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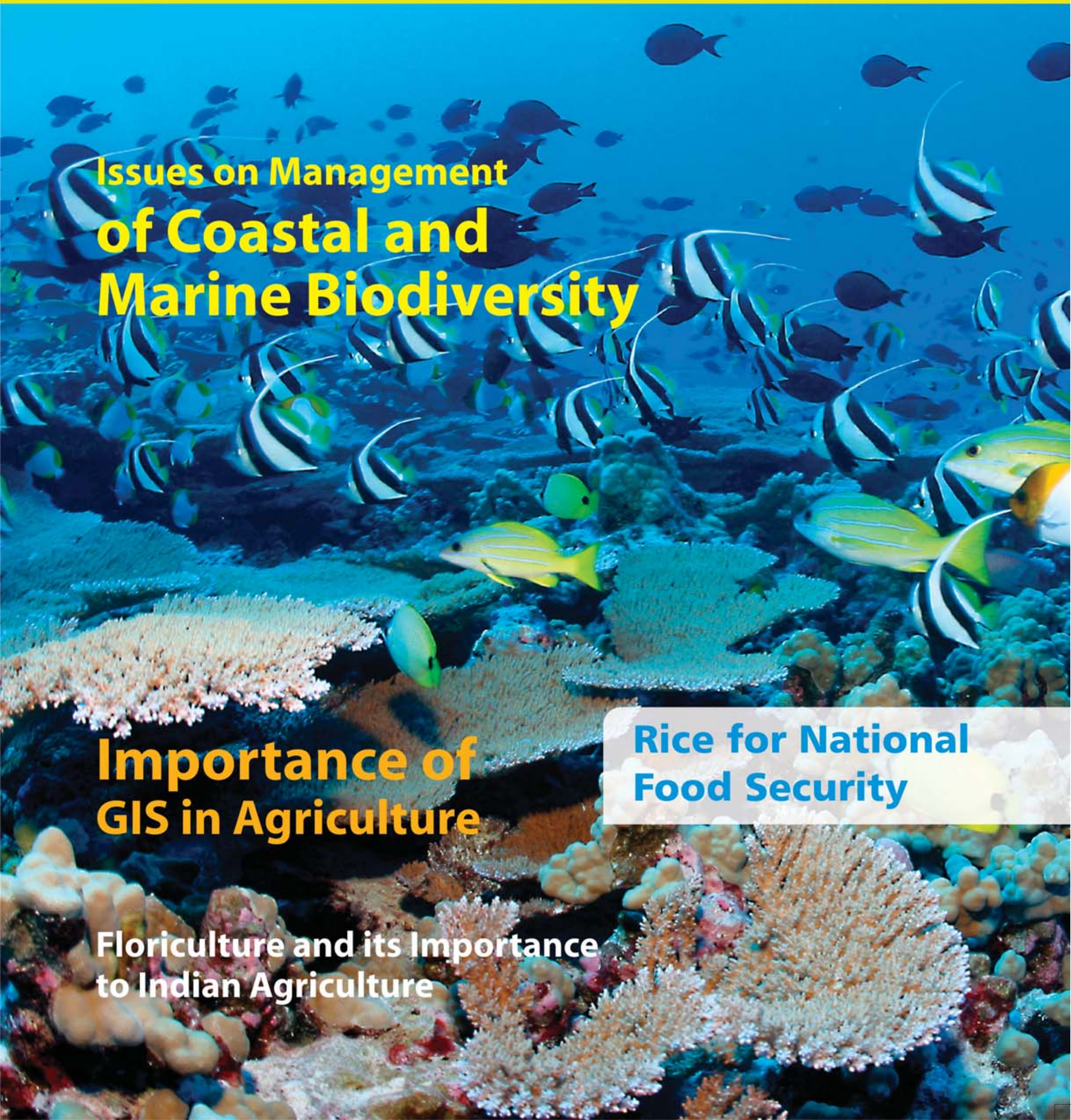

Issues on Management of Coastal and Marine Biodiversity

Rice for National Food Security

Importance of GIS in Agriculture

Floriculture and its Importance to Indian Agriculture

EDITORIAL

Vocational Education–Need of the hour

India with its largest youth-population in the world is facing a piquant situation-a bourgeoning skill deficit of its work force threatening its global competitiveness in terms of cost efficiency. This aspect has been highlighted in the recent World Economic Forum (WEF) report "*Stimulating Economies through Fostering Talent Mobility*". The report calls for swift action before it is too late.

The report gives the big picture by analysing talent shortages across 22 countries and 12 industry sectors. It calls up governments, companies, educational institutions and international organizations to join hands and address talent crunch and enhance talent mobility. The report recommends several ways to do this—such as auditing current and anticipated future skills and its shortages through strategic skills planning; developing skills recognition mechanisms for native-born and migrant workers and designing inclusive and comprehensive migration policies from students to experienced workers.

One of the weaknesses of Indian education system is that it does not place due emphasis on vocational education and training (VET). As a result, a mismatch exists between desired skills and available skills at the manpower front. A comparison with some leading countries can put the issue in perspective.

The USA, with a population of 300 million has a VET enrolment of 11.3 million; Germany with a population of 85 million has 2.85 million VET enrolments; and China with population of more than 1300 million has 90 million under VET, while India with a population of 1100 million has only 3.5 million VET enrolments.

Clearly India's planners and captains of industry are alive to this challenge. There is also the realisation to arrest this trend of accentuating shortage for skilled manpower in India's 509 million strong work force spread in agriculture, industry and service sectors. This has led the Government of India to establish the National Skill Development Corporation in 2008 to address the challenge to impart the right skills required by a growing economy in Mission Mode, by also roping in the private sector initiatives in skill development.

The NSDC was established with a corpus of Rs.1000 crore of which 51 percent has been contributed by the private sector to fund competent education entrepreneurs and NGOs who would promote vocational education centres across India. It will also develop appropriate PPP models to enhance, support and coordinate private sector initiatives.

NSDC is providing funding support to private players, industry bodies, entrepreneurs and NGOs. More details can be seen at the www.nsdcindia.org website. It is appropriate that such initiatives need to be strengthened for the benefit of our youth in the country and raise India's global competitiveness further.

A.K. Garg
Editor-in-Chief

I N S

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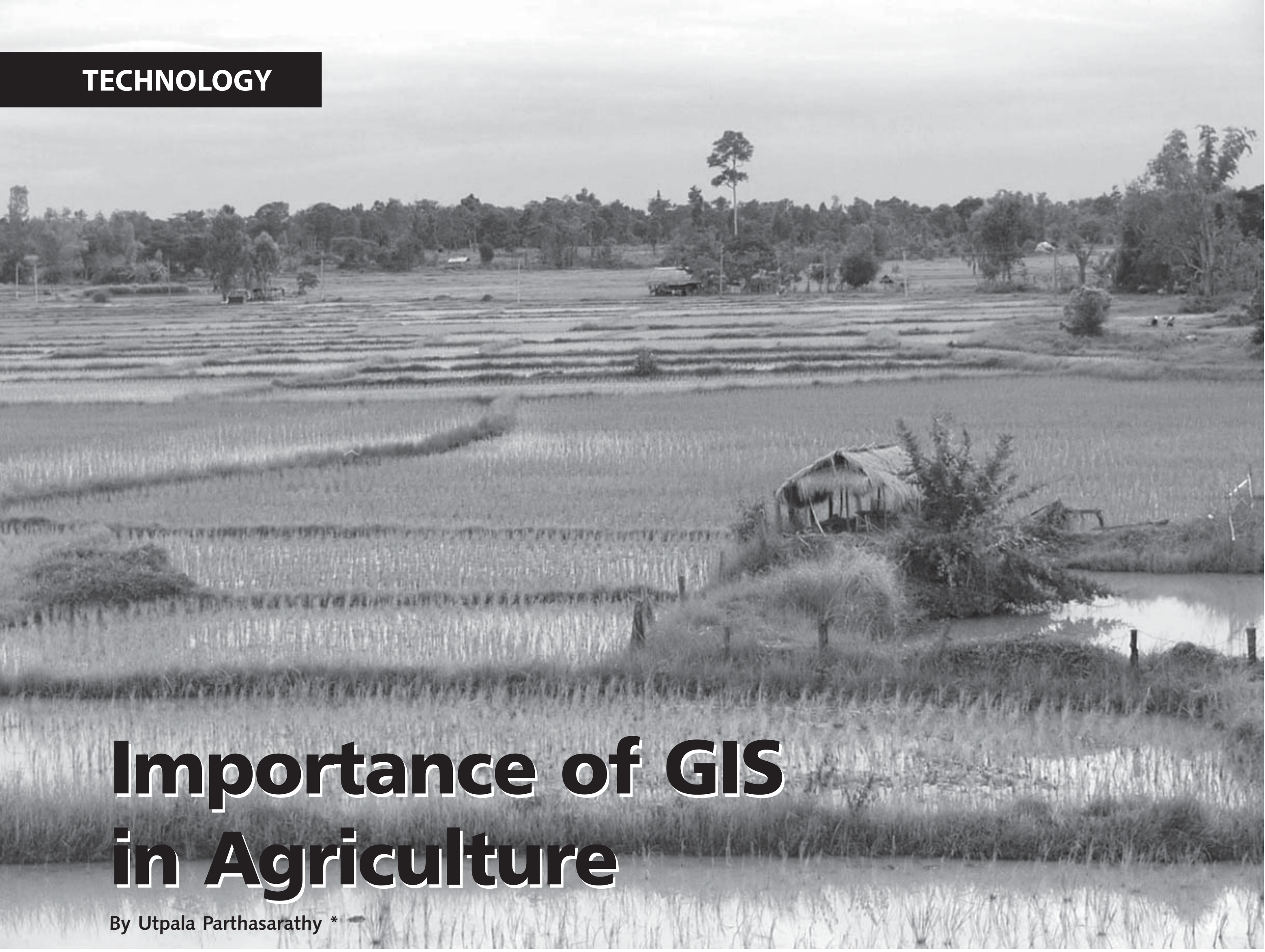

Importance of GIS in Agriculture

By Utpala Parthasarathy *

A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. GIS can perform complicated analytical functions and then present the results visually as maps, tables or graphs, allowing decision-makers to virtually see the issues before them and then select the best course of action. GIS is playing an increasing role in agriculture production throughout the world by helping farmers increase production, reduce costs, and manage their land more efficiently.

Balancing the inputs and outputs on a farm is fundamental to its success and profitability. The ability of GIS to analyze and visualize agricultural environments and workflows has proven to be very beneficial to those involved in the farming industry. Making decisions based on geography is basic of all development. Where, what and when are all related to the spatial phenomenon. By understanding geography and people's relationship to location, an overall idea of environmental, administrative and social set up of an area of interest is generated.

A geographic information system (GIS) is a technology for comprehending geography and making intelligent decisions. A thematic map has a table of contents that allows the reader to add layers of information to a base map of real-world locations. With an ability to combine a variety of datasets in an infinite number of ways, GIS is a useful tool for nearly every field of knowledge from archaeology to zoology.

A good GIS program is able to process geographic data from a variety of sources and integrate it into a map project. Many countries have an abundance of geographic data for analysis, and governments often make GIS datasets

GIS allows viewing, understanding, questioning, interpreting, and visualizing data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. It answers questions and solve problems by looking at the data in a way that is quickly understood and easily shared

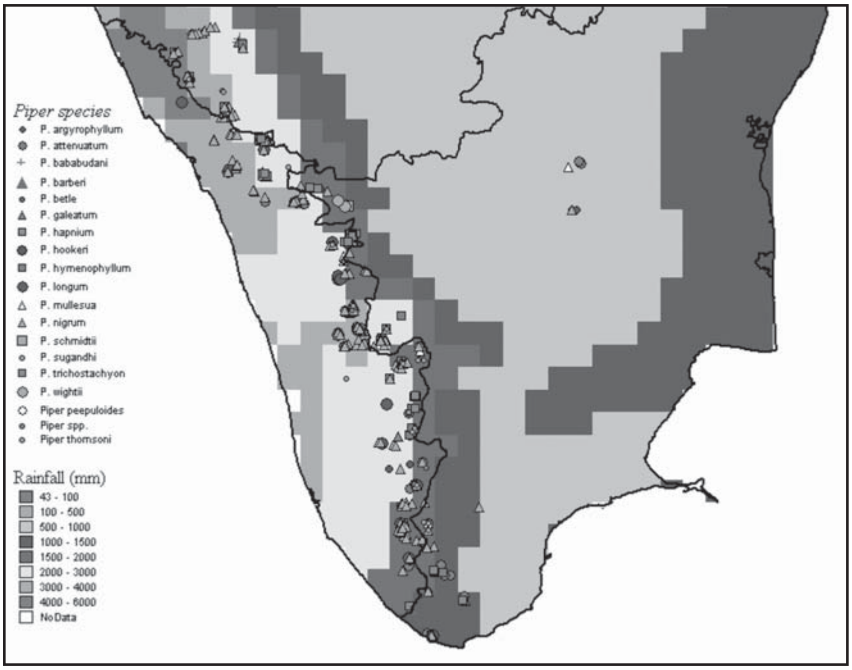

Fig-1. Precipitation Map of southern India and piper species distribution drawn with the help DIVA-GIS.
(Source: Utpala et al .Current Science 91(5).2006)

publicly available. Map file databases often come included with GIS packages; can be obtained from both commercial vendors and government agencies. Some data is gathered in the field by global positioning system (GPS) that attach a location coordinate (latitude and longitude) to a feature.

GIS allows viewing, understanding, questioning, interpreting, and visualizing data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. It answers questions and solve problems by looking at the data in a way that is quickly understood and easily shared. GIS technology can be integrated into any enterprise information system framework.

GIS has mainly three views;

1. The Database View: A GIS is a unique kind of database of the world—a geographic database (geo referenced database). It means all the attribute data should be with longitude and latitude and could be plotted in the digitized map.

2. The Map View: A GIS is a set of intelligent maps and other views that show features and feature relationships on the earth's surface. Maps of the underlying geographic information can be constructed and used as "windows into the database" to support queries, analysis, and editing of the information.

In the above figure different types of *Piper* species are given in different symbols and rainfall are given in different color which tells what intensity of rain fall is suitable for what species.

3. The Model View: A GIS is a set of information transformation tools that derive new geographic datasets from existing datasets. These geo-processing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets.

The above map (Fig-2) shows that Orissa, West Bengal, Assam, Parts of

States	Area (ha)	Production (tonne)	Productivity Kg/ha
Andhra Pradesh	2160.00	16460.00	7620
Arunachal Pradesh	4450.00	32880.00	7388
Assam	18180.00	123990.00	6820
Bihar	808.00	1208.00	1495
Karnataka	8280.00	10850.00	1310
Kerala	12226.00	56288.00	4604
Madhya Pradesh	5760.00	7240.00	1257
Maharashtra	1308.00	1254.00	959
Manipur	2240.00	3700.00	1652
Meghalaya	1865.00	21500.00	11528
Mizoram	4530.00	38070.00	8404
Nagaland	1870.00	21500.00	11497
Orissa	15810.00	30640.00	1938
Sikkim	6683.00	35634.00	5332
Tamil Nadu	660.00	12735.00	19295
Tripura	1364.00	2895.00	2122
Uttar Pradesh	830.00	2370.00	2855
West Bengal	7694.00	13953.00	1813

Table-1, Showing State wise area and production of Ginger for the year2004-2005
(Source: Spices board,2006)

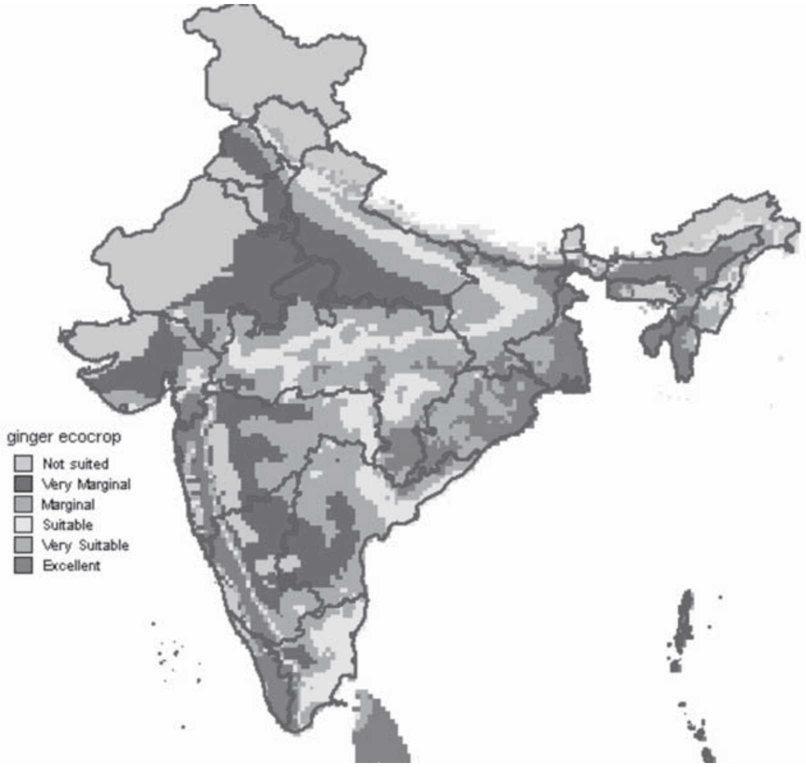

Fig-2.GINGER – Site suitability map ,Eco-crop model of DIVA GIS ***(Source:Utpala et al 2006** JOSAC 15(2).*

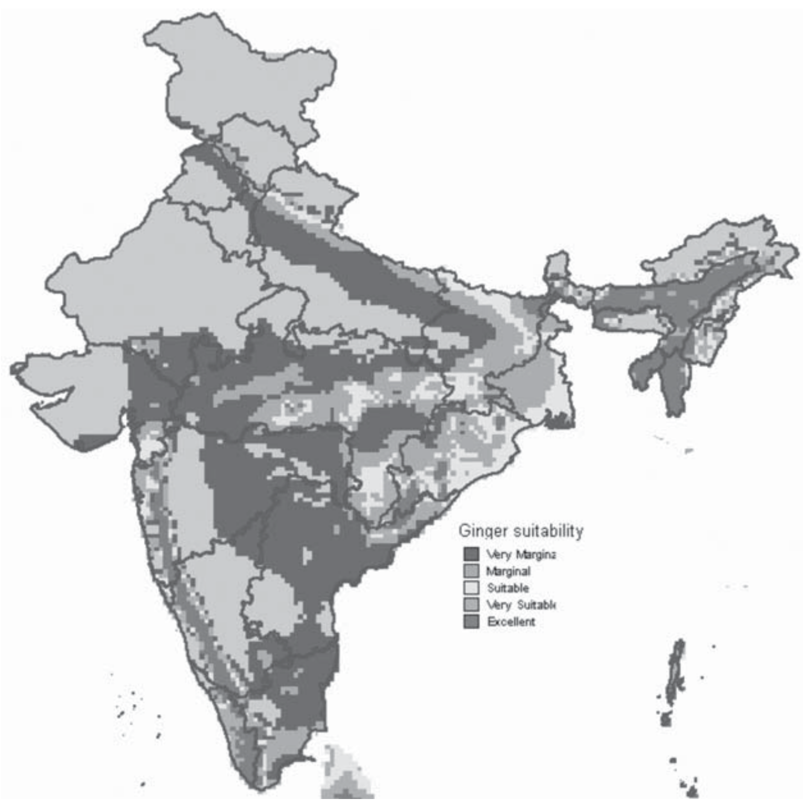

Fig-3.Future of ginger suitability if temperature increases by -1.5°C to 2°C ***(Source:Utpala et al 2008** JOSAC 17(2)*

Bihar, MP and Kerala are very suitable for ginger cultivation. A look at the area-production (table-1) shows that area in these states under ginger cultivation is very high. It shows with or without awareness of the suitability farmers are growing the suitable crops, but due to lack of modern infrastructure Orissa and West Bengal are not having that much productivity. Fig-3 is a predictive model which shows if Temperature rise by 1.5 to 2°C, Orissa, West Bengal Bihar, Tamilnadu will become marginally suitable for ginger cultivation, where as Western coastal states will remain highly suitable.

Geography plays a role in nearly every decision. Choosing sites, targeting market segments, planning distribution networks, responding to emergencies, or re-drawing country boundaries—all of these problems involve questions of geography. GIS technology can reduce administrative tasks by rationalizing processes and procedures, thus making it possible to speed up the operations to be performed by the farmers (harvest declarations, uprooting or new plantation requests, etc.).

The GIS is a transverse information system that helps the farmers by:

- Instantaneously locating of plots for cultivation.
- Obtaining measurements of the perimeter lengths and surface areas of plots.
- Drawing new plots, in a manner that is integrated with the making of requests and declarations.
- Performing of editing operations on existing plots (new arrangements, segregation, modification of vertices, etc.).
- Performing of comparative studies of the plots in a specific area, based on their variety, year of planting or condition. Groups with similar characteristics are visually identified by means of different colours.
- The attribute data is maintained trough a set of database, that permit to update information related to farmer's field integrated with the cartography.

Producers should use GIS to better manage their farms by creating information-dense reports and maps that give them a unique perspective of their operations. The powerful analytical capabilities of GIS offer an array of options for visualizing farming conditions, as well as measuring and monitoring the effects of farm management practices.

Combined with remote-sensing technology, GIS can be used to precisely determine and control inputs, saving preventive expense and reducing the amount of soil damage. Farm managers also can use GIS to submit government program applications, simplifying the time-consuming multistep processes.

Some important responsibilities which are required to reduce the risk of loss and increase profitability for the farmers are to monitor market trends, improving the yields, and predicting weather, all these can be easily monitored by GIS. The *Farmer's Almanac* could been easily replaced with geospatial analysis and predictive modelling. With these GIS tools at their disposal, farmers now have the ability to visualize their land, crops, and management practices in unprecedented ways for precise management of their businesses.

Today, accessing spatial data has become an essential farm practice in the developed countries. Government agencies such as the U.S. Department of Agriculture (USDA) and the European Union host Web sites that deliver valuable information to help farmers better understand their land and make more informed decisions. This data can be accessed on the Internet and used to create intelligent maps for better farm business practices.

In a map of an agricultural area, one layer might represent the boundaries of a piece of land; a second layer soil types; another the crop yield or a specific soil treatment; and still another, irrigation. GIS can show, for example, how the relationships between soil type, fertilizer, and water affect crop yield on a given square acre of land. A map depicting how soil variability influences crop yield suggests precise soil management solutions.

GIS lets farmers perform site-specific spatial analyses of agronomic data. The United States Department of Agriculture uses GIS to map a nation's farms not only by property lines but also by crop and yield. A farmer uses GIS to forecast crop yields and determine fertilizer spread. Precision agriculture is a relatively new area that combines the latest in geographic technology with cropping situations to optimize inputs, reduce waste, and generate the maximum possible yields. The technology often involves the use of GPS and remote sensing for data collection, GIS for data processing and analysis, and variable rate technology for implementing ideal models. These systems are designed for use in all types of agricultural systems, from row crops to dairies, and the technology has seen widespread adoption across the world

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UNION BUDGET 2010 & AGRICULTURE SECTOR

Realistic Focus on the Needs of Farm Sector

Unlocking the retail chain to tackle food prices is really commendable

By G. Kalyan Kumar

The Union budget for fiscal 2010-11 presented by Finance Minister Pranab Mukherjee on 26 February has displayed a reasonable focus on Agriculture, which is timely as soaring food prices are pinching all citizens. In the Budget, the Government of India raised the allocation for agriculture to Rs 208.7 billion from Rs 163.7 billion in the last Budget.

Outlays

Compared to last year, there is an increase of about Rs 4,000 crore in the plan allocation for agriculture in this Budget. Flagship schemes such as the *Rashtriya Krishi Vikas Yojana* have got greater support. Rs 300 crores have been allotted to the *Rastriya Krishi Vikas Yojna.*

In the Budget Speech, the finance minister diagnosed many ills of the farm sector and prescribed several cures through the budget. However when it came to doling out the cash part, the FM seems to have gone with a tight fist and outlays under different overheads have not matched the tasks at hand. This is not to forget that the 21.6 percent increase in the overall Central plan outlay for agriculture and allied sectors is still one of the highest in recent years. And Pranab Mukherjee deserves a big hand.

Strategy

The Finance Minister unveiled a four-pronged strategy to revive the agriculture sector.

Easier access to farm loans; greater focus on value addition to the food-processing sector; cutting food wastage; and boosting farm productivity were the Finance Minister's growth *mantra* to

Compared to last year, there is an increase of about Rs 4,000 crore in the plan allocation for agriculture in this Budget. Flagship schemes such as the *Rashtriya Krishi Vikas Yojana* have got greater support. Rs 300 crores have been allotted to the *Rastriya Krishi Vikas Yojna.*

check food inflation in double digits.

As a prelude, the Minister hiked the target to Rs.3,75,000 crore (3.75 trillion) rupees for farm credit that is 15 percent more than the last fiscal. This was a welcome step. The four-pronged strategy seeks to unlock the supply side constraints that have abetted food inflation in recent months. By hitting at wastages in the food supply chains right from the field to the market to the dining table will involve investments in raising farm output, promoting the food processing sector to facilitate both reduction and value addition of the farm produce. The FM has taken the route.

Farmer Loans

The lessening of the financial burden on farmers has been the thinking of previous UPA budgets. Significant steps have again been taken in this direction. To quote the FM directly, "In view of the recent drought in some states and the severe floods in some other parts of the country, I propose to extend by six months the period for repayment of the loan amount by farmers from December 31, 2009, to June 30, 2010".

"I propose to raise the (this) subvention for timely repayment of crop loans from one percent to two percent for 2010-11. Thus, the effective rate of interest for such farmers will now be five percent per annum". Definitely, the interest incentive would go a long way in inculcation good financial discipline among Indian farmers, which can really be beneficial in the times to come.

Subsidies

The Finance Minister also used his scissors to restrict Food Subsidy and reduced it from Rs 56,002 crore in 2009-10 to Rs 55,578 crore for the coming fiscal. There are fears that the decrease can affect the Food Security Bill. Coupled with that, this year's allocation for strengthening the PDS is marginal at Rs 30 crore. That is too small. A big shortcoming is that there is no substantial allocation for irrigation even as the farming sector suffered worst drought.

The FM did not spare the fertiliser subsidy part either; he reduced it by Rs 3,000 crore from last year's allocation as part of a strategy to switch to a nutrient-based subsidy policy. Experts fear that when nutrient-based subsidy policy comes into effect, urea prices may increase at least 10 percent. In the aftermath, manufacturing companies will decide the retail price of fertiliser and can lead to a spiralling of prices.

One notable aspect of farm budget is the outlay of Rs 400 crore to launch a Green Revolution in the country's eastern regions. Areas under eastern UP, Bihar, Orissa, Jharkhand, Chattisgarh and West Bengal will enjoy the fruits of this enhanced attention. These were the regions plagued by low farm productivity

Officially the nutrient based subsidy policy will become effective from April 1, 2010. This, the government hopes, will promote balanced fertilization through fortified products and extension services of the fertiliser industry. Positively, this can also lead to an increase in agricultural productivity and ensure better returns for the farmers. It is hoped that the policy is expected to reduce volatility in the demand for fertiliser subsidy in addition to containing the subsidy bill. The new system hopes direct transfer of subsidies to the farmers.

Retail Chain

Pranab Mukherjee's announcement to open up of the retail chain to introduce greater competition and bring down farm

gate prices, wholesale prices and retail prices is a right step. But the minister has not specified the road map in detail. One visible step in this direction can be seen in the concessions on import tariff for mechanised farm produce handling systems at *mandi* level; construction of cold storages and facilities for chilling, and refrigerated transportation of perishable farm produce from farms to the *mandis* and retail outlets.

Eastern Thrust

One notable aspect of farm budget is the outlay of Rs 400 crore to launch a Green Revolution in the country's eastern regions. Areas under eastern UP, Bihar, Orissa, Jharkhand, Chattisgarh and West Bengal will enjoy the fruits of this enhanced attention. These were the regions plagued by low farm productivity. Similar programmes in the 1960s and 70s had helped in making a switch over to high-yielding crops in northern regions and self-sufficiency in food production was the end-result. The fact that only Rs 400 crore has been earmarked makes it too little for a task of such a scale.

Boosting Pulse

To boost the production of pulses and oilseeds, the budget earmarked an investment of Rs 300 crore. Under the plan, the government will help pulse and oilseed farmers in 60,000 villages that depend on rainfall for water supply. India consumes around 17 million-18 million metric tons of pulses a year and imports 2 million-3 million tons through state-run companies and private traders as local production is insufficient to meet demand.

But the allocation of Rs 300 crore does not scale up to meet the ambition behind the programme. Most of the interventions needed for stepping up the productivity of pulses and oilseeds in non-irrigated areas — such as water harvesting, watershed management and soil health improvement are very cost-intensive.

The Budget proposes restoration of soil health through conservation farming involving minimum tillage and ecological balance through biodiversity preservation. But in terms of funding all these tasks have been clubbed with another ambitious mission of imparting climate resilience to agriculture with an outlay of just Rs 200 crore.

To alleviate the credit woes of farmers, Mukherjee has extended the cushion of a flexible deadline. He has extended the time period by six months to June 30, and reduced the interest rate for those who make repayments on time to 5 percent from 6 percent earlier.

PDS

Important changes have been proposed in PDS delivery prices. A subsidy of Rs. 10/Kg would be provided on pulses to tide over the price rise. An additional subsidy of Rs. 15/Kg has been provided on edible oils. The importance of better management was signified. Food security cannot be ensured until and unless the entire process is managed well and professionally.

To arrest the heavy wastage of grain procured for buffer stocks and public distribution system, the FCI has been hiring godowns from private parties for a guaranteed period of 5 years. The new budget has extended this period to 7 years. The finance minister has made a good beginning in the supply side economics.

The icing on the farm budget is the announcement to add another five big food parks to the already existing 10 parks. In total, the Budget portends decent growth for the farm sector besides giving a policy direction to sustainable growth.

Floriculture and its Importance to Indian Agriculture

By B.K. Banerji *

Civilization began with traditionally, the inhabitants of each country or region depended on the food-basket filled by the farmers, i.e., everybody depended on agriculture and was interested in its fate. Floriculture is an ancient farm activity with immense potential for generating remunerative, self-employment among small and marginal farmers and follows the same path. Besides earning the much-needed foreign exchange, it is getting due attention these days and the floriculture is one of the few industries with very bright prospects and thus becoming a very important component of Agriculture. Now it has become a multibillion dollar business with millions of job opportunities. The Foreign Trade Policy (FTP) has identified certain thrust Sectors with prospects for export expansion and potential for employment generation. Agriculture is one of the thrust section. Under Agriculture Sector a new scheme Vishesh Krishi Upaj Yojna (Special Agricultural Produce Scheme) has been launched to boost export of fruits, vegetable, flowers, minor forest produce and their value added products. The main benefits of the scheme are given below:

- Liberalization of import seeds, bulbs, tuber and planting material
- Liberalization of export of plant portion, derivatives and extract to promote export of medicinal plants and herbal products.

The present paper deals with floriculture and its importance to Indian Agriculture. Floriculture has been associated with our culture and heritage since ancient time. In our country people have been using flowers for worshiping and for decoration of temple premises. Indian women used flowers for ornament making in historic times. The present time demand of flower is more as it is used as cut flower in bouquet and flower arrangement is gaining popularity especially on occasion like festivals, decoration of wedding banquet and reception halls and celebration of special days. (Valentine's Day).It has been proved that flowers have been known to enhance creative ability and work performance in human being. At global level, Flora business is around US$50 billion which is expanding day by day. Now the concept has been changed. Earlier floriculture was merely restricted to growing of traditional flowers in our country but now has emerged to a modern high tech Agro-based Industry. In the era of increasing modernization, India is fast emerging as a significant player of the flora industry and will be super power of the future.

The impact of Indian floriculture in the World market will be very high in future due to floriculture biodiversity and its wide range of value added products. Indian floriculture is characterized by growing, cut flower crops; loose flower crops; foliage ornamental plants; trees, shrubs and climbers, edges and hedges; annuals, biennials and perennials, cacti and other succulents; grasses, reeds, bamboos and ground covers; bulbous ornamentals, plants viz. bougainvillea,

china aster, carnation, chrysanthemum, dahlia, gerbera, gladiolus jasmine, lily, marigold, narcissus, rose, tuberose, tulip, water plants and bonsai plants, dry flower from cultivated and wild plants, potted plants for domestic market. The main advantage of Indian floriculture is its large number of flora which is growing at different altitude, agro-climatic and edaphic zones with broad spectrum of humidity, rain fall and temperature.

This large number of flora is now exploited for developing novel products for floriculture industry and cut flower trade. The Asian countries like India, China, Korea and Vietnam etc. are moving in the direction of more intensive floriculture. At present the global floriculture export stand at Euro 5.1 billion which is expected to touch Euro 9.0 billion by 2025.The global export is increased over ten folds from0.5 billion to 5.1 billion during 1975 to 2005, which is poised to double by 2025. Export potential of floriculture products from India is high as it is endowed with following:

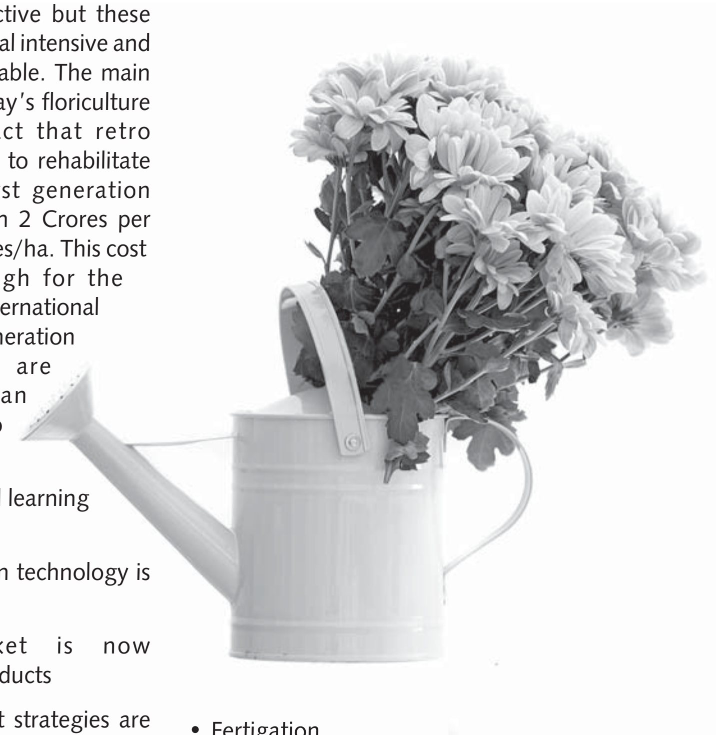
- Proximity to market in Japan, Russia, South-East countries.
- The Government allows subsidy on air-freight for export of cut flowers and tissue culture raised plants.
- Freight rates are subsidized for export to Europe and west Asia, South East Asia.
- Import duties have been reduced on cut flowers, flower seeds and tissue culture raised plants.

Status of Indian Floriculture: Indian floriculture is growing in a fast speed and survey of literature reveals it is hardly two decades old. The main reason behind the late starting is the failure in venture of the first generation project in the country. Earlier projects were not successful due to various reasons in this lucrative business. The first generations of the projects were absolutely dependent on the foreign technology where buy-back arrangements were assured in the agreement. The package includes cent per cent EOU which provides easy import of ordinary green house structure, cold storage facilities, irrigation and fertigation systems, high quality planting material and over and above technical supports. No doubt that these projects were initially very attractive but these projects were highly capital intensive and made the project non-viable. The main success story behind today's floriculture is only due to the fact that retro inspection is being done to rehabilitate these projects. The first generation project cost ranged from 2 Crores per hectare to as high 4 Crores/ha. This cost range was bit very high for the projects to be viable in International Market. The second generation projects (decade old) are successful in Indian floriculture due to following reasons:

- The hard, troubled and learning period is now over
- Dependence on foreign technology is minimized
- International market is now recognizing Indian products
- Non-traditional market strategies are becoming successful and now giving good results
- Dependence on import capital items are minimized

All these facts give us full comfort and confidence to build up the new projects without falling in the trap of foreign tech tie-ups and buy back arrangements. Most of our first generation export oriented flower projects were clustered around particular location like Bangalore, Delhi, Hyderabad and Pune. The second generation indigenous floriculture industry is setting up in new regions like Gujarat, North Karnataka, Southern Maharastra, Uttaranchal, North east, Jammu and Kashmir. The credit goes for this successful venture to hard and devoted work of various Research Institutions (Indian Agricultural Research Institute, New Delhi; National Botanical Research Institute, Lucknow and Indian Institute of Horticultural Research, Bangalore) and efforts of more than 30 states Agricultural Universities, seriously involved in research work on following:

- Development of new and novel cultivars
- Techno-economics of ornamental plant
- Agro-technology,
- Integrated Pest Management,
- Integrated Nutrient Management,



- Fertigation
- Tissue culture
- Drip irrigation system

The adoption of right technology has given comfort to growers in new regions to compensate the climatic advantage.

Modern trend in Indian Floriculture: The large scale commercial cultivation, protected cultivation in poly houses and green houses is selectively new to the country. Overall the green house industry is doing well in our country but the development in this sector is not smooth and uniform across the country. It is doing very well in certain pockets where as the progress in other areas in not that much encouraging. In the terms of acreage under floriculture, Gujarat is currently on the top in the country, closely followed by Pune region in Maharashtra. Trend in the recent past indicates that Himanchal Pradesh, Uttarakhand and North East are fast emerging as the future floriculture hubs in India. It is so because more and more farmers are convinced with the success story and high profitability of poly house produce and approaching the Poly House Industry for setting up units in their areas. Rajasthan Government has also taken initiatives in this direction and is planning to set up about a thousand green units for which the state government has already registered certain authorized agencies for the purpose.

Opening of world market under the WTO regime there is a free movement of floriculture products. India itself has a good scope in the future. Indian floriculture has experienced many ups and downs. Export of flowers and floral products have picked up, domestic market which is expanding fast. The area under production of flower is around 126235 hectare. It is mostly concentrated with states of Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal. The industry is characterized by sale mostly of lose flowers (Chrysanthemum, crossandra, Jasmine, marigold, and tuberose etc.) and dry flowers. The export surplus is there in the cut flower segment (anthurium0, carnation, gerbera, orchids, rose etc).

Export Basket: The world wide consumption of floriculture products is estimated at US$80 million. Cut flowers contributed about 60 percent of the world trade; the rest of trade covers live plants, cut foliage and dry flowers etc. India is situated close to major flower consuming countries compared to its Asian counter parts; the scope in the flower trade is quite obvious. The cold winters in major flower producing countries in Europe works to the advantage of India. In particular, area like Bangalore, Nasik, Hyderabad, Pune and North East enjoys moderate climate all through the year. All these factors should enable India to garner export earnings worth Rs.1000 million annually. The floriculture trade now grows at 25 to 35 per cent. The export of floriculture produce during 2004-2005 and 2005-2006 are as follows:

	2004-05	2005-06
Dry flowers	45%	71%
Fresh cut Flowers	10%	18%
Live Plants	7%	9%
Bulbs	3%	1%
Foliage	13%	1%
Flowering Plants	22%	-

The data shows that India has tremendous impact on world in the field of floriculture and its produce. Now foreign companies are looking for Indian Partners for sourcing flower supply. Indian floriculture has twin objectives i.e. more income in one hand and employment generation on the other. The export basket includes not only cut flowers but also bulbs, tubers, fresh foliage, tissue cultured plants and the much sought after dry flowers and plant parts and value added products. Cheaper technology for green houses, the country is also exporting green houses and accessories, though on a limited scale.

Growing System: In our country there are two main types of growing system i.e. soil based cultivation and water based cultivation system or hydroponics. Soil based cultivation is successful in the region where soil is rich, fertile and well drained. The nature of soil is always heterogeneous and advances of soil borne disease are very high. Hydroponics is gaining popularity in rapid speed. The new generation of project are adopting hydroponics cultivation while the first generation project were totally dependent on soil based cultivation except one or two were transition stage by adopting this new methods but could not sustain due to lack of proper technology and high cost of it. Only one successful project on indigenous hydroponics technology has triggered the hydroponics boom in the country. Now small growers of one Acre land are adopting this technology and the project with hydroponics technology can be implemented at very reasonable cost. Availability of abundant coco-peat in India, which is the main media for cultivation in substrate has played very important role in this direction. Indian growers are benefited and now India became leading exporter of co-co peat to Europe, Australia and North America.

Export of Indian Green Houses: Indian green houses are cost effective, sturdy and have long life, can be erected in definite frame of time schedule. Indian green houses are designed according to climatic requirement of the region and meet the standards set by world leading green house makers. Today these green houses are competing with the world standard and Indian green houses are being exported to Africa and South East Asia. Top quality irrigation system is developed in India for hydroponics green houses. Climate controls required for green house are still not developed in our country and still we are depending on imported controllers.

Floriculture, an Extreme Focused Segment: Floriculture is identified as an extreme focused segment by the ministry of Agriculture and commerce for the development of Nation. It will definitely have impact in the world floriculture Market. Following are some important recent development to boost the floriculture Industry in India:

- Model floriculture Center
- Floriculture Infrastructure Park
- Flower Auction Center
- New Flower Market
- Centers of Floriculture
- Flower Growers Association
- Agri-export zone for Floriculture
- Scheme for Floriculture Development

1. Model Floriculture Center: It was established in Maharashtra and Karnataka with the financial assistance of Government of India during the eight plan period. Followings are the major objectives of these centers:

- To demonstrate cut flower cultivation technology
- To established germplasm bank for flower crops
- To supple plant material for commercial cut flower cultivation
- To impart training on post-harvest management of cut flower

2. **Floriculture Infra structure Park**: It is being established in Hosur in Tamil Nadu TANFLORA. The farm size is 50 hectare and it is situated at Talegaon, Pune. Park facilitates following activities:

- Collection and integrated approach in terms of cultivation
- Post harvest management
- Marketing of cut flower

The similar types of plans are in pipe line for setting up floriculture infrastructure parks in Uttar Pradesh, Himanchal Pradesh and Karnataka.

3. Flower Auction Center: Flower auction center plays an important and major role to serve a common platform for the growers and buyers. The first flower auction has been set up in

Bangalore with joint efforts of Karnataka Agro Industries Corporation (KAIC) and South Indian Flowers Growers Association. At present this auction center has been, upgraded to International Flower Auction Bangalore. The financial assistance has been given by APEDA. Proposal for establishment of Modern flower auction center at Ghaziabad (Delhi), Goregaon (Mumbai), Bangalore and Pune are in pipeline.

4. New Flower Market: Local flower markets are being strengthened at Delhi, Mumbai, Kolkata, Bangalore, Ahmedabad, Surat, Chennai, Indore and Jaipur etc.

5. Centers of Floriculture: Bangalore (Karnataka), Pune (Maharashtra), and Hossure (Tamil Nadu) are main floriculture centers of India. The new floriculture centers are Himachal Pradesh, Uttaranchal, North East states, south Gujarat are emerging as a new floriculture centers.

6. Flowers Growers Association: The flowers growers' association can play a significant role in strengthing and sustaining floriculture Industry. Flower growers associations are formed in the country and are trying to help the growers to sustain their commercial floriculture activity. These associations have advantage of collective dealing with the government bodies and marketing organization. Following are the important flowers growers association which have been established and smoothly functioning:

- South Indian Floriculture Association (SIFA)
- Belgaum Horticulture and Floriculture Association
- Surat region flower Growers Association
- Maharashtra Flower Growers Association

7. Agri-export zone for Floriculture: Agri export Zone for Agriculture has been established to boost the Floriculture Industry by Agriculture and Processed Food Export Development Agency (APEDA) in Sikkim, Tamil Nadu, Uttaranchal, Karnataka and Maharashtra. Identification of new export zone is in pipeline.

8. Scheme for Floriculture development: Floriculture projects are

financed by Government of India under Ministry of Agriculture and Ministry of Commerce which are as follows:

- National Horticulture Board (NHB) www.nbh.gov.in
- National Horticulture Mission (NHM) www.nhm.gov.in
- Small Farmers Agribusiness Consortium (SFAC) www.sfac.gov.in
- Agriculture and Processed Food Export Development Agency (APEDA) www.apeda.gov.in

These organizations work exclusively for development of export for Agriculture and Processed food, including Floriculture.

Quality Planting Material: We have quite a few reputed plants nursery that are providing international quality plants. These are high cost effective as compared to the imported plant material.

Indian Floriculture after Eight Five-Year Plan: It was the eight five year plan which first accorded the status of a separate programme for floriculture. The floriculture sector went through grulling times, and many units that came up in early minutes went sick for want of experience. Area around flower cultivation doubled from 52,000Hectares in 1993-94 to 103,000hectares in 2001-2002. A large numbers of units were set up in clusters in area around Bangalore, Delhi, Pune and Hyderabad for starting production of cut flowers, primarily for export markets. Success story came from states like Mizorum, Nagaland, Manipur and Sikkim. Women have taken lead in forming co-operatives to launch well maintained floriculture units that grew flower like anthurium, roses, lilies and Orchids, all fit for export market. Although India exports, floriculture products to Japan, Netherlands, USA, Germany, UAE and U.K., the volumes are not much compared to other exporting countries. In the EU market, India faces intense competition from East African countries like Kenya and Tanzania, while in the Japanese market its competitors are South Korea, Thailand, Australia and New Zealand. Robust growth from 180million in 1993-94 to 3.05 billion in 2005-06 was recorded. India's share in the 11 billion dollar global market for flowers and flower products is only 0.65 percent, hence the growth potential is large. Recently, some Dutch companies have also shown eagerness to have tie-up arrangements with Indian counterparts for sourcing of flowers for sale in International Markets. It clearly shows impact of Indian floriculture in world trade.

SWOT and Indian Floriculture: SWOT (Strength, weakness, opportunity, Threats) analysis with special reference to International Market, shows that India has got immense potential for export of floriculture produce and can take a prominent place in the world trade. The government has also shown its willingness to promote the interest of floriculture amongst the growers through major steps taken in providing fiscal and taxation relief. Import duties have been reduced from 55 to 25 percent for specified goods used for horticulture and green houses.

Schemes of Government of India: Recognizing the floriculture sector's to the national economy, the government of India has introduced many scheme to spur growth. Prominent among the schemes under implementation by APEDA and NHB are followings:

- Transport assistance
- Infrastructure development
- Subsidies for new floriculture units

APEDA established a market facilitation centre (MFC) at Aalsmeer in the Netherlands. The worlds largest flower auction located at Aalsmeer sells more than 30 million flowers and plants every day. It is a largest commercial building of the world spread over in 878,000m^2 of floor space. It acts like link between buyers and sellers, especially large flower importers and big retail chains. Cold storage facilities at important Airports like New Delhi, Mumbai, Hyderabad, Bangalore, Chennai, Trivendram and Kochi have been created for better post harvest handling of flowers. Such facilities are also being setup at Ahmedabad, Amritsar, Kolkata and Bagdogra airport.

NABARD role in Indian Floriculture: NABARD has played a very significant role in promoting the floriculture industry with credit support in India. Technology developed by the research organization to grow the floriculture under controlled conditions has successfully been adopted by the bank which helped in growing of the high quality products for export. The bank has contributed in a very big way to cut flowers as well as in tissue culture. Activities of the Bank are as follows:

- Periodic meetings at state and National level
- Circulation of the model scheme on ornamental crops such as Anthurium, carnation, Orchids and roses
- Publication of the quarterly document 'Technical Digest' which deals with the latest development in the field of floriculture sector
- Compilation and circulation of research results achieved at various research universities in the country
- Sharing dialogue with bankers and other agencies involved in development of floriculture

E-Commerce in Indian Floriculture: E-commerce has brought revolution in Floriculture industry. Indian florist who could only sell to consumers in one town is now reaching to millions of potential customer's world wide. www.rosebazaar.com is the first and only online flower auction with the fastest real time auction with response speeds of 1/50th second. Rosebazar.com was initiated as a venture of Karuturi Floritech Ltd., now Karuturi Network ltd, as an e-commerce initiative results in disintermediation in Global Floriculture business. www.rose bazaar.com is a part of Karuturi Networks Ltd. which is a multifaceted company having varied interests in software development, call centers, floriculture, trading, broad brand. Internet services and the networking space. It enhances transparency for buyers and sellers to come closer to each other www.rose bazaar.com facilitate Internet technology for the benefit of the Industry:

- It simulates physical auction model
- Results in sequential auction of the items
- An user friendly graphical interface which has a global reach
- It has a proxy bidding (pre-bidding before auction) where in flower trade is made online
- Bulked orders can be booked
- Customized orders can be ordered for scientific requirements
- Promotes buying flowers of choice and digital image of flowers can be seen
- Details regarding multi location and multiplicand are available.

Favourable Factors: Following favorable factors offer India, foreign exchange earning potential of Rs.1000 crores. The current spread is over 110 hi-tech floriculture companies covering an area of 500 ha mostly under rose cultivation. The average investment in each floriculture projects ranges between 2-4crores per hectare. Most units are around 3-4hectare in size. One of the largest projects is CCL Flowers ltd. Bangalore which has more than 25 hectare growing roses. The floriculture export from India increased over the year to reach a mark 300 crores during 200-06 annually through floriculture trade with an annual growth potential of 25 to 35 percent. Indian Floriculture has following advantages:

- Good sunshine all through the year
- Optimum temperature zone in certain parts of the country
- India is situated comparatively closer to major flower consuming centers than its Asian counter parts.
- Geographic location of India is equidistant to Europe and east Asian country
- Good scope and potential in flower trade
- Severe winter in major flower producing European countries is also advantageous factor to India especially areas like Bangalore, Pune, Hyderabad, Nasik, North East which enjoys moderate climate all through year
- Prospects of Auction Market for floriculture products coming up shortly at Singapore. It will be an added advantage to India.

Setting of Flower Auction Centre: Growers and traders should also be happy that the Government of India has approved the setting up of flower auction centre in Bangalore, Mumbai, Noida (New Delhi) and Kolkata. The prospect of an auction market for floriculture products coming up shortly at Singapore gives an additional advantage to India.

It is crystal clear from the above quoted examples and description that floriculture industry and cut flower trade if growing with a fast speed and foreign countries are taking interest in our developed technology specially green houses. Impact of Indian Floriculture in the world market in near future will be very high. It clearly shows that floriculture has tremendous importance in Indian Agriculture as it is a very potential source of siphon of foreign money in one hand and in the other provides lots of job opportunities along with upliftment of the growers/farmers community.

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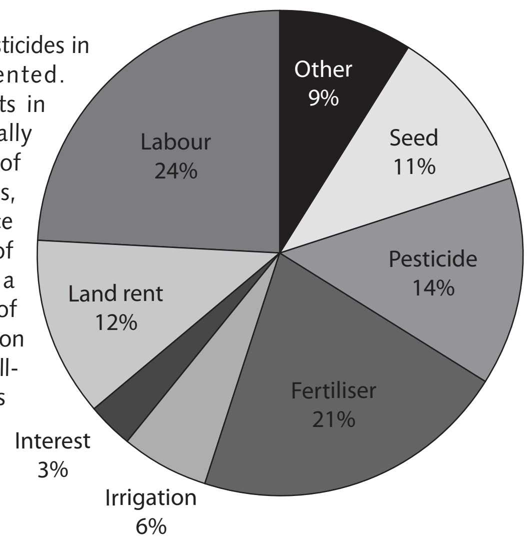
Agrarian Crisis and Economics of Pest Management

By Ramanjaneyulu *

Agrarian crisis in India is a complex situation resulting from the lopsided policies in technology, development, support, regulatory and market systems. Pests and pesticides contribute to the major economic and ecological problems affecting the farmers, crops and their living environment. Farming in India evolved over centuries of farmers' innovations in identifying locally suitable cropping patterns and production practices. The crisis of food production and geo-political considerations during 1960s created conditions in many developing countries particularly in India to strive for food self-reliance. The country has chosen the path of using high yielding varieties (more appropriately high input responsive varieties) and chemicals which brought about what is popularly known as green revolution. This continued as a quest for modernization of agriculture which promoted the use of more and more of high yielding varieties/hybrids, chemical pesticides and fertilizers across crops and situations displacing farmers' knowledge, own seeds and practices. The country could become self reliant for a while, farmers lost self reliance in the process due to excessive dependency on external inputs and are caught in serious ecological and economic crisis. This crisis is manifesting itself in the form of migration, indebtedness and in extreme cases as farmers' suicides.

The problems of pests and pesticides in farming are well documented. Among the production inputs in agriculture chemicals especially pesticides occupy major share of costs in crops like cotton, chillies, paddy etc. The pest resistance and resurgence due to abuse of pesticides propelled mainly by a lack of awareness, regulation of pesticide marketing extended on credit with high interests by "all-in-one dealers" (money lenders cum dealers of seeds/fertilizers/pesticides) and lack of market support ended up pushing hapless farmers into a vicious debt trap from which suicides were sought as a way out. The same pesticides which were promoted to solve the farmers' problems were consumed by these



farmers to kill themselves.

Realizing the ecological crisis caused by the chemicals in agriculture agricultural scientists and industry has initiated middle path approaches like Integrated Pest Management (IPM), Integrated Nutrient Management (INM) etc where chemical inputs were partially replaced by bio-inputs derived from botanicals, microbes and other biological sources. These middle path approaches though reduced the chemical usage to an extent could not make head way in shifting agriculture into more sustainable model as the approach itself in based on the safe external input based farming concept. In midst of this farmers and various organizations associated with farmers supplemented by hitherto neglected ecological agricultural science initiated new models of farming by making best use of natural processes and locally available natural resources. Most of the inputs are internalized into farm itself. The framework of understanding each component in agriculture is different for them. For example, when dung is applied to the fields INM/ chemical framework understands soil nutrition as a chemical property and counts the nutrients in dung and calculates how much quantity of dung is needed. They come with astronomical figures and say it is impossible task. Whereas in ecological approach focus is on enriching the soil microbes and building the soil health therefore dung is applied as a fermented product which is seen as a microbial culture. The nutrient content of these products per se may be lower but the amounts of nutrients that can be biologically are enormous. Therefore in this approach one needs only small quantities of dung where as regular chemical science and INM calculates astronomical quantities of dung to be applied to meet the nutrient requirements of the crops and hence justify chemical fertilizer use. Similarly pest management also is understood as using products to kill insects where as the ecological approaches like Non Pesticidal Management understands pest management as restoring ecological balance.

Many of the ecological initiatives remain small owing to lack of proper support from the mainstream organizations as it does not fit in the dominant paradigm. The groups working on these ecological methods also could not take them onto a large scale as they could neither articulate the new approach in the way the mainstream institutional science understands nor could demonstrate on a scale to create conviction.

One such initiative is the 'Non Pesticide Management' of crop pests to reduce the costs of cultivation by adopting a set of practices based on farmers' knowledge supplemented by modern science which makes best use of local resources and natural processes by the farmers and women self help groups in Andhra Pradesh. Centre for Sustainable Agriculture provided technical support in designing and implementing NPM from 2004 to 2007. During Kharif 2007, more than 3,50,000 farmers from 1800 villages in eighteen districts of the state are practicing NPM in more than 7 lakh acres in various crops. Sixteen of these districts are part of the 32 districts with serious agrarian crisis identified by the Government of India. The savings (on chemical pesticides) in costs of cultivation on pest management ranged from Rs. 600 to 6000 per ha without affecting the yields. The savings on the health costs are also substantial. Non Pesticidal Management is one of the components of the 'Community Managed Sustainable Agriculture' program with technical support from Centre for Sustainable Agriculture and its partner NGOs and financial and administrative support from the Society for Elimination of Rural Poverty, Government of Andhra Pradesh. Today the program is run by the women self groups with the help of successful farmers as the resource persons. During 2009-10, the program covered more than 17 lakh acres (12 lakhs during kharif and 5 lakhs during rabi).

Non Pesticidal Management is one of the components of the 'Community Managed Sustainable Agriculture' program with technical support from Centre for Sustainable Agriculture and its partner NGOs and financial and administrative support from the Society for Elimination of Rural Poverty, Government of Andhra Pradesh

This opened up new learning that ecological farming is possible on a large scale, it can meet the demands of farming (production and profitability) provided proper institutional and support systems are created.

Managing the Problem: Integrated Pest Management

The attempts to overcome the serious economical and ecological problems of the chemical pesticides have given rise to alternative systems to manage pests and pesticides.

Integrated Pest Management: In an attempt to slow the development of pest resistance, improve the financial basis for agricultural production, and improve the health of the farming population, systems of Integrated Pesticide Management have been introduced around the world. IPM is an ecological approach to plant protection, which encourages the use of fewer pesticide applications.

The eld experiences gave rise to several paradigms of IPM which agriculturists presently adhere to.

The learning from IPM projects and FFS

experiences worldwide should have led to research on the complex interaction between crop ecology, agronomic practices, insect biology, and climate change to develop effective methods to manage disease and insect control strategies. Similarly the farmers' knowledge on using the local resources could have been captured and the principles could have been standardized. But FFS mostly remained as a paradigm shift in agricultural extension: the training program that utilizes participatory methods "to help farmers develop their analytical skills, critical thinking, and creativity, and help them learn to make better decisions". The agriculture research and extension system worldwide still continue to believe in chemical pesticide based pest management in agriculture. The effectiveness of the IPM FFS could have been enhanced by broadening the focus from a single crop to a broader systems approach, to address other matters, such as water management, crop rotation, crop diversication and marketing (Mancini et al., 2005). Though FFS is seen as a knowledge intensive process, main focus was on taking external institutional knowledge to farmers. Proper space was not provided for traditional knowledge and practices or grass root innovations by farmers. In a study by Mancini (2006) evaluating the cotton IPM FFS in Andhra Pradesh, farmers reported that their condence in implementing the new management practices was not strong enough to translate into a change in behaviour. This supports the argument that an effective, empowering learning process is based on experience, rather than on simple information and technology transfer (Lightfoot et al., 2001).

Pesticide industry is aware of the growing pest resistance towards their pesticides. Many of the pesticides become useless as the pests develop resistance and loose their market before they can recover the costs involved in developing the product leaving aside the prots. This situation has forced the pesticide industry to come up with their paradigm of IPM called "Insecticide Resistance Management" (IRM) which is a proactive pesticide resistance-management strategy to avoid the repeated use of a particular pesticide, or pesticides, that have a similar site of action, in the same eld, by rotating pesticides with different sites of action. This approach will slow the development of one important type of resistance, target-site resistance, without resorting to increased rates and frequency of application and will prolong the useful life of pesticides. This resistance-management strategy considers cross-resistance between pesticides with different modes of action resulting from the development of other types of resistance (e.g., enhanced metabolism, reduced penetration, or behavior changes) (PMRA, 1999). Though pesticide industry states that it fully supports a policy of restricted pesticide use within an IPM programme, it perceives a clear need for pesticides in most situations. Furthermore, its practice of paying pesticide salespeople on a commission basis, with increased sales being rewarded with increased earnings, is unlikely in practice to encourage a limited use of pesticides (Konradsen et al., 2003). Right from the time of the Rio Earth conference, India has been highlighting this IPM policy in all its ofcial documents. The ICAR had also established a National Centre for Integrated Pest Management in 1998. In India a total of 9,111 Farmers' Field Schools (FFSs) have been conducted by the Central Integrated Pest Management Centres under the Directorate of Plant Protection, Quarantine & Storage from 1994–1995 to 2004–2005 wherein 37,281 Agricultural Extension Ofcers and 275,056 farmers have been trained in IPM. Similar trainings have also been provided under various crop production programmes of the Government of India and the State Governments (Reports of Government of India available on http://www.agricoop.nic.in). IPM is sought to be made an inherent component of various schemes *viz*., Technology Mission on Cotton (TMC), Technology Mission on Oilseeds and Pulses (TMOP), Technology Mission on Integrated Horticultural Development for NE, J & K, Himachal Pradesh, Uttaranchal, Technology Mission on Coconut Development etc. besides the scheme "Strengthening and Modernization of Pest Management" approach in India being implemented by the Directorate of PPQ&S [Plant Protection, Quarantine & Storage]. The problems with chemical pesticides also prompted the research systems and industry to look for alternatives. Several schemes and projects have been initiated to research, produce and market bio-pesticides and bio-control agents which are recommended as non chemical approaches to pest management. Today, there is much data generated by the agriculture research establishment in India to show that non-chemical IPM practices across crops have yielded better results in terms of pest control and economics for farmers. However, the eld level use of pesticides has not changed much. The ofcial establishment usually claims that pesticide consumption in the country has come down because of the promotion and deployment of IPM practices on the ground by the agriculture research and extension departments (as was informed to the Joint Parliamentary Committee in 2003). However, the actual progress of IPM on the ground has been quite dismal and small. Further, the government often fails to take into account the fact that even if pesticide consumption has decreased in terms of quantities due to a shift to consumption of low-volume, high-concentration, high-value pesticides, the real picture in terms of number of sprays and costs involved is still the same for the farmers. The Integrated Pest Management (IPM) initiatives which have come up as alter- native though largely debates about the effects of pesticide on human health and on environment still believe that pesticides are inevitable, at least as a last resort and suggests safe and "intelligent use." On the other hand, replacing chemical products by biological products by itself may not solve the problem of pest management with restoration of ecological balance. While the inevitability of pesticides in agriculture is promoted by the industry as well as the public research and extension bodies, there are successful experiences emerging from farmers' innovations call for a complete paradigm shift in pest management.

Shifting the Paradigm: Non Pesticidal Management

The ecological and economical problems of pests and pesticides in agriculture gave rise to several eco-friendly innovative approaches which do not rely on the use of chemical pesticides. These initiatives involved rediscovering traditional practices and contemporary grass root innovations supplemented by strong scientific analysis mainly supported by non-formal institutions like NGOs. Such innovations have begun to play an important role in development sector. This trend has important implications both for policy and practice. One such initiative by Centre for World Solidarity and Centre for Sustainable Agriculture, Hyderabad was Non Pesticidal Management.

The 'Non Pesticidal Management' which emanates from collaborative work of public institutions, civil society organizations and Farmers in Andhra Pradesh shows how diverse players when come together to work in generating new knowledge and practice, can evolve more sustainable models of development.

Pest is not a problem but a symptom. Disturbance in the ecological balance among different components of crop ecosystem makes certain insects reach pest status. From this perspective evolved the Non Pesticidal Management which is an 'ecological approach to pest management using knowledge and skill based practices to prevent insects from reaching damaging stages and damaging proportions by making best use of local resources, natural processes and community action'.

Non Pesticidal Management is mainly based on the following:

- Understanding crop ecosystem and suitably modifying by adopting suitable cropping systems and crop production practices. The type of pests and their behavior differs with crop ecosystem. Similarly the natural enemies' composition also varies with the cropping systems.
- Understanding insect biology and behavior and adopting suitable preventive measures to reduce the pest numbers.
- Building Farmers knowledge and skills in making best use of local resources and natural processes and community action. Natural ecological balance which ensures that pests do not reach a critical number in the field that endangers the yield. Nature can restore such a balance if it is not meddled with too much. Hence no chemical pesticides/pesticide incorporated crops at all. For an effective communication to farmers about the concept effectively and to differentiate from Integrated Pest Management which believes that chemical pesticides can be safely used and are essential as lost resort it is termed as 'Non Pesticidal Management

Pest is not a problem but a symptom. Disturbance in the ecological balance among different components of crop ecosystem makes certain insects reach pest status

During Kharif 2005, NPM in paddy was taken up in 6 villages of 2 mandals in Kurnool district. It was successfully implemented by 57 farmers in 28.4 ha. On an average there was a saving of Rs. 2000 per acre in cost of plant protection compared to conventionally grown paddy. In yields, NPM farmers got additional yield of around 375 kg/ac, which may be attributed to increased number of natural enemy populations in the Rice Ecosystem that has happened due to continuous monitoring and timely interventions. In monetary terms, a net extra benefit of Rs. 4640 per acre was made by NPM farmers compared to non NPM farmers.

Table-5 Economics of NPM v/s conventional Paddy in Kurnool dist (2005-06)

Village	Farmer		Area (ha)		Cost of Plant Protection (Rs/ha)		Yield (q/ha)	
	NPM	Con	NPM	Con	NPM	Con	NPM	Con
Arlagadda	16	15	8.4	12	400.0	2525,2	56.83	56.13
Durvesi	5	15	5.2	59.4	490.4	3116.8	61.87	65.5
Bhupanapadu	4	5	1.6	2	440.0	2000.0	56.25	58.87
Alamuru	17	23	7.6	10	480.0	3240.0	55.45	53.8
Konidedu	6	9	2.4	3.8	520.0	2280.0	64.05	50.12
Panyam	5	9	2	3.6	724.8	2680.0	64.5	48.13

(Source: Annual Report, NPM, 2005-06)

Each participating farmer saved up to Rs. 6400 to Rs.12400 per ha on an average (average across crops and across districts) on pest management expenses. With more area and more farmers coming into the program the saving will be higher. The ecological and other benefits would be enormous.

Table-6 Economics of NPM across crops (2005-06)

Crop	Cost of Plant Protection (Rs/ha)		Saving (Rs/ha)
	Conventional	NPM	
Cotton	12600	2520	10080
Chillies	37600	5000	32600
Pigeon pea	3760	800	2960
Groundnut	3760	800	2960
Castor	5000	1000	4000
Paddy	5000	600	4400

(Annual reports of NPM 2005-06)

The benefits are not only seen in areas of high pesticide use but in areas of low pesticide use. The crop could be saved from the pests and diseases and managed well instilling new interest in the farmers.

Table-7 Reduction in costs of pest management in Ananthapur, 2005-06

Village	No. of farmers	NPM area (in ha) 2005-06	2003-04 pesticide usage (in Lt)	Value of pesticides (Rs)	Value of NPM extracts (Rs)	Total saving (Rs)
Chinnajalalapuram	39	73	7,000	540000	54600	485400
Madirepalli	36	56	5,000	400000	44480	355520
Guruguntla	36	42	4,687	656000	36400	619600
Total	**111**	**171**	**16,687**	**1596000**	**135480**	**1460520**

Source: (Annual Report, NPM 2005-06)

Transgenic Insecticide Resistant crops: not a solution either

As the problems of chemical pesticides are becoming evident the industry has come out with yet another technological fix in the form of insect resistant genetically engineered crops like Bt cotton. The results of the last four years (2002-2005) of commercial cultivation of the Bt cotton in India, especially in Andhra Pradesh clearly shows devastating effects such technologies can have on the farming communities. This comes from the fact that the seed is four times the price of conventional seeds and Bt crops often are not even completely resistant to those pests that they claim to be resistant to (Bt cotton performance reports by state governments available at http://www.indiagminfo.org). In addition other sucking pests will affect the crop and chemicals are needed again. The first three commercial Bt hybrids released in AP were withdrawn from commercial cultivation (GEAC, 2005).

It should be added that studies have assessed the variability of Bt toxin production under carefully controlled conditions, rather than the real life conditions of farmers' fields. Under real life condition toxin production of the crop is extremely uneven (Kranti, 2005).

Transgenic Bt plants, which produce their own insecticidal toxins, have the similar effects like chemical pesticides. However, unlike topical sprays, which become inactive after a short period of time, transgenic Bt plants are engineered to maintain constant levels of the Bt toxin for an extended period, regardless of whether the pest population is at economically damaging levels. The selection pressure with transgenic Bt crops will therefore be much more intense.

Today the experience of Bt cotton in several areas specially dryland regions is well known. The sucking pests are on increase. The newer questions like toxicity to smaller ruminants and soil microbes, are raised by several scientists across the world and the farmers are complaining on this issue.

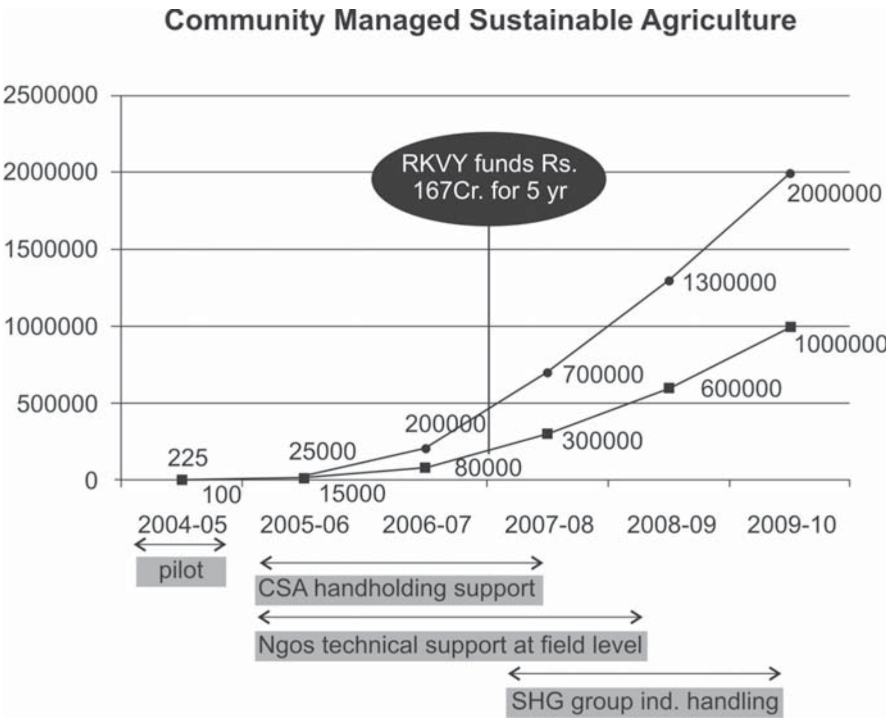
The economic analysis of NPM and Bt cotton

A study was taken up by Central Research Institute of Dryland Agriculture (CRIDA) to compare the performance of NPM in Bt and Non Bt cotton. The study showed that NPM in Non Bt cotton is more economical compared to Bt cotton with or without pesticide use (Prasad and Rao 2006)

Table-3 Comparative economics of Bt cotton vs Non Bt cotton with NPM

Strategy	Genotype	No. of chemical spray	Cost of cultivation (Rs/ha)	Yield (kg/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)
NPM	Non Bt	0	16320	2222.5	45120	28800
NPM	Bt	0	15560	2220.0	43640	28080
Control	Non Bt	5.0	16400	2087.5	41240	24840
Control	Bt	3.8	18120	2242.5	44440	26320

Source: (Prasad and Rao, 2006)



The pests and pesticides have seriously affected the farm based livelihoods in rural areas. The last five yrs years experience shows that moving towards local resource based sustainable agriculture as the only way to sustain the livelihoods of small and marginal farmers and Community Based Organizations like Federations of women self help groups form an excellent institutional platform for scaling up such models. To sustain agriculture and agriculture based livelihoods, this calls for a complete paradigm shift in the way agricultural practices are understood, developed, promoted and supported. The new paradigm is based on the local resource based technologies and a community managed extension systems.

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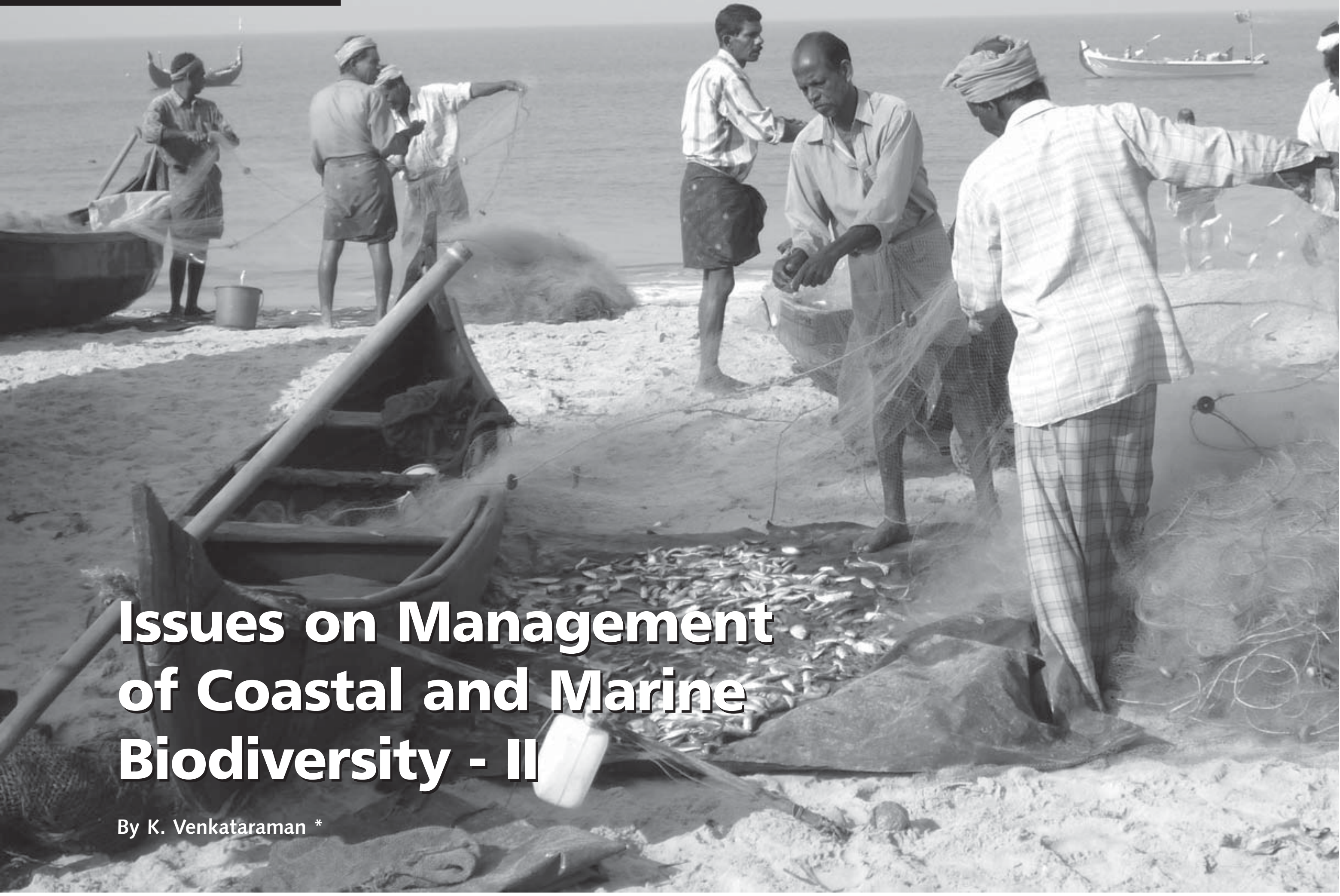

Issues on Management of Coastal and Marine Biodiversity - II

By K. Venkataraman *

Coastal Habitat Conversion and Land Filling

The competition for space in coastal areas is encouraging more projects designed to create new, usable land by converting coastal habitats such as estuaries, shallow reef flats, beaches, and mangroves to other uses through land filling. Several large and well-known reclamation areas in India are located in the urban centres of Mumbai and Chennai. The economic justification for these is strong given the tremendous need for quality land for urban expansion and renewal. However, these land reclamation efforts should be viewed as exceptions. There is often little justification to fill a coastal habitat because reefs, mangroves, and seagrasses are naturally valuable and their existence is finite. For every square meter of seagrass bed destroyed, we lose a lifetime of natural production of invertebrates and fish not only for the present but also for the future generations. Whenever an area is lost to human encroachment, it will never return and can never be recreated somewhere else. In short, the implications of habitat conversion and land filling are the following:

- Total and permanent loss of the natural habitats and their ecological and economic functions;
- Permanent decrease in localized fish catch and traditional livelihood opportunities for society's most economically vulnerable;
- Significant pollution in the form of sediments that can spread to many square kilometres and last for years after the construction is completed;
- The potential of increased risk of sinking and flooding; and
- The potential of disrupted drainage patterns that will change the natural mixing of fresh water and sea water and thus affect marine organisms not

The most common impacts of tourism development and activities are not much different from those on account of pollution, coastal development, mining, and others that involve construction in beach and shoreline areas

tolerant to fresh water.

Mining and Quarrying

Mining and quarrying along the coastal areas of India are subject to environmental impact assessment in all cases. Nevertheless, these activities continue illegally, without proper assessments, in many areas as small-scale and sometimes large scale operations. Coastal mining which is the primary concern here, has impacts that are not always obvious but can significantly change shoreline dynamics and beaches if not properly regulated. The mining activities and their most important impacts are as follow:

- Sand mining from beaches causes beach erosion and eventual disappearance of the beach. All white-sand beaches in India are generated from the natural erosion of reef corals and shells which, when deposited on a beach, are ground into sand. The rate of beach formation is slow; mining of beach sand removes a finite resource that takes hundreds to thousands of years to rebuild through natural processes;
- Sand mining from submerged reef or sandy areas stirs up silt in the water column and changes water-flow patterns. Also, the sand removed from a submerged area can easily be part of a yearly wave and current cycle that places the sand on the beach for a part of the year and under the water for another part of the year. The obvious result of sand mining is that the beach will not return during the next cycle; and
- Mining of any material in a coastal area always results in some polluting silt and runoff material that smother near shore habitats.

Tourism Development

Tourism-related activities in the coastal zone are increasingly common in India. The coastal areas and all their resources are one of the primary attractions for tourists. Most people come for a beach, swimming or some variation of this theme. Consequently, the amount of economic development supported by tourism, including resorts, shorefront developments, roads, boating and diving, has escalated in recent years especially in some areas. The lack of proper planning in much of the tourism sector is a major issue and is causing many problems. Although it is in the interest of tourism developers to maintain the environmental quality most tourists come to enjoy, the opposite is occurring in many instances.

The most common impacts of tourism development and activities are not much different from those on account of pollution, coastal development, mining, and others that involve construction in beach and shoreline areas. The impact of tourism is more related to certain forms of recreation that cause both biophysical damage to the environment and social changes within the communities where tourism flourishes. The recent introduction of motorized recreation vehicles (glass bottom boats), has added new dimensions, to the need for regulation in shore areas. The issues associated with tourism can be removed only with better education and planning, and most of all, marketing tourism for the country in a manner that attracts 'eco-friendly' tourists.

Human Impact

The significant role of the coastal environment in absorbing and diluting pollutants from human activities largely goes unnoticed. The efficient and absorptive capacity of seawater buffers hides the impacts of large perturbations from pollutants. The transportation role of water is crucial in the maintenance of coastal ecosystems because all marine ecosystems are dependent on the incubation and movement of larvae that provide new recruits of fish and invertebrates to coral reefs, seagrass beds and the larger marine fisheries we use. At the same time pollution due to human impact of all kinds is carried by water and affects all living coastal resources and their ability to grow and reproduce naturally. As the sea becomes more polluted we lose living coastal resources at an increasing cost to society.

There are numerous types of human impact common in India but a few are pervasive and are causing increasing harm to coastal and marine ecosystems and fisheries production. Types of human impact that can be addressed by coastal management include:

- Domestic sewage from coastal cities, municipalities and ships most of which is dumped directly and untreated into the sea;
- Domestic solid waste from cities municipalities and ships most of which is dumped into rivers, canals, shoreline areas and which then moves to the sea;
- Mine tailings and sediments from quarrying and mining in coastal and upland areas, much of which flows to the sea through streams and rivers;
- Industrial organic and toxic waste which. although often treated or restricted, is frequently dumped into rivers and the sea;
- Agricultural chemicals that pollute nearby rivers, streams and groundwater some of which end up in coastal waters;
- Oil and fuel leaks and spills from ships.

The overall impact of pollution on coastal areas and marine waters is degradation of the ecosystem, lower environmental quality, and most significantly, lower natural production. Pollution prevention, treatment, and disposal measures must be implemented to maintain the life support system provided by coastal ecosystems. The public must be educated about the fact that dilution is not the solution to pollution.

Food Security

India is a major exporter of seafood. The export of marine products from India has gone up by 28 percent quantitatively and 19 percent in terms of value. According to the marine Products Export Development Authority (MPEDA), India exported 461,329 tonnes of seafood valued at $1478.48 million dollars in 2004-05 as against 522,164 tonnes valued at $1644.21 million during 2005-2006. Frozen shrimp (70%), fish, cuttlefish and squid are the major export earners and account for 92.64 percent of the total exports.

India is facing the beginning of a crisis in the securing of food from marine resources (Vivekanandan, 2001). Over fishing, coastal habitat destruction and illegal fishing are primary contributors to the decrease in the available food-dependent fisheries. The goal of coastal and coral reef management is to manage all of our coastal resources in a sustainable manner while allowing the greatest benefit to accrue to the largest number of people for the longest possible time. Key issues affecting food security that can be addressed by coastal management are as follow:

- Continued increase in mechanized and traditional fishing effort resulting from population growth and migration to coastal areas;
- Slow economic development in coastal areas providing few alternatives to traditional fishers;
- Use of habitat and fishery-destructive fishing practices;
- Illegal commercial fishing in traditional fishing grounds waters;
- Open access to fishery resources;
- Unsustainable economic development;
- Degradation of coastal habitats; and
- Weak implementation of coastal management programs at local and national levels.

Fisheries of all kinds in India are near or have surpassed sustainable levels of catch. Most studies show that important fisheries are over-fished and that the real return in terms of volume of catch and economic value is declining (Vivekanandan, 2001). In some cases where volume has increased and value of catch has decreased because of changes in the ecological composition of the fishery. A particular issue is the continuous fishing of juveniles of commercial species. The causes are complex but the result is that fishing effort is greater than the resource can support and many habitats are degraded. The impact from this over-fishing is initially subtle but the end result is fewer fish and lower reproductive capacity of remaining fish.

As the primary mandate for managing coastal waters lies with the local government, municipalities, and cities must serve as action centres for results. State Governments and their coastal communities must serve as stewards of coastal resources to sustain food production and economic benefits. State Governments are in a strong position to implement a variety of coastal management to improve the benefits derived by local communities from their coastal areas. Government of India has a major role in supporting local governments to fulfill their mandate in managing coastal resources.

Biodiversity Conservation

About 13,000 species of fauna and flora are reported from coastal and marine regions of India. With 250+ species of corals, more than 2,000 species of fishes, 14 species of seagrasses, hundreds of seaweed species and literally thousands of species of different types of marine invertebrates (Venkataraman and Wafar, 2005), India parallels Indonesia, Malaysia and Philippines in its rich tropical marine biodiversity in the world. This wealth of biodiversity is one of the factors masking the serious impacts of over fishing. For instance, in temperate marine ecosystems where diversity is relatively lower, the loss of one species anywhere in the food chain can result in the collapse of the whole system. In tropical marine

India has a long history of administration of marine ecosystem but the first official administrative management policy was laid under the Indian Forest Act, 1927

ecosystems with diverse and complex food webs, the loss of one species may go initially unnoticed by humans; however, with the loss of many species and important habitat, eventually the integrity of the ecosystem will decline and ultimately collapse. For example in India:

- Squid and cuttlefish abundance has increased as a result of reduced predation and changes in the ecosystem and composition of the fish species present;
- Sting rays have become very scarce due to over fishing and reproduction is failing and new recruits are less abundant;
- Groupers and snappers are much less abundant than 20 years ago due to over fishing that eliminates adult spawning fish;
- Low-value or 'trash' fish make up a large portion of the fish catch because of ecosystem changes;
- Top predators (sharks, barracuda, tuna) are almost wiped out in many areas;
- Ornamental and precious shells are missing from shallow water habitats;
- Local extinction of dugongs, sea turtles, whale sharks, and other large marine animals as a result of overexploitation, by-catch, and habitat destruction; and
- Local extinction of ornamental corals, shells, sea horses, aquarium fish, and live food fish consequent to increased international trade demands.

Key biodiversity issues to be addressed by coastal management in India are as follow:

- Use of destructive methods to collect aquarium fish and live food fish that has proliferated destruction of habitats in addition to over fishing of valuable species;
- Poor management of all critical habitats that support much of the marine biodiversity in shallow waters; and
- Over fishing and over-collection of valuable near shore organisms resulting in ecosystem changes and lowered biodiversity.

Over fishing, habitat loss, and international trade in coral reef-generated products have led to the destruction and local extinction of the organisms being collected, and often their habitat itself. Without improved coastal management, India risks the loss of significant numbers of marine species and habitats and the integrity of the coastal ecosystem that serves as a life support system. People must decide that they want dugong and other endangered species to survive, and for this to happen, a behavioural change in them is very essential.

India has a long history of administration of marine ecosystem but the first official administrative management policy was laid under the Indian Forest Act, 1927. It was clubbed with natural resource conservation. Next came the Forest (conservation) Act 1980 and then the National Forest Policy, 1988. It was also discussed in the wildlife (Protection) Act of 1972, Environmental (Protection) Act 1986, Coastal Zone Regulation act 1992. Coastal Zone Management Plans of the state government are the legal tools which are applicable for administration of marine environment. Maritime and Port policies and Port Acts of the states are other administration tools.

Conclusion

The coastal and marine ecosystems of prime importance to India include coral reefs, seagrass and algal beds, soft-bottom communities, mangrove forests, estuaries, and beaches. All are under increasing threats from human development and resource extraction activities and their natural productive functions are becoming impaired. The basic management strategy for all these systems should be that of precaution, as these systems are destroyed and lost, they will not easily come back. The losses to people dependent on them for fishing and food, recreation, other forms of income and aesthetic purposes cannot be measured.

A healthier marine environment needs integrated policy approaches, which involve scientific disciplines to address the complexity of the interaction between the social and natural systems in the coastal and marine environment. The need for a single administration to deal with governmental responsibilities for policy implementation is recognized and the Government of India is taking steps to initiate programmes which involve inter-departmental collaboration.

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Rice for National Food Security

By B. C. Viraktamath *

The current Indian population of 1.17 billion is expected to reach 1.3 billion by 2020 and 1.4 billion by 2025 AD. Since rice is the staple food for most of us, food security depends on it. Globally rice is cultivated now on 160 million hectares with annual production of around 650 million tons and average productivity of 4.18 tons/ha (FAO stat 2007-08). More than 90 percent of the rice is produced and consumed in Asian countries. The other continents in which rice is grown are Africa (7.78% of the global area), South America (6.4%) and North America (1.4%). In India during the period 2008-09, rice was cultivated in an area of 44.0 million hectare with a production of 99.3 million tons of rice, with an average productivity being 2.13 t/ha milled rice.

Though, rice production growth trend had kept in pace with population growth rate during last five decades, signs of decreasing growth rate are evident. This has been a cause of concern. During the green revolution period the semi-dwarf, fertilizer responsive, high yielding genotypes of rice and wheat were introduced, which led to phenomenal increase in production and productivity of these crops. There appears that the technology introduced during the green revolution has reached its diminishing return phase. Hence it is very pertinent to critically consider whether the rice production can be further increased to keep pace with population growth with the current green revolution technologies. It is estimated that by 2020 at least 115-120 million tons of milled rice is to be produced in India to maintain the present level of self sufficiency. Is there a need for a paradigm shift in rice research to meet the challenges of the future decades for ensuring food security? Do we need to adopt the gene revolution technologies? The possibilities

Considering the demand for food for the population, plant breeders developed varieties that matured early with higher yield potential. The key to the success was the selection of the genotypes with rapid vegetative vigor at the earlier growth stages

and prospects of utilizing the new technologies for enhancing rice productivity are for food and nutritional security are examined here.

Breeding Strategies for Post-Green Revolution Era

Most traditional varieties in tropical and subtropical Asia grown during 1960s matured in 160-170 days and many were photoperiod sensitive. These were suitable for growing one crop of rice a year during the rainy season. Considering the demand for food for the population, plant breeders developed varieties that matured early with higher yield potential. The key to the success was the selection of the genotypes with rapid vegetative vigor at the earlier growth stages. This helped farmers to grow two rice crops during the year in areas where good irrigation facilities existed, or introduce a non-rice crop in the rice-based system depending on the resources available. While the profitability in rice farming increased with new varieties, a relatively small number of improved varieties, however, replaced thousands of traditional ones, thereby reducing the genetic variability of the rice crop. The reduction in biodiversity, coupled with vegetative growth and continuous cropping, increased the vulnerability of the rice crops to insects and diseases. Scientists addressed this problem by incorporating resistance to major insects and diseases in newly released modern varieties. Large germplasm collections were screened and donors for resistance identified. Utilizing these donors, improved varieties with resistance to three major diseases (blast, bacterial blight and tungro) and three insects (brown planthopper, green leafhopper and gall midge) have been developed. Large-scale adoption of varieties with a broader genetic-base has helped stabilize rice yield and reduce the use of pesticides.

During this phase, the emphasis has also been on development of grain quality suited to different regions of the country and for export. Improved scented varieties like Pusa Basmati, Sugandhmati, Yamini etc. have enhanced rice exports. While 1.1 million tones of basmati rice worth 3,000 crores is exported from the country, even non-basmati type varieties are exported to the tune of 3.0 million tones worth another 3,000 crores of rupees in foreign exchange.

Genetic transformation is another tool that promises to revolutionize Indian rice production scenario. The most important advantage of transgenic technology is the capacity to mobilize useful genes from non-rice gene pool to rice with least disruption to rice genome

Development and Use of Hybrids

Convinced of the potential of hybrid rice technology to enhance productivity and production of rice, in light of the remarkable success of the Chinese in this field, Indian Council of Agricultural Research (ICAR) initiated a goal oriented project in December, 1989 to develop and utilize hybrid rice in Indian Agriculture. First set of hybrids were developed and released in 1994. Till now 43 hybrids have been released, 28 from public sector and 15 from private sector. The hybrid rice seed production and cultivation packages have been developed and optimized. During the year 2009, hybrids were cultivated in an area of 14 lakh hectares. It is expected that during the next five years hybrids will cover 2-3 million hectares. The popular hybrids being cultivated in the country are 6444, PHB-71, KRH-2, Sahyadri etc. More than 20 private seed companies are actively involved in hybrid rice research, development and large scale seed production. Over 95 percent of the hybrid rice seed in the country is produced by the private sector.

By cultivation of hybrids farmers are obtaining an additional yield advantage of 1-2 t/ha, the additional net profit being in the range of Rs. 3,000 – 5,000 per ha. In hybrid rice seed production, seed yields of around 2.0 t/ha are obtained with a net profit of Rs. 25,000 to Rs. 30,000/- per ha for the seed growers.

At present hybrids are cultivated in Uttar Pradesh, Chattisgarh, Jharkhand, Bihar, Haryana and Punjab. Some of the major constraints to further expansion of hybrid rice are unacceptable grain quality, lack of resistance to major pests and diseases and higher seed cost. Research efforts to overcome these constraints are underway. Recently released hybrids like DRRH-3, Suruchi have excellent cooking quality. It is expected that hybrid rice will play a major role along with the New Plant Type (NPT) varieties, in raising the productivity and production of rice in the coming decades.

Development of aerobic rice adapted to water stress conditions

Water stress is an important abiotic stress limiting rice yields across the world. Traditionally rice crop requires almost thrice the quantity of water when compared to maize and wheat. The progressive reduction in water resources across the world necessitates the development of alternative strategies to combat water stress in rice. One such strategy is the development of "aerobic rice" which can survive moderate drought. Biotechnology can help in development of aerobic rice through the application of molecular markers, genetic engineering and genomic tools. Novel molecular and biotechnological methodologies can be used to identify stress-related genes and use them as probes for selection of tolerant genotypes and for generation of transgenic plants. Similarly, identification and utilization of molecular markers linked to gene(s) associated with drought tolerance can tremendously boost the capacity of rice cultivars to resist water scarcity.

Deployment of Biotechnological tools

The efforts of rice breeders have no doubt brought the rice yield levels to such a stage where at least for the present, food production growth will outrace population growth. But we should not be complacent as the vagaries of monsoon and disturbing trend with respect to soil health are bound to destabilize rice production and we must therefore be ready to face the challenges of the future by judicious and prudent application of biotechnological tools. From a breeder's perspective, biotechnology helps to add precision in the breeding process to become more target oriented and purposeful compared to traditional breeding. Biotechnology can help in improving rice breeding through:

1. Transfer of economically important traits across genus/ species barrier into the rice gene pool (i.e. Broadening the genetic base)
2. Manipulation of target trait without disruption to the non target regions of the rice genome (i.e. Increasing efficiency in selection)
3. Shortening the breeding cycle

The three broad applications of rice biotechnology that are expected to contribute both directly and indirectly towards rice improvement efforts in India are discussed here.

DNA Marker Technology

The application of molecular markers in rice improvement started with the efforts of Cornell University and IRRI using RFLP markers for development of molecular linkage maps in rice. The first restriction fragment length polymorphism (RFLP) map of rice was developed in 1988. Later a comprehensive genetic map was developed with more than 2250 DNA markers. RFLPs being laborious and costly were then replaced with more robust, simple to use PCR based markers like microsatellites or simple sequence repeats (SSR), Inter-simple sequence repeats (ISSRs), Sequence tagged sites (STSs) etc. These simple PCR based markers help breeders to track the introgression of the target genes across segregating progenies. Markers tightly linked to the gene(s) of interest can be used at any crop stage for testing the presence of the gene(s) without waiting to observe its phenotypic manifestations. In addition, markers, which are co-dominant (eg. Microsatellites) also help us know the allelic status of a gene and thus are very helpful in recurrent/backcross breeding programs for introgression of recessive but agronomically important gene(s). More than 25 agronomically important rice genes have already been tagged with markers and can readily be deployed by breeders in breeding programmes.

A successful use of marker-aided selection (MAS) has been shown in pyramiding four Xa-genes for bacterial blight resistance. A similar success story with respect to development of bacterial blight resistant rice cultivars through marker assisted selection has been reported by the research group at Punjab Agricultural University, Ludhiana. DRR, Hyderabad has also been working towards this objective and breeding lines of the elite cultivar 'Samba Mahsuri' with three bacterial blight resistance genes (*Xa21, xa13 & xa5)* are ready for field evaluations and preliminary tests suggest that these lines do possess excellent BLB resistance along with grain quality and yield similar to that of Samba masuri. This material has been developed through an Inter-Institutional collaboration between Centre for Cellular and Molecular Biology, Hyderabad and Directorate of Rice Research, Hyderabad.

Genetic engineering for rice improvement

Genetic transformation is another tool that promises to revolutionize Indian rice production scenario. The most important advantage of transgenic technology is the capacity to mobilize useful genes from non-rice gene pool to rice with least disruption to rice genome. Ever since the publication of the first reports on successful production of transgenic rice plants of Japonica in 1988, a large number of rice varieties have been introduced with agronomically and economically important genes. Direct DNA transfer methods such as protoplasts, biolistic method and Agrobacterium-mediated methods are being used routinely in rice transformation in the biotechnology laboratories across the world including India. Transgenic indica rice tolerant to biotic stresses such as insect pests and disease causing organisms like viruses, fungi and bacteria have been developed and tested by research groups worldwide Transgenic rice with herbicide resistant gene has also been tested under field conditions.

In India, transformation studies initially involved standardization of various gene transfer techniques. The marker genes freely available in public domain to most researchers like *gus* and *hygromycin* resistance were widely used for confirmation of transformation events. Subsequently, genes that confer resistance to pest or disease were targeted and within a few years, Nayak and co-workers reported the development of first transgenic rice with Bt gene in 1997. Since then, several groups started working on transfer of different genes into important genotypes of rice, most notably the introduction of *Bt* genes such as *cry1A(b)*, c*ry1A(c)* to obtain resistance against yellow stem borer. Research groups in India have recently succeeded in transferring *Bt* genes into indica rice cultivars such as IR64, Karnal Local and Pusa Basmati using *Agrobacterium* strategy. Similarly, work is progressing in development of transgenic rice resistant to bacteria leaf blight and sheath blight using constructs with *Xa21* and Thaumatin like proteins. Production of transgenic plants of cv. Chaithanya possessing *gna* lectin gene which confers resistance against sucking insect pest of rice has been reported.

Engineering rice to survive adverse abiotic stresses is also receiving attention. The abiotic stresses, which limit rice yields, include Salinity, alkalinity, drought and cold. Traditional breeding has contributed significantly to salinity tolerance and salt tolerant varieties like CSR10, CSR11, CSR27, CSR30 etc. have been developed in India. But unlike biotic stress resistance where a single gene conferred resistance can effectively combat the pest/disease, abiotic stress tolerance is complicated due to the involvement of many genes. Studies using molecular markers basically aim at tagging and mapping of genes/QTLs associated with abiotic stress tolerance. Once tightly linked markers are available for such QTLs associated with the tolerance traits can be pyramided in the background of a popular high yielding cultivar. Genetic engineering is another promising biotechnology approach for developing rice cultivars with enhanced abiotic stress tolerance. It is beyond doubt that transgenic technology offers more powerful solutions for incorporation of complex traits like abiotic stress tolerance compared to traditional breeding approaches.

Nutritional quality improvement is another area where genetic engineering is playing a critical role. Considering the inadequacy of rice with respect to human nutritional requirement and the non-availability of enough genetic variation in rice gene pool with respect to nutritional traits, researchers worldwide have targeted deployment of transgenes from other taxa for nutritional improvement of rice. Three genes - two from daffodil and one from a bacterium *Erwinia uredovora* – have been used to provide the biosynthesis pathway for the production of beta-carotene, a precursor of Vitamin A, in rice. Transgenic rice, known popularly as Golden Rice, has already been produced through transformation on a japonica rice variety, T309 and recently in an indica rice IR64. Since the inventors of the technology have donated it free-of cost to developing countries like India, Department of Biotechnology and Indian council of Agricultural Research have formalized a programme to transfer the beta-carotene biosynthetic traits to locally popular Indian rice varieties through marker assisted backcross breeding and genetic transformation. Directorate of Rice Research, Hyderabad, Indian Agricultural Research Institute, New Delhi, University of Delhi, South Campus, New Delhi and Tamilnadu Agricultural University, Coimbatore have been entrusted with the responsibility of developing Indian version of 'Golden rice'.

Ferric chelate reductase gene allows plants to absorb more iron from soil, thus, widening the scope of rice varieties with high iron uptake. Similarly soybean Ferretin genehas been cloned into rice and have reported two-fold increase in iron content in rice grains. It has been reported that a thermo-tolerant phytase gene from *Aspergillus fumigatus* has been transferred to rice and this has resulted in tremendous increase in iron content in rice grains due to degradation of iron chelating phytic acid by the phytase enzyme. Similarly, over expression of cystein-rich protein, which increases the cysteine content that may substantially degrade phytate during food preparation and digestion, is another exciting development in using biotechnology for nutritional improvement.

Transgenic technology is also being employed to attempt to convert rice from C3 to C_4 plant. It is hoped that through this the photosynthetic efficiency and consequently, the yield can be increased tremendously. The researchers at the Washington State University have made efforts in engineering C_4 photosynthesis pathway, using an *Agrobacterium*-mediated transformation system. They have independently introduced into rice three maize genes encoding the C_4 photosynthetic pathway enzymes: phosphoenolpyruvate carboxylase (PEPC); pyruvate orthophosphate dikinase (PPDK); and NADP-malic enzyme (ME). The transgenic rice plants expressed high levels of these genes and the maize enzymes remained active in rice plants. Most importantly, PEPC and PPDK transgenic rice plants exhibit higher photosynthetic capacity than untransformed plants, mainly due to an increased stomatal conductance (i.e., more atmospheric CO_2 becomes available for fixation). Preliminary field trials conducted in China and Korea also show 10-30 percent and 30-35 percent increases in grain yield for PEPC and PPDK transgenic rice plants, respectively. A further enhancement of the photosynthetic capacity of rice will require engineering a limited C4 pathway of photosynthesis by simultaneously expressing the three previously mentioned key enzymes in proper cellular compartments. Ultimately, for the most efficient operation of the pathway to concentrate CO_2 around Rubisco in the leaf, the concomitant installation of Kranz leaf anatomy will be essential.

Application of Genomics for Rice Improvement

Similar to DNA marker technology and rice transgenics, rice genomics is another area full of prospects. The developments in the last five years have been explosive and we now have a complete sequence of the rice genome. As the rice genome is being completely sequenced, biotechnologists have started a systematic assessment of the phenotypes resulting from the disruption of putative gene sequences with genetic resources such as mutants, near-isogenic lines, permanent mapping populations, and elite and conserved germplasm. Functional genomics, to a large extent, is analogous to the extensive germplasm screening that has allowed the extraction of useful traits in conventional breeding programs, yet with DNA sequence level precision on a global genome scale. The judicious utilization of the sequence information through functional genomic analyzes will certainly offer solutions to many a breeding problems through means hitherto not thought of. The availability of rice genome information is the foundation for the identification of orthologous genes in cereals and also facilitates the sequencing of other cereal genomes. An international collaboration was established for completion of rice genome sequencing and to coordinate the concerted utilization of sequence information for the benefit of humankind. This initiative called the International Rice Genome sequencing Project (IRGSP) is publicly funded and has 8 countries as its members. IRGSP has recently released completion of rice genome sequencing to ten-fold redundancy.

Crop and Resource Management

Crop and resource management research intensified with the introduction of management and input responsive, photo-insensitive plant type based high yielding rice varieties. The latter provided ample opportunities for increasing cropping intensity depending on the resources available and developed, indicating the need for development of management technologies for intensive and efficient use of resources and inputs to realize the yield potential with enhanced factor productivity of evolved rice varieties and the production system. Combination of cultural and input management strategies involving identification of nutrient efficient varieties, integrated management of nutrients with balanced use of inputs, appropriate crop residue and organic/green manuring practices, use of modified fertilizers and production potential of cropping systems and their sustainability were some of the areas of research pursued.

The unique system of soil puddling for rice establishment, weed and water control not only benefited rice growth and nutrition, but also favoured loss of nutrients like nitrogen through several means from the system resulting in low N use efficiency. Rice derives more than two-thirds of its total N from native soil pool and about 25-35 percent from the applied fertilizer N. Nitrogen losses through volatilization and leaching accounted for about 50 percent from fertilizers such as urea (Rao and Shinde, 1985). Coating of urea with suitable materials to control transformation of applied N in soil reduced N loss and increased its utilization by rice. Neem cake-coated urea (NCCU) applied as basal dose performed better than split-applied prilled urea under uncontrolled water situations in diverse soil types. Neem-cake possesses both urease and nitrification-inhibition properties, and a 10-15 percent higher efficiency through NCCU than prilled urea is common. Placement of fertilizer N in the reduced zone of soil decreased gaseous loss and improved use efficiency of the applied N. Urea super-granules (USG) developed for placement at desired depth, i.e. 10-15 cm, were extensively tested across the country. The field trials indicated 6 to 30 percent higher efficiency due to basal placement of USG over the conventional split application of prilled urea. Subsurface application of urea solution in the root zone of rice 10 days after transplanting by an indigenously fabricated applicator was also found equally effective in improving use efficiency of applied fertilizer N. Under controlled irrigated systems application of N fertilizer in 2 or 3 split doses depending on the duration of the crops to match with plant requirement of modern HYVs, preferably incorporating basal dose in the soil and top dressing after draining water improved N use efficiency (Rao and Kundu 1995). About 26 percent of N efficiency was attributed to poor water control generally encountered in rainfed low land systems. Real time N management guided through chlorophyl meter or leaf colour chart enhanced N use efficiency substantially and saved 20-30 percent of N fertilizer.

Water management showed strong interaction with the efficiency of applied N as well as that of water. While rotational irrigation at 7 day interval resulted in significant yield reduction and increase in N loss through ammonia volatilization showing seasonal variations (Rao, 2002), a 4- day cyclic irrigation optimized water use with no loss of grain and applied N. A net saving in irrigation water to the extent of 18-24 percent could be achieved in transplanted irrigated rice with rotational irrigation resulting in substantial improvement in water use efficiency (DRR, 2003). Rice varieties differ in their response to nutrient and water management indicating importance of choice of varieties for integration to ultimately reach high input and resource use efficiency. Rice varieties like Swarna, Rasi, IET 15342, IET 11771, IET 12884 and hybrids were observed to be more efficient in utilizing nitrogen while Rasi, IET 12884 and hybrids recorded higher water use efficiency by 22 percent over continuous submergence.

Grain yield response to phosphorus application is substantial in most of acid and heavy clay soils. Dipping of rice seedlings in super phosphate soil slurry before transplanting or nursery application of P proved effective in terms of cost reduction with no yield loss and saved nearly 40 percent of P fertilizer, while as P source, DAP or ammonium polyphosphate (APP) proved superior to SSP for their higher P use efficiency. Application of mixture of phosphate rock and SSP or phosphate rock alone (applied 2-3 weeks before planting or sowing) were efficient P sources for rice particularly in acid soils of pH 6.0 or below. Varieties such as Rasi, Vikas etc, showed considerable tolerance in low soil P fertility and also responded to P application indicating choice of such varieties for different levels of crop management.

Management of potassium (K) involves its application in single or split doses depending on soil type and crop/variety demand. In high rainfall areas with coarse-textured soils, split application of K (half at planting and half at panicle-initiation stage) gives higher efficiency. Based on the research findings, split application of K in rice has been recommended in Andhra Pradesh, Kerala, Orissa and Uttar Pradesh. Benefits of split application of K in rice have also been realized in West Bengal and North-Eastern hills regions. The productivity of rice hybrids is improved by split application of K (basal and at PI stage) to support high grain filling demand of the hybrids. In intensively cultivated rice crop systems with total productivity of more than 10-12 t/ha it is preferable to apply higher (25-50%) dose of K to maintain nutrient balance in the system and prevent its depletion for sustaining long term productivity of the system. Recycling of rice residues not only supplied substantial K into the system thereby saving fertilizer K, but also maintained favourable soil quality and its productivity.

Almost half of the rice growing soils are deficient in Zn. It was found that Zn deficiency in rice can be alleviated by applying 50 kg $ZnSO_4$/ha at transplanting once in 2 or 3 seasons. However, the optimum rate varies with the type of soil and its deficiency status, variety and method of Zn application. Rice yields decline appreciably with a 10-20 days delay in Zn application on Zn-deficient soils. Broadcasting and mixing of $ZnSO_4$ into soil is the most efficient method. Mid-season correction can be done with foliar sprays of 0.5 percent $ZnSO_4$ solution. In salt affected soils it is advisable to double the dose of $ZnSO_4$.

Scarcity of labour and increasing wages make the manual weeding less efficient and uneconomical. Several herbicides like butachlor, oxadiazon, anilophos and oxyflurofen were found effective in controlling common weeds in lowland rice. Recent research has shown that use of herbicide combinations like butachlor + 2, 4-D Na, anilophos + 2, 4-D EE, pretilachlor + 2, 4-D EE, bensulfuron- methyl + butachlor etc. control wide spectrum weed flora and were cost effective in transplanted rice. Butachlor + safener, Pretilachlor + safener or Pyrazo sulfuron ethyl gave best control of weeds in direct-sown rice under puddle conditions.

Rice crop established by broadcast sowing of seeds under puddled conditions generally suffers from uneven growth and gives lower yields than a transplanted rice crop. Line sowing of sprouted seeds at 20 cm spacing with a row seeder produced excellent crop stand and similar yields to that of transplanted crop. Varieties like 'Vikas', 'IET 9994', 'IET 10402' and 'Jalapriya' performed well.

Crop Protection through Integrated Pest Management

Major focus of recent research in field of crop protection has been on development of specific pest and multiple pest resistant rice varieties for different rice ecologies, studies on variability of pest populations, identification of new effective and eco-friendly chemicals, development and evaluation of alternative strategies for regulation of pest populations, development of weather based pest forewarning systems and formulation and on farm evaluation of integrated pest management packages for various situations.

New sources of broad spectrum resistance against insect pests and their biotypes have been identified in a concerted network program. The results of this multi-location evaluation covering 15,820 accessions of germplasm during 1993-99 period identified 276 accessions resistant to blast, 50 to bacterial leaf blight, 28 to sheath blight, 282 to brown planthopper, 74 to stem borer and 395 to gall midge. Utilising some of these sources of resistance breeding for multiple pest resistance was intensified. Some of the recently release pest resistant varieties display multiple resistance.

Effective, economic and eco-friendly insecticides for need based application in the managements of insect pests have been identified. These include fipronil (75 g a.i. ha^{-1}), carbosulfan and chloropyriphos (1.0 kg a.i. ha^{-1}) as granular applications and sprays of fipronil (50 g a.i. ha^{-1}) against pest complex and of thiomethoxam and imidacloprid (25 g a.i. ha^{-1}) against leaf and planthoppers. Commercial neem formulations were found to be moderately effective against BPH, WBPH, GLH and leaf folder under greenhouse conditions.

Among the newer formulations of fungicides evaluated capropamid 30 SC for blast, thifluzamide 2 SC for sheath blight and Opus 12.5 SC for false smut were highly effective. Procarb and copper hydroxide (3 g/1) were effective against false smut. Isoprothiolane, kasugamycin, tricyclazole and carpropamid were identified as effective and blast specific fungicides and Validamycin, thifluzamide, and hexaconazole as sheath blight specific fungicides. Among biopesticides, Achook and Neemgold for blast control and AFF-3 for sheath blight control appeared promising.

Biocontrol agent like fluorescent *pseudomonas* strain controlled sheath blight disease either alone or in combination with carbendazim. A combination of fluorescent *Pseudomonas* sp. and *Bacillus* sp. was also effective in controlling sheath blight. But *Pseudomonas florescense* was found ineffective in reducing blast and in preventing yield loss. An entomopathogenic nematode *Rhabditis* sp., was found to be potential against stem borer and leaf folder. *Trichogramma japonicm* and *T. chilonis* has shown promise against stem borers and leaffolders.

Use of sex pheromone in population monitoring and pest control through mass trapping and mating disruption has been demonstrated on large scale FLDs and on farm trials.

Effective integrated disease management strategies against blast and sheath blight involved cultivation of resistant varieties and need based fungicide application. For BLB it involved cultivation of resistant varieties and judicious nitrogen application. IPM package for insect pests under rainfed rice production systems consisted of resistant variety, balanced fertiliser application, release of Trichogramma egg parasitoids, use of pheromone traps against yellow stem borer and need based application of pesticide as the situation demands. Such a package effectively checked pests and resulted in increasing net profits of the farmers.

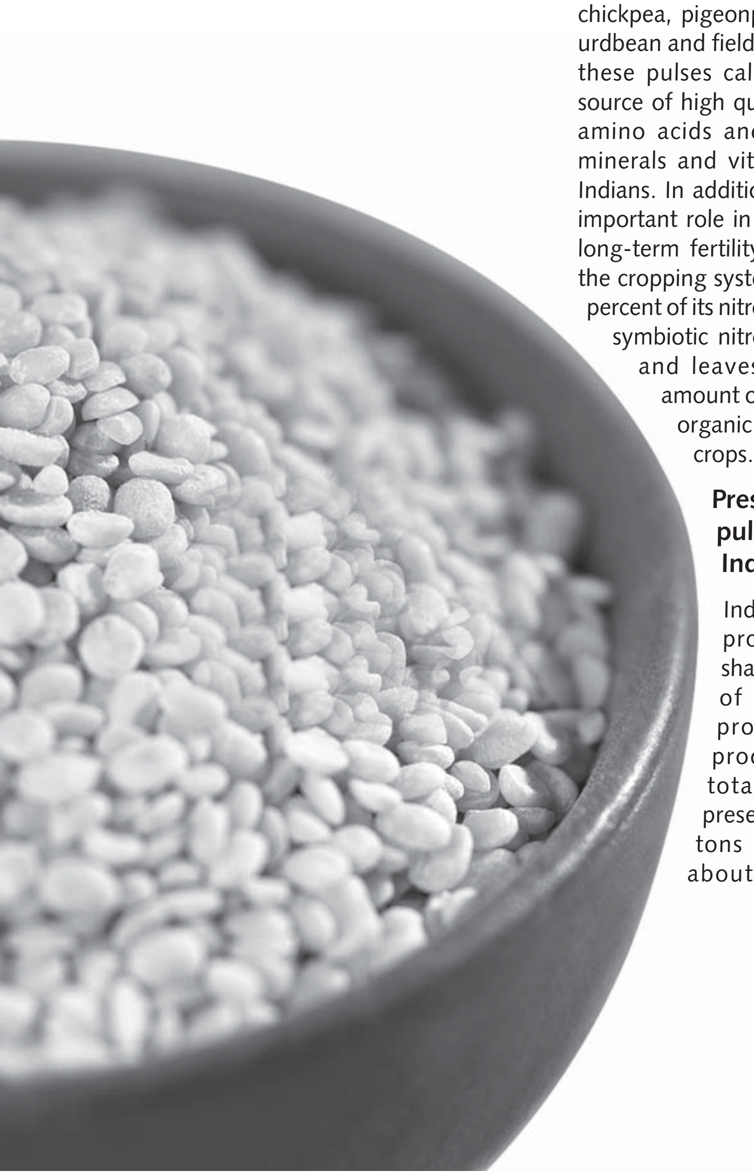
Conclusions

In view of the growing demands from the ever increasing population, it is imperative that rice production and productivity need to be enhance through the existing yield barrier through application of modern tools of science. Anticipatory, strategic and basic research on rice needs to be strengthened with financial and policy support to meet the future challenges of climate change, water crisis and land and labour shortages. It is also equally important to make rice cultivation more profitable with less labour.

** Project Director, Directorate of Rice Research, Hyderabad*

Impact of Climate Change on Production of Pulses in North India: A Concern

By P. S. Basu *



Pulses, an integrated component of food crops for millions of India

Pulses are one of the important segments of Indian Agriculture after cereals and oilseeds. These pulses constitute chickpea, pigeonpea, lentil, mungbean, urdbean and fieldpea. The split grains of these pulses called *dal* are excellent source of high quality protein, essential amino acids and fatty acids, fibres, minerals and vitamins for millions of Indians. In addition, pulses also play an important role in improving soil health, long-term fertility and sustainability of the cropping systems. It meets up to 80 percent of its nitrogen requirement from symbiotic nitrogen fixation from air and leaves behind substantial amount of residual nitrogen and organic matter for subsequent crops.

Present status of pulses production in India

India is the largest pulse producing country and shares approx. 75 percent of global chickpea production. The production potential of total pulses in India is presently about 15 million tons covering an area of about 24 million hectare majority of which falling under rainfed condition where irrigation facilities are inadequate or not available. Pulses are predominantly grown under resource poor and harsh environments frequently prone to drought and other abiotic stresses. These crops are extremely important to be consumed as supplementary protein diet as well as improving soil health by enriching nitrogen and organic status. In spite of the fact that pulses are wonderful crops among all foodgrains, even though they are least preferred by farmers to grow because cereals are more remunerative. Pulses are considered as high risk or orphan crops being neglected since long even after green revolution. As a result, the productivity of the pulses in India is sufficiently low even less than 1 ton per hectare compared to wheat and rice. To meet the demand of pulses, India is at present importing about 3 million tons, therefore the country as a whole is short of about 3 million tons of pulses. To increase the pulse production to the tune of about 18 million tons from existing 15 million tons in future appears to be a difficult target as pulses are being constantly pushed towards non-hostile environments where other crops can not be grown. Another major constraints of pulse production in India is drastic climate change, the impact has now been realized as a major threat for expansion of pulses in north India.

2007-08	
Production	: 14.77 million tons
Area	: 23.63 million ha
Yield	: 637 Kg/ha
Import	: 2.83 million tons
Export	: 0.27 million tons

Table 1: Present Status of Pulses in India

Pulse growing states of India and changing scenario

The major producers of pulses in the country are Maharastra (19%), Madhya Pradesh (17%) , Andhra Pradesh (11%) , Uttar Pradesh (11%), Rajasthan (11%) followed by Karnataka (9%) which together share about 78 percent of total pulse production while remaining 22 percent is contributed by Gujarat, Chhattisgarh, Bihar, Orissa and Jharkhand. The. major pulses of northern India are. chickpea, pigeonpea, lentil, fieldpea, mungbean and urdbean

The Indogangetic plains of northern India , once considered as the pulse basket of India is showing a declining trend in pulses area which are quite heavily replaced by wheat , rice and maize due to better irrigation facilities. The six northern states e.g. Rajasthan, Haryana, Punjab, Uttar Pradesh, Bihar, Jharkhand are together contributing about 30 percent of total area and 27 percent of total production of the country as per 2007-08 Agricultural statistics data. The present trend revealed that area under pulses declined from 10.12 million hectare to 8.16 million hectare (about 20%) in north India. Among major pulses grown in north India, chickpea suffered maximum loosing 63 percent area from 4.98 million hectare to 1.85 million hectare. It is a serious concern for sustainability of agro-ecosystem of northern India.

Annual growth rate in food grain production in north India

Annual growth rate of rice steadily increased followed by wheat which could be primarily due to wide irrigation facilities in north India particularly Punjab, Hisar etc. Pulses suffered a major setback with a drastic negative growth rate followed by coarse cereals. Importantly , pulses and partly coarse cereals are constantly being replaced by cereal crops specially rice.

The trend showed that among pulses , chickpea areas are declining to a great extent and also production of winter pulses (chickpea, fieldpea, lentil etc) under rainfed is more pronounced than Kharif pulses (mungbean and urdbean).

Impact of global warming on production of pulses

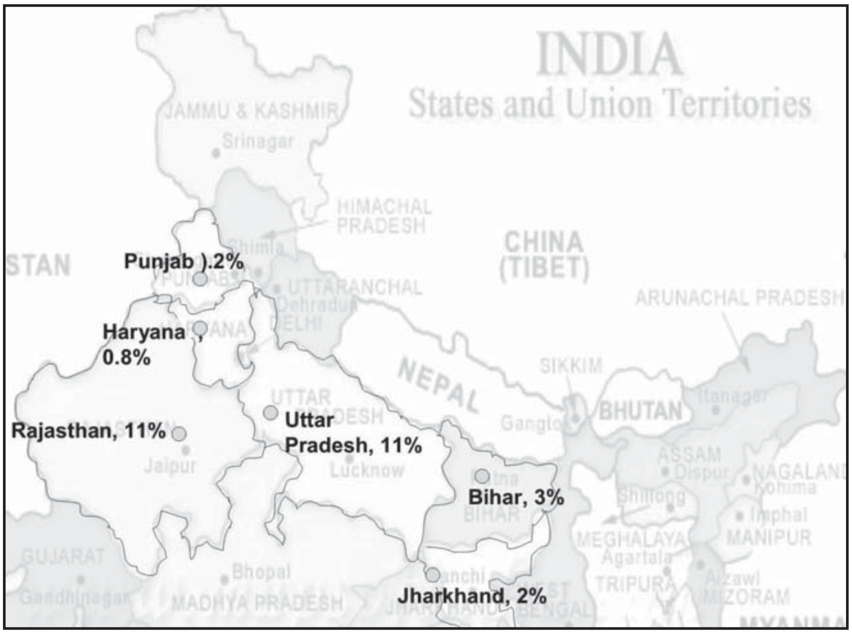


Fig 1: Contribution of six northern states towards pulse production in India (percent of total pulse production of India)

Northern States	Area (m ha)	Production (m t)	Yield (kg/ha)
Rajasthan	3.87	1.55	401
Haryana	0.17	0.10	602
Punjab	0.03	0.02	804
UP	2.15	1.58	731
Bihar	0.61	0.50	818
Jharkhand	0.41	0.31	736
Total North India	7.24	4.06	560
All India	23.63	14.77	625

Table 2: Area, Production and yield of pulses in northern states of India during 2007-08

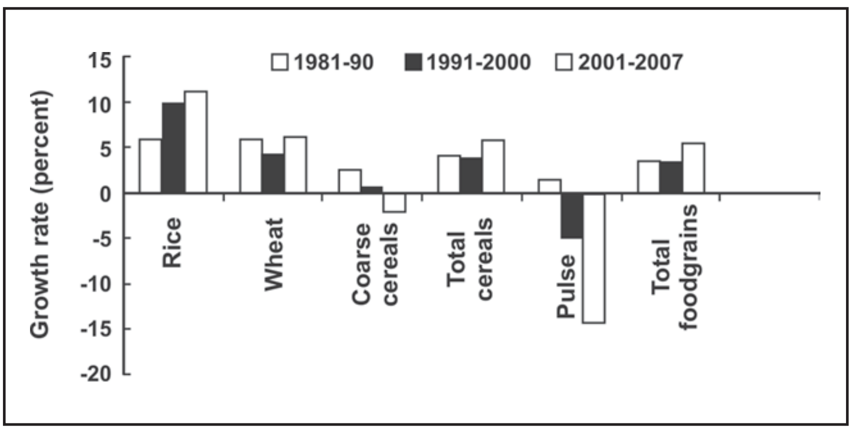


Fig 2: Annual growth rate in foodgrain production in northern region

According to the available reports, India is most vulnerable to climate change. Intergovernmental Panel on climate change (IPCC) projected that after 2050, temperatures would rise by 3-4 degrees over current levels. Major impacts of climate change will be on rain fed crops which account for nearly 60 percent of cropland area. Pulses are occupying the major share of rainfed agriculture in the country. Reduction in yields as a result of climate change are predicted to be more pronounced for rainfed crops being cultivated in Indo-gangetic plains under limited water supply situations because there are no coping mechanisms for rainfall variability. The predicted changes in temperature and their associated impacts on water availability, pests, disease, and extreme weather events are all likely to affect substantially the potential of pulse production.

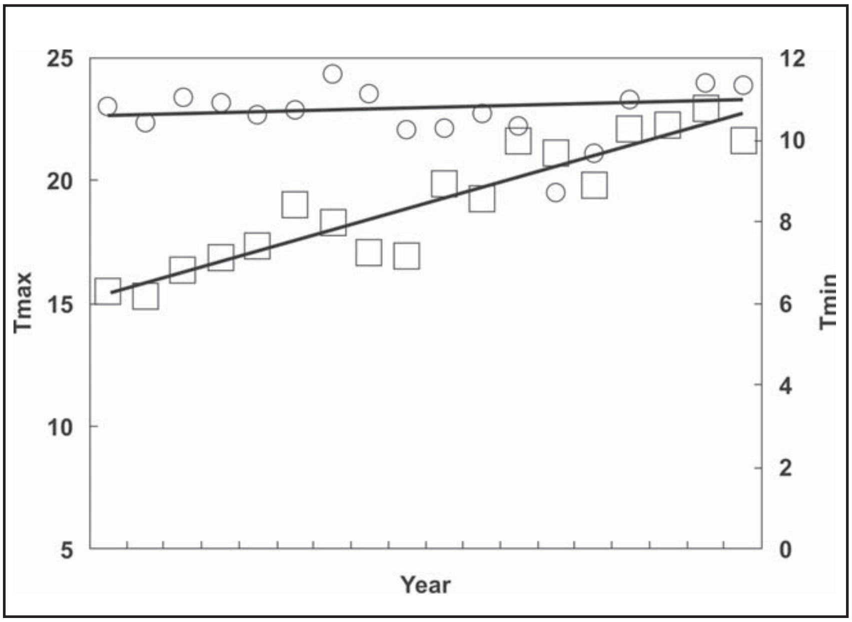


Fig 3: Trend of Temperature (max/min): Northern India

Evidence of climate change in north eastern plain zone as an example

Nearly two decades of temperature data at Kanpur on maximum/minimum temperature during pod filing stage (January-February) showed that minimum temperature of the winter night increases more than the day-time maximum (Fig 3). During reproductive phase of the chickpea the day temperature maximum in the month of March 2008, abruptly increased to 41^{0}C which was detrimental to pod setting and abortion (Fig 4).

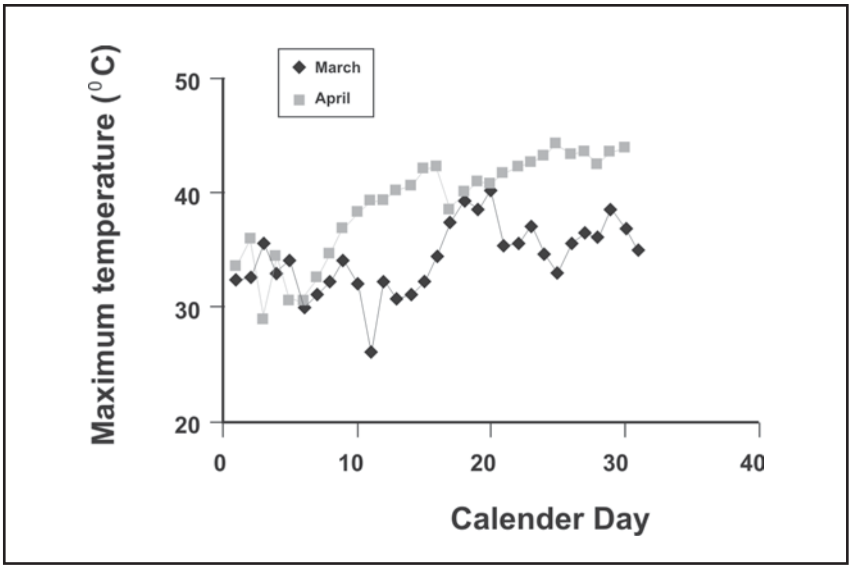


Fig 4: Maximum day temperature during March-April, 2008

Most critical inputs for enhancing pulse productivity in changing scenario of climate change

The impact of climate change on pulses is quite indirect and appears to be more serious. Present climate pattern may likely to induce frequent drought or drought like situation. Rainfed agriculture is expected to suffer severe water crisis due to delayed monsoon, uneven distribution and above all complete failure of rain as a result of climate change. For the past few decades average rainfall in rainfed conditions is inadequate to sustain agricultural productivity and particularly rainfed agriculture is pushing towards desertification. Analysis of daily rainfall data over India during the period 1951–2007 reveals an increased propensity in the occurrence of "monsoon-breaks" over the subcontinent. Annual rainfall, especially during winter and monsoon months (June to July), has decreased in over 68 per cent of the country, claims a recent study by Indian Institute of Tropical Meteorology, Pune. Scientifically, it has not yet been well understood, how present climate change affecting the rainfall pattern, however, practically it has been realized that rainfed crops have been suffering recurrent moisture stress. Major climatic changes due to global warming would lead to erratic and decreased rainfall, said RK Pachauri, chairman of the Intergovernmental Panel on Climate Change (IPCC). The *El-nino* effects and abnormal increase in Indian and Arabian sea surface temperatures have been found to be associated with changes in South-west monsoon and recurrence of drought events in India. The rainfall in northern plains, however, will become more uncertain compared to central and southern India.

Adaptability of pulses in diverse climates

Major pulses such as chickpea, pigeonpea, lentils grown under rainfed are subjected to multiple stresses such as drought, high and low temperatures, high solar radiation, salinity and water logging. The adverse situations will more pronounced if the present trend in climate change will continue as projected through various weather prediction models. To cope with these adverse abiotic factors, pulses have wide adaptive mechanisms such as very deep rooting system in pigeonpea and chickpea, high degree of dehydration tolerance, phenotypic plasticity, wide ranging sensitivity towards photothermoperiods and higher moisture retention capacity. All these attributes enable them to thrive well under any non-specific abiotic stresses and provide them to adapt in diverse climatic conditions such as from tropical, sub-tropical and temperate conditions. The water requirement of pulses is about one-fifth of the requirement of cereals, though, response of different pulses vary towards diverse climatic conditions as per their genetic make up.

Geographical shift in area of pulses

Cool-season winter pulses under northern plains of India gradually shifting towards "Warm winter" climates. This is primarily because of – asymmetric pattern of warming that is night-time minimums increasing more rapidly than daytime maximums. This trend will continue in the future.

There has been a significant change in the scenario of pulses cultivation in India during the past three decades. The expansion of irrigated agriculture in northern India has led to displacement of chickpea with wheat in large area. There has been a shift in chickpea area from the cooler long-season environments to warm short-season environments.

Total pulses area of about 10.83 million hectare in north India averaging over five years period from 1971-75 declined to 8.16 million hectare during the period of 2006-08. On the other hand, area of pulses increased from 11.34 to 15.01 in central and south India during the same three decades. Among pulses, chickpea area decreased more than 50 percent from north India during 2003-08 considering the base year 1971-75. While area, production and yield of lentil, another cool-season legume in Uttar Pradesh remained stable over a long period. Productivity of pigeonpea (Arhar) in north India remained stable inspite of the fact that about 25 percent decrease in area observed within four decades. Contrary to this, area of cultivation of mungbean and urdbean has increased almost double in north India along with significant increase in the productivity of these two summer crops. The major reasons for increasing both area and productivity in these two summer/kharif crops could be due to incorporation of many short duration varities grown as catch crops in various cropping systems under irrigated condition of north India.

Chickpea (*Cicer arietinum* L.) is a cool-season legume well adapted within temperature range of 30/15^{0}C (day maximum and night minimum) for optimum growth and pod filling. The northern plains of India once represented a potential production zone for chickpea due to long winter period favouring high biomass production and pod filling. However, the crop in this region is now adversely affected by climatic change, showing a trend of increasing minimum night temperature more than that of maximum day temperature. The asymmetric pattern of temperature rise resulted in a warmer winter, less dew precipitation and heavy evapo-transpirational water loss. The crop often experiences abnormally high temperature (>35^0 C) and atmospheric drought during reproductive stage.

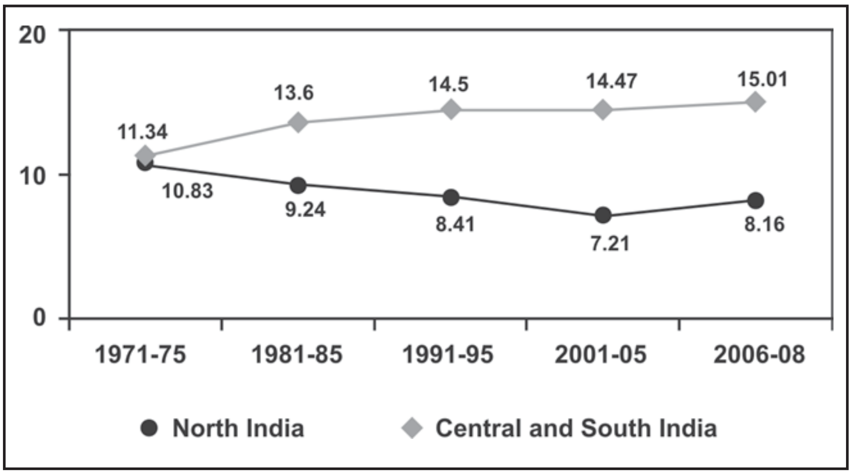


Fig 5 : Geographical shift in area of total pulses

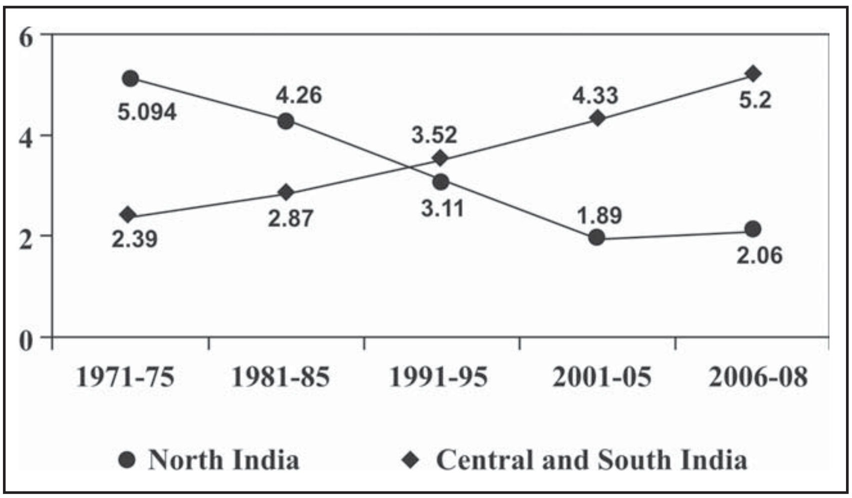


Fig 6: Geographical shift in area of Chickpea

Productivity of long duration pulses varieties.

Earlier long duration chickpea (gram) varieties have been introduced for northern plains by plant breeders that flower late and podding continued till end of the march or April beginning. This particular long duration features have been inherited keeping in view of past environment in northern India which remained cooler and support good growth , pod setting and produce higher yield. Now, these long duration varieties during the reproductive phase are subjected to unprecedented high temperature beyond a threshold level which exceeds the tolerance limit of chickpea. As a result, even leading chickpea variety released for north India BG 256 started showing significant reduction in the grain yield. Another pulse crop fieldpea, considered to be most cold tolerant species among pulses grown during *Rabi* in northern plains, has virtually lost its yield potential and probably this crop is most adversely affected as compared to others. Fieldpea is highly sensitive to heat stress and hot weather often prevails during podding stage is a serious concern for limiting productivity of fieldpea in north India under present scenario of climate change. Among pulses, pigeonpea is very sensitive to abrupt fluctuations of temperatures either lower or higher sides leading to massive flower drop during exposure to such temperature extremities. This negative impact of temperature extremities is, however, largely compensated by regular fresh flush of flowers that keep on appearing during the developmental stages concomitant with favourable temperatures.

Under long term strategies, several initiatives can be taken such as, breeding and popularization of region specific short duration pulses with combined tolerance to ascochyta blight and cold., development of extra large seeded *kabuli* chickpea varieties, short duration pigeonpea varieties for sequential cropping with wheat

Temperature extremities – consequences

Vegetative growth or pre-anthesis biomass production in most of the pulses in northern plains has been already noticeably decreased as a result of rise in temperature during early growth stages. The chickpea varieties bred for northern plains were well adapted to cool winter and were medium to late flowering types while those adapted to warm central and south India are early and short duration. These short duration genotypes adapted to warm central and south zones thus tend to escape terminal drought and high temperature and mature before onset of severe stress. On the other hand, the productivity of medium to late chickpea genotypes adapted to cooler environments of northern plains had been earlier reported to be higher than the central and south zones by virtue of longer crop duration, moderate temperature during grain filling and larger biomass accumulation has been reported to be declining over the years.

Extreme and unpredictable weather condition in northern plains of India are the major driving force destabilizing the productivity of rainfed pulses . Adverse consequences of low temperature on chickpea are clearly visible in Punjab areas during winter which leads to folding and bending of apical tip, necrosis and massive reduction in the pollen germination and growth of pollen tubes. While high temperature lowers the fertility of pollen, induces forced maturity and seed size reduces drastically.

Region specific biotic and abiotic factors

In north India, low and high temperature above threshold level of tolerance in pulses particularly chickpea and pigeonpea (<7^0C and >35^0C) , erratic and deficient rainfall during monsoon months, increase in the salinity following excessive irrigation using groundwater, severe incidence of disease and pests like Ascochyta blight, Botrytis grey mould, wilt, root rot and weed menance etc are some of the threatening events realized recently.

In contrast to north Indian climate, Central and South India are gradually becoming hostile environment for pulses. Moderate temperature during initial growth phase, availability of region specific well-adapted pulse varieties, limited option to change cropping system due to lack of irrigation facilities, high moisture retention capacity of wide spread black soil of southern India, requisite physico-chemical properties to sustain growth of pulses and relatively low disease incidence and weed menace are some of the positive factors associated with geographical shifting of pulses from North India to central and south India.

Reasons for reduction in pulses area in North: Summary

Critical analysis of the north Indian environments revealed that agroecosystem of this regions is becoming fragile and posing a potential threat for pulses cultivation. Some of the major underlying reasons for deteriorating conditions are as follow:

- Extensive cultivation of rice-wheat cropping system in these regions due to heavy irrigation facilities replacing pulses.
- Farmers choice shifted towards more remunerative crops under heavy irrigation.
- Over-use of groundwater (71% of total water used for irrigation) enhancing salinity and making non-hostile environment for pulses
- Increased incidence of Ascochyta blight aggravated with low temperature.
- Excessive fertilizers, pesticides and irrigation deteriorated soil quality, porocity, aeration, texture, organic matter, reducing native rhizobium population and thus inhibiting root proliferation.
- Fast depletion of micronutrients (Zinc, Sulphur and boron) from soil due to continuous cultivation of exhaustive crops in the region.
- Little scope to break the disease cycle and restore the soil health as a result of cereal-cereal cropping system.
- Inadequate rainfall amount during monsoon season causing frequent initial moisture deficit that eventually retards poor or delayed germination, slowing down the biomass production. For the past two decades monsoon rainfall in the entire north zone remained deficient or significantly deviated.
- Asymmetric pattern of temperature increase i.e. night minimums is increasing more rapidly than day time maximums.
- High yielding long duration pulses varieties bred for northern conditions are not coping with recent climatic changes with too low temperature at initial growth and abrupt high temperature during reproductive phase.

Strategies for increasing pulse production in north India

The short and long term strategies could be made in order to revive the declining pulse area in north India. Some of the short term strategies are crop diversification and diversion of high water requiring crops to less water intensive crops., promoting pulses in light-textured and shallow soils, replacement of low yielding low value coarse cereals to high yielding high value pulse crops, promote intercropping or mixed cropping in dry areas with pulses, popularization of existing production technologies through extension network.

Under long term strategies, several initiatives can be taken such as, breeding and popularization of region specific short duration pulses with combined tolerance to ascochyta blight and cold., development of extra large seeded *kabuli* chickpea varieties, short duration pigeonpea varieties for sequential cropping with wheat, breeding for wilt resistant, root rot complex combined with reproductive stage tolerance to high temperature, soil reclamation to prevent degradation and restore fertility and long term monitoring of hydrological cycle, soil nutrient status, climatic change through Geographical information system (GIS), remote sensing and meteorological database for these high risk zone.

Anticipated area expansion

About 7 lakh hectare of land from Punjab, Haryana, Delhi, Western UP can be expanded for pulses through diversification of rice-wheat and maize-wheat cropping system by substituting wheat by chickpea/fieldpea/lentil (1 lakh ha), popularization of munbean as catch crop after wheat (5 lakh ha)

Similarly another 7 lakh hectare of land from UP, Bihar, Jharkhand, Orissa, West Bengal and Assam can be brought under pulses through diversification of rice-wheat and rice-rice cropping system by catch cropping of mungbean (2 lakh hectare), substituting wheat with lentil (3 lakh hectare), expansion of chickpea and lentil in Diara land and Tal area of UP, Bihar in rice fallows (1 lakh hectare), Intercropping of urdbean and mungbean with spring sugarcane (1 lakh hectare)

Conclusion

Most profound effect of Global warming is a drastic change in the rainfall pattern, delayed monsoon or inadequate precipitation leading to conversion of some parts more drier and vulnerable, particularly in rainfed agroecosystem. Water crisis as a result of climate change is quite imminent. Drought will further intensified in the regions already suffering shortage of water resources .Pulses are mostly cultivated under these rainfed regions which are severely threatened by recurrent drought events which are unpredictable. No precise weather prediction models are available so far for onset of monsoon rainfall in Indian sub-continent. Pulses, are obviously is at high risk. Most immediate effect of climate change on pulse productivity is unavailability of water or rain. Therefore, breeding strategies should be made to develop more resilient crops**.** Genetic resources including wild types and land races should be well preserved to inherit useful genes for drought and heat tolerance. Effective water management practices for specific regions should be adopted to save precious water. We must intensify research on assembling genetic material for a warming India, developing short duration pulses fitting into different cropping systems.. Novel genetic combinations for tolerance to higher temperature and moisture stress can be developed through the tools of recombinant DNA technology.

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AGRI NEWS

BRIC Agriculture Ministers Meeting in Russia

The agriculture ministers of BRIC nations (Brazil, Russia, India and China) are meeting in Moscow on 26 March to discuss issues related to the food security and augment information exchange for their agricultural development, including mitigation of negative impact of climate change on it by way of modernisation. Union Minister Sharad Pawar will represent India.

This will be the first ever meeting of BRIC to discuss efforts to ensure global food security.

With a total population of 2.83 billion, BRIC nations jointly produce 40 per cent of wheat and are a source of 50 per cent pork and more than 30 per cent of poultry meat in the world. The four nations are home to 42 per cent of the global population and 32 per cent of the arable land.

The BRIC agriculture ministers will discuss the problem of import restrictions in their countries on the agricultural produce and ways to remove them by adopting mutually acceptable standards of quality control.

BRIC group of fastest emerging economies are expecting to impart dynamism to the positive development of global economy.

P. K. Basu is India's new Agriculture Secretary

Prabeer Kumar Basu has assumed office as Union Agriculture and Cooperation Secretary. Basu belongs to the 1976 batch of IAS. He had been Special Secretary in the Agriculture Ministry since November 2009, after serving for over two-and-half years as Additional Secretary.

Share of Farm in GDP Shrinks

Agriculture's share in the gross domestic product pie has started to shrink alarmingly: it is down to 14.6 percent from 18.9 percent in 2004-05.

While industry has maintained its GDP — measured at factor cost — contribution at 28 percent, services carved out a bigger share at 57.2 percent. "The services sector, which has been India's workhorse for well over a decade, has continued to grow rapidly," the survey noted.

The survey has expressed serious concern over the sluggish performance of agriculture and its declining contribution to GDP since over 60 percent of the population is dependent on farm income. The report asked the government to take serious initiatives for a targeted 4 percent farm sector growth.

It called for reversing the decline in private sector investment in agriculture, saying "consistent decline in the share of private sector investment in the agriculture sector is a matter of concern". The survey suggested that this "trend needs to be reversed through the creation of a favourable policy environment and availability of credit at reasonable rates on time for the private sector to invest in agriculture." During the current fiscal, agriculture is expected to contract by 0.2 percent due to poor rain.

Record Wheat Harvest Expected

A Senior agriculture scientist in the Union Ministry of Agriculture has claimed that India is going to have the highest-ever wheat production in its history owing to good weather conditions prevailing during the current Rabi season.

Speaking at an international wheat conference in Ahmedabad, S Nagarajan said that India, the second largest wheat producer in the world after China, is expecting a wheat production of over 82 million tonnes, about 1.7 million tonnes more than the last year.

India annually consumes 76 million tonnes of wheat and estimated production will exceed the requirement.

"It is expected to be a big relief for the government as the kharif production was much below the requirement due to poor monsoon and drought in several parts of the country. Bumper wheat production might help in stabilizing the food grain prices," he said.

Giving credit to good favourable weather conditions, he said that a prolonged winter with low temperature prevailing in the wheat-producing belt of the country would lead to a 'memorable' wheat harvest in the country.

He said that low temperature coupled with good sunshine during the appropriate period would prolong the maturity period and even one day increase in maturity period meant increase in wheat production by at least 40 kilogram per hectare. "We had a very good winter during January and February favourable for wheat crop," he said.

Nagarajan said that so far the weather had been totally favourable for wheat crop. Even the winter rain in the wheat belt occurred at very appropriate time beneficial for the crop.

AGRI TECH NEWS

New Technologies can Help Crop Development

"New technologies can help the development of crops that produce significantly higher yields and crops more adaptable to climate change," a the top U.S. agriculture official said.

Speaking June 3 at a United Nations meeting of world leaders called to discuss the global food crisis, Agriculture Secretary Ed Schafer urged more investment in support of scientists and research institutions, reversing a several-year trend of reduced agricultural research funding. He also called for more access to rural credit so farmers can benefit from new technologies.

The U.S. Agency for International Development (USAID) plans to invest $150 million in new agricultural development programs with the goal of doubling food production and food trade by 2013 in countries "with the potential to become major producers in their regions," Schafer said in Rome.

By promoting new technologies, including biotechnology, and improving market information systems, distribution networks and storage facilities, countries also can improve rural economies, he said.

At a separate June 3 discussion on the benefits of biotechnology, USAID Administrator Henrietta Fore said that biotechnology-based crops currently are being grown in more than 20 countries, including India, China and South Africa.

Discussion panelists from Bangladesh, Burkina Faso and the U.N. Food and Agriculture Organization said that biotechnology also can be used in fisheries farming. The Philippines, for instance, has used biotechnology to develop a disease-resistant type of shrimp, they said.

Biotechnology and Climate Change

Biotechnology can help countries adapt to climate change, according to Schafer. The United States is leading an international effort to build an enhanced agricultural monitoring and famine early warning system, Schafer said.

Since the late 1990s, Schafer said, use of new technologies in the United States has resulted in historic increases in maize yields. Modern technology use in the United States also has resulted in a 29 percent reduction in herbicide usage and an 81 percent reduction in insecticide usage.

Schafer said all countries should abide by global trading rules agreed to through the World Trade Organization and support science-based evaluation and regulations to ensure that safe and effective technologies are available to researchers and farmers around the world.

He said the effort to solve the world food crisis must be a global one. The United States, the world's largest food-aid donor, will continue to coordinate aid efforts with United Nations agencies, other major donor countries and international institutions, he said.

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