices and delivering them to the government at lower levy prices. If he failed to discharge his 'levy' obligations he risked being handcuffed and paraded in public places in great ignominy.

All transport, storage, trade, processing and export of agricultural produce were severely restricted if not totally banned. This was done by raising the boggy of consumers' interest and the obligation on the part of the government to ensure food security.

The government did put up a show of ensuring remunerative prices by introducing a system of Minimum Support Prices (MSPs); but manipulating to make them work not as minimum prices the farmers should ever receive but as the signal of the maximum prices the traders need to pay for the agricultural produce.

The government did not need to depress the prices of each of the hundreds of agricultural commodities. It could depress the agricultural economy in general and keep the farmers permanently 'needy' by depressing artificially prices of just about a dozen commodities.

These anti-farmer policies were sought to be justified by various arguments:

1. The desirability of low-cost economy;
2. The need to promote industry by keeping prices of wage goods and raw material low;
3. Need for comprehensive consumer protection; etc

This is a brief summary of the essentials of the State policy on agriculture. And, all that I have written in last 30 years was essentially a commentary on the various methods used by the government to exploit the '*Bharat*' to the benefit of the '*India*'.

2. First three steps to the Resurrection of the *MahaBali*

We are barely at the end of the epoch when almost 200,000 farmers committed suicide in India. It is recent memory that the Loan Waivers and Debt Relief Scheme of the Central government has disappeared into thin air and is benefiting only the bank barons of the cooperative system. The hue and cry about inflation has pushed the government to taking a number of measures that are depressing the agricultural commodity markets.

It would indeed be difficult to imagine that this darkest hour in the history of farmers marks the dawn of the most splendorous era for the farmers when they will not only be out of the penury and misery but would belong rightfully to the top echelon of the society. Agriculture will become once again the preferred vocation in comparison with both the trade and the service.

It is a long long time since the farmer was in that kind of a situation. That was in the "*Treta*" Yuga in the regime of the great King "*Mahabali*". This latter was the son of *Virochana*, who was begat by *Prahlad*, the son of *Hiranyakashyapu*, the demon King who was killed by the Lord *Vishnu* in his incarnation as half Lion form.

Lord *Vishnu* appearing as a half lion destroyed *Hiranyakashyapu* and saved *Prahlad*. *Mahabali* was renowned for many qualities of heart and head like, generosity and munificence. Located some where in the present state of Kerala, he earned such a vast reputation for being the benefactor of the farmers that even the gods became jealous. They manoeuvred to send Lord *Vishnu* as midget *Brahmin* to the *Mahabali*'s court. The puny *Brahmin* asked *Mahabali* for land enough to cover just three steps. As the "*Vishnu Purana*" story goes, after his request granted, the puny *Brahmin* started to expand in size till he filled up all sky. Then, in one step he covered the earth, in the second the heaven and asked *Bali* where he should put his foot for the third step? The simple hearted *Bali*, astonished at the enormous proportions the puny *Brahmin* had assumed, bowed down before *Vishnu* who quickly put his foot on *Bali*'s head. Triumphantly, the cunning priest trounced the great *Mahabali* into the earth.

According to epics, this marked in the "*treta*" epoch the end of the era when nature was bountiful, land munificent and farmers considered the highest echelon of the society.

The *Vishnupurana* goes on to recount that Lord Vishnu so regretted his deed that he promised to become, till eternity, the gatekeeper of *Mahabali*'s mansion in the heavens. It is also said that *Vishnu* ordained that *Mahabali* would revisit the earth once a year to meet his people. Even today the annual return of the *Mahabali* is celebrated in the form of the Festival of "*Onam*" in Kerala.

Since the vanquishing of the *Mahabali*, all social and political systems have ranked the agriculturist as the lowest rung of the social order. All the Indian languages have a

saying, which connotes "Agriculture is the best vocation, trade comes next and service is the meanest". Since independence from the British rule, however, the things have gone topsy-turvy. So much so that farming is considered the meanest of the vocations and menial service has gained all the prestige. Even large holders of farmland, these days, are happy to sell a part of their holding in order to get their sons even a menial job under the Government or any employer for that matter.

It would appear that things are going to change again. On that unhappy day in the *Treta* Yuga, *Vamana*, the puny *Brahmin,* trounced the farmer king *Mahabali* in three steps. Coincidently, it would appear that the great *Bali* would start resurrecting in three steps here and now in the 21st Century.

Climate change and Global warming might come out to be the first leverage the farmer will get for his resurrection. Food scarcity is already causing riots in many developing countries. Food prices are going sky high all around. Even the daily bread that the farmer produces will become a highly coveted precious commodity. The very scarcity of food will make easier for the farmers to dictate food prices.

The shortage of petroleum and sky rocketing prices of petrol and diesel will provide the second leverage for the resurrection of the farmer. The crude oil is to be found in the oil wells of OPEC countries that are dictating the prices as an instrument of global terrorism. Very few farmers are aware of the fact that they are all sitting on abundance sources of petrol substitute and petrol additives. Practically, all forms of biomass that contain alcohol in good proportion promise to become great sources of Ethanol. Ethanol can be produced with fairly elementary technology from sugarcane, molasses, sugar beet and even agricultural waste of all kinds. Very shortly, most farmers would be able to produce sugar beet, corn, sorghum and even various forms of biodegradable waste to produce Ethanol or comparable bio-fuel as a cottage industry.

In a curious resemblance to the *Vishnu Purana* story, it is now for the farmers to ask the descendants of *Vamana* for just three Graces:

- That the farmer enjoyed freedom of producing Ethanol from all they produce on their land, without any restrictions;
- That the government does not try to impose any restrictions on the use of Ethanol as an additive to petrol/diesel;
- That the government does not intervene to depress the free market prices for the Ethanol.

Briefly, the resurrection of the *Mahabali* presupposes nothing but that the descendants of *Vamana* give up the cussed policies and practices of duping the simple-minded heirs of *Mahabali*.

The *Mahabali* will have his historic Vendetta. Buried deep down the bowels of the earth, Mahabali is throwing up for his favourite children the richest of bounties. Unfortunately, the descendants of *Vamana* are already trying to impose restrictions

on the manufacture of ethanol, on the proportion in which it can be mixed with petrol. They will try all tricks in the trade to depress the market price of the new precious agriculture commodity.

Then will come the third step of resurrection. All that the farmers need is freedom of market and technology. The rise of the futures commodity market could play a very important role in bringing about the resurrection.

Three steps: global warming, tapping of ethanol as a farm resource and freedom of markets and technology and we may witness of the resurrection of the *Mahabali* here and now.

Founder, Shetkari Sanghatana and Former Member of Parliament (Rajya Sabha)

International Cooperation in Agriculture Brings Benefits to China

China adopted the reform and opening-up policy at the end of 1970s. Guided by the policy, growing international cooperation and exchange in the past 30 years propelled exchange of agricultural talents, imported plentiful of advanced and pragmatic farm technologies, fine varieties and modern management concepts, and obtained a great deal of foreign fund in different forms. All those have played a very significant and irreplaceable role in narrowing gap with advanced agri-technologies, speeding up poverty alleviation in the countryside, accelerating rural industrial upgrading and developing modern agriculture.

In the time of significant underspending, the benefit of foreign fund and aid was incredible. A lion part of the funding was used on poverty alleviation and disaster relief, benefiting tens of millions of people in the poor areas. From 1980 to 1995, China obtained project funding of 5.7 billion USD through international financial institutions like the World Bank and other foreign countries, equivalent to over 40% of national capital spending in agricultural (92.6 billion RMB) over the same period. WFP and IFAD leveraged 960 million USD to China (WFP aid 700 million USD, and IFAD preferential loan 260 million USD) for poverty alleviation and development, equivalent to 20% of national spending in poverty alleviation (33.9 billion RMB) over the same period of time.

Many widely used technologies with good performance, such as earth mulching, rice dry nursery and sparse seedling, agricultural remote-sense, stalk ammonization, IPM, mechanized chicken farming, cage fish culture, fruits and vegetables preservation processing, were introduced through international cooperation and exchange, or innovated on the basis of exchange. Economic benefits generated by those technologies are hard to count.

Introduction of advanced and scientific management concept was also very influential. For example, project management concepts which are very popular at present were actually introduced through international funded projects by the World Bank and UNDP. At that time project management manuals developed by the World Bank were the most important learning materials, popular but hard to obtain. With project implementation, Chinese people began to learn about and practice these concepts. Concepts, methodologies and requirements on project design, implementation, evaluation, monitoring, economic and financial analysis, economic, social and ecological benefit analysis, which were rather strange at the time, are widely used now.

Ge Songxue

China makes it clear in its Twelfth Five-Year Plan (2011-2015) that it is necessary to intensify efforts to introduce more advanced technologies, equipments, facilities and human sources from other countries, and improve effectiveness; to give greater play to demonstration activities in promoting industrial restructuring and transforming development patterns of agriculture; to increase technical, managerial and institution capacity for attracting various economic players; improve strength and capability of agricultural sector in participating in international cooperation and competitiveness; and improve overall capacity of agricultural production, risks control and competitiveness.

As both China and India are great agriculture based countries, it will benefit both countries by strengthening international cooperation and exchange in agriculture. I hope to see more activities taken place in the coming time.

Counsellor for Science and Technology,
Embassy of China in India

INTERNATIONAL AGRICULTURE CONSULTING GROUP

Indian initiative towards food and agriculture solutions

Vision

Our vision is to be a leading provider of Indian regional expertise in food and agriculture and to outstand as key advisory partners on food security concerns, policy planning and strategy framework for sustainable development through agriculture.

Mission

Our mission is to initiate and support micro and macro level changes in agriculture by providing Indian expertise and solutions for research, extension, education, training, institutional frame, policy planning, agribusiness and project consulting so as to address their major agricultural concerns relating to farm production, food security, environment sustainability, rural employment, economic growth and human resource development.




Objectives

1. Provide Indian expertise to deliver solutions to agricultural issues and concerns through formulation of agro and rural development projects, farming solutions, micro and macro level national agriculture planning, policy support, organized research, extension infrastructure and institutional set-ups, value addition and market linkage services.
2. Manage short terms management programs, training and entrepreneurship course for farmers, research & extension personnel, officials and professionals of various countries while recognizing and understanding ecological, technological, social and economic concerns related to their food and agriculture sector.
3. Facilitating students from different countries in enrolling in food and agricultural degree programs; management and entrepreneurship courses offered by various institutes and recognized universities of India, so as to help various countries in developing human resource for creative and productive change at ground level.
4. Organizing delegation level visits from India to various countries and of different countries to India for participation in agri and business summits, learning and exposure at technology institutions, agri universities, model farms etc., and discussing possibilities for joint ventures, collaborations and promoting better understanding in agriculture and agribusiness.
5. Facilitating Governments, Corporates or Institutions to venture globally and act as total solutions providers in implementation of foreign agriculture projects by providing research structure, technical assistance and investment planning in food, farming, agribusiness or agriculture development programs.

INTERNATIONAL AGRICULTURE CONSULTING GROUP
IACG

Technical Partner

ICAR

Corporate Office
A-10, 2nd Floor, Sector - 19, Noida - 201301
Ph: 0120-2519630, 4224861 Fax: 0120-2519628
E-mail: president@iacg.in, Website: www.iacg.in