ADVANCEMENTS IN HORTICULTURE AND AGRICULTURE
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(FOR BOTH ENGLISH AND TAMIL MEDIUM)

AGRICULTURAL DEVELOPMENT-POLICY DIMENSION

The salient features of the new agricultural policy are:

1. Over 4 per cent annual growth rate aimed over next two decades.
2. Greater private sector participation through contract farming.
3. Price protection for farmers.
4. National agricultural insurance scheme to be launched.
5. Dismantling of restrictions on movement of agricultural commodities throughout the country.
6. Rational utilization of country's water resources for optimum use of irrigation potential.
7. High priority to development of animal husbandry, poultry, dairy and aquaculture.
8. Capital inflow and assured markets for crop production.
9. Exemption from payment of capital gains tax on compulsory acquisition of agricultural land.
10. Minimize fluctuations in commodity prices.
11. Continuous monitoring of international prices.
12. Plant varieties to be protected through legislation.
13. Adequate and timely supply of quality inputs to farmers.
14. High priority to rural electrification.
15. Setting up of agro-processing units and creation of off-farm employment in rural areas.

Sustainable Agriculture

The policy will seek to promote technically sound, economically viable, environmentally non-degrading, and socially acceptable use of country's natural resources–land, water and genetic endowment to promote sustainable development of agriculture. Measures will be taken to contain biotic pressures on land and to control indiscriminate diversion of agricultural lands for non-agricultural purposes. The unutilized wastelands will be put to use for agriculture and afforestation. Particular attention will be given for increasing cropping intensity through multiple-cropping and inter-cropping.

Rational utilization and conservation of the country's abundant water resources will be promoted. Conjunctive use of surface and ground water will receive highest priority. Special attention will be focused on water quality and the problem of receding ground-water levels in certain areas as a result of over-exploitation of underground aquifers. Proper on-farm management of water resources for the optimum use of irrigation potential will be promoted.

Erosion and narrowing of the base of India's plant and animal genetic resources in the last few decades has been affecting the food security of the country. Survey and evaluation of genetic resources and safe conservation of both indigenous and exogenously introduced genetic variability in crop plants, animals and their wild relatives will receive particular attention. The use of biotechnologies will be promoted for evolving plants which consume less water, are drought resistant, pest resistant, contain more nutrition, give higher yields and are environmentally safe. Conservation of bio-resources through their ex situ preservation in Gene Banks, as also in situ conservation in their natural habitats through bio-diversity parks, etc., will receive a high priority to prevent their extinction. Specific measures will also be taken to conserve indigenous breeds facing extinction. There will be a time bound programme to list, catalogue and classify country's vast agro biodiversity.

Food and Nutritional Security

Special efforts will be made to raise the productivity and production of crops to meet the increasing demand for food generated by unabated demographic pressures and raw materials for expanding agro-based industries. A regionally differentiated strategy will be pursued, taking into account the agronomic, climatic and environmental conditions to realize the full growth potential of every region. Special attention will be given to development of new crop varieties, particularly of food crops, with higher nutritional value through adoption of bio-technology particularly genetic modification, while addressing bio-safety concerns.

A major thrust will be given to development of rainfed and irrigated horticulture, floriculture, roots and tubers, plantation crops, aromatic and medicinal plants, bee-keeping and sericulture, for augmenting food supply, exports and generating employment in rural areas. Availability of hybrid seeds and disease-free planting materials of improved varieties, supported by a network of regional nurseries, tissue culture laboratories, seed farms will be promoted to support systematic development of horticulture having emphasis on increased production, post-harvest management, precision farming, bio-control of pests and quality regulation mechanism and exports.

Animal husbandry and fisheries also generate wealth and employment in agriculture sector. Development of animal husbandry, poultry, dairying and aqua-culture will receive a high priority in the efforts for diversifying agriculture, increasing animal protein availability in the food basket and for generating exportable surpluses. A national livestock breeding strategy will be evolved to meet the requirements of milk, meat, egg and livestock products and to enhance the role of draught animals as a source of energy for farming operations and transport. Major thrust will be on genetic upgradation of indigenous/native cattle and buffaloes using proven semen and high-quality pedigreed bulls and by expanding artificial insemination network to provide services at the farmer's doorstep.

Generation and Transfer of Technology

A very high priority will be accorded to evolving new location-specific and economically viable improved varieties of agricultural and horticultural crops, livestock species and aquaculture as also conservation and judicious use of germplasm and other bio-diversity resources. The regionalization of agricultural research, based on identified agroclimatic zones, will be accorded high priority.

Application of frontier sciences like bio-technology, remote sensing technologies, pre and postharvest technologies, energy saving technologies, technology for environmental protection through national research system as well as proprietary research will be encouraged. The endeavour will be to build a well-organized efficient and result oriented agriculture research and education system to introduce technological change in Indian agriculture. Upgradation of agricultural education and its orientation towards uniformity in education standards, women empowerment, user-orientation, vocationalization and promotion of excellence will be the hallmark of the new policy.

The research and extension linkages will be strengthened to improve quality and effectiveness of research and extension system. The extension system will be broad-based and revitalized. Innovative and decentralized institutional changes will be introduced to make the extension system farmer-responsible and farmer accountable. Role of Krishi Vigyan Kendras (KVKs), Non-Governmental Organizations (NGOs), Farmers Organizations, Cooperatives, corporate sector and para-technicians in agricultural extension will be encouraged for organizing demand-driven production systems. Development of human resources through capacity building and skill upgradation of public extension functionaries and other extension functionaries will be accorded a high priority. The Government will endeavour to move towards a regime of financial sustainability of extension services through effecting in a phased manner, a more realistic cost recovery of extension services and inputs, while simultaneously safeguarding the interests of the poor and the vulnerable groups.

Inputs Management

Adequate and timely supply of quality inputs such as seeds, fertilizers, plant protection chemicals, bio-pesticides, agricultural machinery and credit at reasonable rates to farmers will be the endeavor of the Government. Soil testing and quality testing of fertilisers and seeds will be ensured and supply of spurious inputs will be checked. Balanced and optimum use of fertilizers will be promoted together with use of organic manures and bio-fertilizers to optimize the efficiency of nutrient use.

Development, production and distribution of improved varieties of seeds and planting materials and strengthening and expansion of seed and plant certification system with private sector participation will receive a high priority. A National Seed Grid will be established to ensure supply of seeds especially to areas affected by natural calamities. The National Seeds Corporation (NSC) and State Farms Corporation of India (SFCI) will be restructured for efficient utilization of investment and manpower.

Protection to plant varieties through a sui generis legislation, will be granted to encourage research and breeding of new varieties particularly in the private sector in line with India's obligations under TRIPS Agreement. The farmers will, however, be allowed their traditional rights to save, use, exchange, share and sell their farm saved seeds except as branded seeds of protected varieties for commercial purpose. The interests of the researchers will also be safeguarded in carrying out research on proprietary varieties to develop new varieties.

Incentives for Agriculture

The Government will endeavour to create a favourable economic environment for increasing capital formation and farmer's own investments by removal of distortions in the incentive regime for agriculture, improving the terms of trade with manufacturing sectors and bringing about external and domestic market reforms backed by rationalization of domestic tax structure. It will seek to bestow on the agriculture sector in as many respects as possible benefits similar to those obtaining in the manufacturing sector, such as easy availability of credit and other inputs, and infrastructure facilities for development of agribusiness industries and development of effective delivery systems and freed movement of agro produce.

Consequent upon dismantling of Quantitative Restrictions on imports as per WTO Agreement on Agriculture, commodity-wise strategies and arrangements for protecting the grower from adverse impact of undue price fluctuations in world markets and for promoting exports will be formulated. Apart from price competition, other aspects of marketing such as quality, choice, health and bio-safety will be promoted. Exports of horticultural produce and marine products will receive particular emphasis. A two-fold long term strategy of diversification of agricultural produce and value addition enabling the production system to respond to external environment and creating export demand for the commodities produced in the country will be evolved with a view to providing the farmers incremental income from export earnings. A favourable economic environment and supportive public management system will be created for promotion of agricultural exports. Quarantine, both of exports and imports, will be given particular attention so that Indian agriculture is protected from the ingress of exotic pests and diseases.

In order to protect the interest of farmers in context of removal of Quantitative Restrictions, continuous monitoring of international prices will be undertaken and appropriate tariffs protection will be provided. Import duties on manufactured commodities used in agriculture will be rationalized. The domestic agricultural market will be liberalized and all controls and regulations hindering increase in farmers' income will be reviewed and abolished to ensure that agriculturists receive prices commensurate with their efforts, investment. Restrictions on the movement of agricultural commodities throughout the country will be progressively dismantled.

TECHNOLOGIES TO BOOST AGRICULTURE PRODUCTION

Indian agriculture has been characterized by many revolutions that changed the very face of this sector. The green revolution, blue revolution, yellow revolution and white revolution have been the important milestones in Indian agriculture. One thing common in all these revolutions was the use of technology. The revolutions could not have occurred without relevant technologies. The technological led agricultural development saw India emerging as world leader in many important food commodities. Our food production which was merely 50 million tonnes at the time of independence has now reached more than 250 million tonnes. Similarly in case of livestock, we are the leading producers of the milk in the world and the largest producers of pulses.

While more than sixty percent of the population depends on the agricultural sector, yet the sector also carries the blot of farmers' suicides, high food inflation, the low yields, the climate threat and the still presence of a considerable population in the grip of below poverty line category. This is also happening at a time when we have to achieve the Millennium Development Goals in the near future. Food production has to be increased in the context of worsening land and water scarcity and climate-change-related weather shocks. The problems in agriculture are not confined to a particular territorial jurisdiction. Some of them have now become universal. Land degradation is also another important factor affecting productivity. This is despite large investments in yield-enhancing varieties.

An IFPRI reports that soil compaction alone has caused yield reduction of between 40-90 per cent in western African countries, and nutrient depletion also reduces productivity in Sub-Saharan Africa (SSA) and South Asia. Meanwhile, twenty African countries are already experiencing severe water scarcity and another 12 will face water scarcity over the next 25 years. Land degradation is worse in areas where poverty and hunger are concentrated. Further the climate change disproportionably affects smallholders as they are more likely to depend on rainfed agriculture and degraded land. All this demands renewed and vigorous efforts towards technologies for agricultural development. Broadly the different types of technologies for furthering agricultural development are as:

Resource conserving technologies: Resources are an important asset for a country. Unfortunately the non judicious use of these has put them in very critical situation. The indiscriminate use of chemicals for increasing productivity and disease controls have polluted water bodies and degraded soils. What is worrying is that there is a gender specific effect to the resource degradation. It is increasing the time required for fulfillment of female responsibilities such as food production, fuel wood collection and soil and water conservation. An array of resource conservation technologies is available. These include zero and reduced tillage. green manuring, crop rotations etc. Resource conservation technologies aim to produce more at less cost while at the same time enhancing the natural resource base and maintenance of soil quality in fairly good conditions. The input use efficiency also gets increased due to the right placement of the seeds and fertilizers at right time and at right depth. Some of the resource conservation practices areas:

- ❖ Reduction of tillage and retention of adequate surface crop residues over the soil. Zero Tillage in wheat has reported to reduce the production costs by 2000 to 2500 per hectare and 15-20 per cent saving in irrigation water. No till wheat is also more tolerant to abrupt climate changes.
- ❖ Similarly by using drip and sprinkler type of irrigation methods the more area can be brought under irrigation than the conventional irrigation methods by canals.
- ❖ The use of Farm Yard Manure (FYM) Compost, and Bio fertilizers also reduce over dependence on the chemicals led intensive cultivation. These also are beneficial for soil health, soil microorganisms and soil fertility in the long run.
- ❖ Promoting diversification of agriculture with subsidiary occupations also lead to enhancement of farm incomes and reduction of risks in case of failure of one of the components.

High yielding technologies: The green evolution of the sixties would not have occurred without the High Yielding Varieties of Wheat and Paddy. These high yielding varieties along with increased area under irrigation fertilizers saw India becoming a bread basket from once being levelled as a begging bowl. Unfortunately, presently also our yields are less comparative to the yields of crops in other countries. This has severely reduced our total production. If Indian agriculture is to remain in competition with the global agriculture it has to increase the per unit yield of its crops. This requires the development and production of seeds which have more yields, are resistant to diseases, are not susceptible to insect pest attack, and can withstand the environmental extremities Sustainable intensification of agriculture is a good alternative to avoid localized chronic food and nutrition insecurity when between 75 and 90 per cent of staple foods are produced and consumed locally.

System of Rice Intensification (SRI) has emerged as an alternative to the conventional rice growing methods. SRI uses less water, is more efficient in using available water and considerable higher yields are achieved by this method.

Unleashing the full potential of smallholders, including that of women farmers, is thus key to global food and nutrition security, creation of decent work, and sustainable agriculture Post harvest technologies: Post harvest infrastructure also plays an important role in Indian agriculture. A considerable proportion of our produce goes wasted in the absence of suitable post harvest infrastructure. A study puts this losses to the tune of rupees 44,000 crore. This can be avoided if suitable post harvest infrastructure is provided to the farmers. As most of the horticultural produce is perishable therefore immediate handling of the produce after harvest is necessary. Suitable post harvest infrastructure in terms of cold storages, processing units, road networks in inaccessible areas, establishment of local regulated markets at the Panchayat levels can give a big boost to the agriculture sector by promoting value addition and food processing. This can also help in creating employment opportunities for the others also.

Climate resilient technologies: The effects of Climate change are being witnessed all over the globe but the vulnerability of Indian agriculture to this is high. This is because a large population is dependent on agriculture and also we lack suitable coping mechanism. Already negative effects of the rising temperatures have been reported in many food crops and the situation can get further aggravated. In India agriculture is mostly in rainfed areas therefore climate resilient technologies are the need of the hour. In the country a project entitled 'National Initiative on Climate resilient Agriculture' has been going on. This aims to enhance resilience of Indian agriculture to climate change and climate variability through strategic research and technology demonstrations in most vulnerable districts of India. The basic purpose is to enable the farmers to cope up with the climatic variability through efficient management of their resources.

Technologies for drudgery reduction: Agriculture in India is prone to drudgery and women that constitute half of the work force in agriculture are more susceptible to this. Mechanization is also another important aspect for enhancing agricultural production. Unfortunately mechanization is very low in India. Farmers still operate with their traditional implements which hamper their performance. Women which constitute an important partners in this sector are still not been recognized properly. A study done in Orissa under the Project, 'Standardization of women specific field practices in rice in Orissa' revealed that women of family contributed highest hours per season in harvesting and post harvest operations (61.66).

But their condition still is deplorable deep down in the drudgery. Women do most of the operations right from the harvesting to winnowing, grading and storage. FAO estimates that giving women better access to land, inputs, and technology could increase yield by 2.5-4 per cent and reduce undernourishment by 12-17 percent. Improved farm tools and implements for reducing drudgery reduction are the need of the day. Our research efforts should also focus on relieving the women of this drudgery by developing appropriate tools that could reduce drudgery of the women engaged in this sector.

The Central Institute of Agricultural Engineering, Bhopal has developed tools such as the seed drill, seed broadcaster, seed treatment drum, hand ridges and dibblers. The marginal and small farmers despite being the major producers of food, especially in developing regions, are the majority of the world's poor people still outside the ambit of technologies and a very large proportion of the chronically undernourished. Agriculture which is not specific to growing of food crops but also includes livestock, apiculture, pisiculture, apiary, goatry forestry etc has to undergo a significant transformation in order to meet the above related challenges. This new agriculture paradigm must ensure that the small and marginal farmers be at the center stage of any technological interventions.

Boosting agriculture productivity, in particular of smallholders, is one of the most effective ways of addressing global poverty and food and nutrition security. Output growth in agriculture is more effective in reducing than poverty than the same growth emanating from other sectors. What is needed is that the appropriate technological interventions be provided to the farming community according to their agro climatic conditions.

NEW TECHNOLOGIES IN VEGETABLE PRODUCTION

In present scenario, survival of farmers, especially small and marginal farmers is challenged by continuously reduced land holdings, decreased subsidies for inputs, increased labour costs, input costs and slow increase in price per unit volume of output of grain-based crops. On the other hand, increasing urbanization, rising purchasing power and increased awareness about health benefits of vegetable consumption among economically middle and high strata of society leads to more demand for vegetables. Welfare schemes of Government of India like MNREGA, Mid-day meal scheme, Food Security Bill provides more scope for economically weaker sections of society to include nutritious and high value commodities (like vegetables) in their diet, by supporting them to invest less on food grains. Under these conditions, diversification of cropping systems with high value crops like, vegetables can be regarded as a viable option for Indian farmers to improve their incomes and the economic viability of Indian agriculture. In this context, some of the new technologies can be pivotal for promotion of vegetable production in the country. Some modern technologies related to vegetable production have been discussed here.

Development of new varieties

Since man started domesticating plants, development of new crops and their varieties for better yield, quality, resistant to diseases, pests and abiotic stresses has become a dynamic process. With the advancement in science and its applications in agriculture, the tailoring of crops became more precise and rapid. Technologies like molecular markers, tagging, sequencing, cloning etc., made it possible to isolate and study specific genes or genomic regions conferring resistance to one or more biotic and abiotic stresses. Such useful genes or genomic regions from wild relatives of crop plants are being transferred to cultivated forms with the help of marker assisted selection (MAS). Kashi Aman, a tomato variety resistant to tomato leaf curl virus has been developed by combining MAS and traditional pedigree breeding method at Indian Institute of Vegetable Research, Varanasi.

Conventional plant breeding approaches have been and always will remain the backbone of any genetic improvement strategies including vegetable crops. In addition to these, biotechnological tools enables the plant breeders to bring favourable genes, often previously inaccessible, into elite cultivars and gives unique opportunities to decrease the losses caused by insects, viruses and other pathogens, as well as to improve nutritional quality of different crops. Many vegetable crops have been genetically modified to include resistance to pests, pathogens and herbicides, and for other improved features like, slow ripening, higher nutritional status, seedless fruit, and increased sweetness. At the end, such products will be successful only if clear advantages along with safety of the products are guaranteed to both growers and consumers.

Nursery raising

Healthy nursery raising is most crucial step in vegetable production, which determines the productivity and profitability in vegetable cultivation. Vegetable nursery is a place where plants are nurtured during the early stages of growth, providing optimum conditions for germination and subsequent growth until they become strong enough to be planted in the main field. A nursery can be as simple as a raised bed in an open field or sophisticated with well equipped instruments like a glass-house with micro-sprinklers and automatic temperature control system. Seedlings can also be grown in pots filled with sterile media to reduce soil borne infection. A number of vegetables during Rabi and Zaid seasons are cultivated by transplanting method, wherein seeds are first sown in nursery beds to raise seedling and then seedlings are transplanted in the main field. The major vegetable crops which are usually cultivated through transplanting method include: tomato, brinjal, capsicum, cauliflower, cabbage, knolkhol, Chinese cabbage, Brussels sprouts, broccoli etc.

Although many of these crops can also be cultivated through direct seeding in the main field, transplanting method is highly recommended because of several advantages like intensive care during seedling stage, reduced cost of cultivation, opportunity for selection of healthy seedlings etc.

Micro irrigation

Water is very crucial component for vegetable production. Vegetables require timely and adequate irrigation for its proper growth which should be managed properly through micro irrigation system so as to promote utilization of each drop and to check the wastage of such critical input. Further, micro irrigation methods are promising methods for applying fertilizers at root zone of the crops. There by micro irrigation helps in efficient utilization of scarce and costly inputs in vegetable production. Micro irrigation is growing fast in India. About 1.3 mha land under vegetables and high value crops is being irrigated through drip irrigation in India. Further, government is providing significant subsidies through several schemes to promote micro irrigation. The nature and type of micro irrigation systems available are as follows:

Sprinkler systems: Sprinkler irrigation is a method of applying irrigation water similar to natural rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops (0.5-4.0 mm) which fall on to the plants on ground like rain water. In vegetables, this system is commercially used for irrigation of peas and sometimes for leafy vegetables. Sprinkler irrigation can also save water to the tune of 25-30% over flood irrigation.

Drip system: Drip irrigation is an effective irrigation system in terms of water conservation.

It minimizes the wastage of water by delivering the water very near to root zone. In vegetables, drip irrigation is known to save 25-70% of water depending on soil, climate, crop and variety. The irrigation efficiency of drip system is very high (85 - 90%).

Micro sprinkler system: This is a combination of sprinkler and drip irrigation. Water is sprinkled around the root zone of trees with a small sprinkler working under low pressure. Water is given only to the root zone area as in the case of drip irrigation but not to the entire ground surface as done in the case of sprinkler irrigation method.

Pulse system: Pulse system uses high discharge rate emitters and consequently has short water application time. The primary advantage of this system is a possible reduction in the clogging problem.

Biwall system: It is extruded dual chamber micro-irrigation tubing manufactured from Linear Low Density Polyethylene (LLDPE). This system is suitable for all closely spaced row crops like sugarcane, cotton, vegetables, onion, tea etc.

Bubbler system: Bubblers typically apply water on a per plant basis. Bubblers are very similar to the point source external emitters in shape but differ in performance. In this system the water is applied to the soil surface in a small stream or fountain. This technology is not much popular in India and it is presently in research stage.

Integrated pest management (IPM)

Vegetable production is challenged by many pests. Pests can include insects, mites, diseases, nematodes, weeds and vertebrate pests. To control these pests many biological agents and their bi products and array of chemicals (pesticides) are being used. The residues of these chemicals have detrimental effect on health of environment and consumers. To avoid this, a holistic approach called Integrated pest management (IPM) has been developed. IPM is a strategy that depends on a range of methods to manage pests within economically acceptable levels and causes least ecological damage. IPM mainly relies on beneficial organism (bio-control agents) to manage insect pests and, on regular crop monitoring to incorporate more preventive strategies to reduce the need for direct control practices and to ensure that pesticides are used only when needed in such a way that they complement the survival of beneficial organisms.

Vegetable cultivation under protected conditions

Production of vegetables under protected condition is the best alternative to use the land and other resources more efficiently under changing climatic scenario. By adapting protected cultivation, year round availability of quality vegetables both for domestic use and export can be assured. Protected cultivation means some level of control over plant microclimate to alleviate one or more of abiotic stress for optimum plant growth, which can be achieved in green houses, poly hoses, net house, poly-tunnels, cold frames, etc. Crop yields under these structures can be several times higher than those of open field conditions. Quality of produce is also superior and input use efficiencies are usually higher under such structures. In many European Countries, USA, Japan, China, Israel, Morocco, Turkey etc, where extreme climate reduces the choices for year round outdoor production, vegetables are being produced in protected environments. India has entered into the area of greenhouse vegetable cultivation recently and the total area under protected vegetable production is around 10,000 hectares.

Post-harvest technologies in vegetables

Although, India is the second largest producer of vegetables and third largest producer of fruits with annual production of 141 million tones and 80 million tones, respectively, it is estimated that 20 -30 percent of horticultural crop such as fruits and vegetables perish due to lack of proper methods of processing and storage. The loss in monetary term is estimated to be about Rs.20 crores annually. It is also estimated that only 2% fruits and vegetables produced in our country are being processed. In India, agro processing sector ranks fifth in the country in size and employs over 1.6 million workers (20% of nation's labour force). Processing sector has the potential to boost the rural economy and generates employment throughout the country.

Post-harvest technology is an interdisciplinary "Science and Technique" applied to agricultural produce after harvest for its protection, conservation, processing, packaging, distribution, marketing, and utilization to meet the food and nutritional requirements of the people in relation to their needs. Some of the modern post-harvest and processing techniques which can be adopted in small scale by rural people especially women are discussed hereunder.

Dehydration: The techniques of dehydration offer a highly effective and practical means of preserving horticultural produce to reduce post-harvest losses. Osmo-air drying is a simple process that can be adopted as home-scale industry by small entrepreneurs like self-help groups for preservation of vegetables for longer duration.

Hurdle technology: Innovative technologies based on hurdle techniques have been developed to give extended shelf life to high moisture foods without refrigeration. Hurdle technology treated fruits were found microbiologically safe with extended shelf life under ambient conditions in flexible pouches. The product can be eaten as such and also have the utility in preparation of salads or can be used in other food formulations.

Minimal processing: Minimal processing is an emerging technological concept, which has gained increased popularity in recent past. The technique enables global marketing of precut fruits and vegetables in pre - packaged form and the products are made for specific end uses viz., curry, salads, pies, stuffing's, toppings and garnishing. Minimal processing allows consumers to have fresh like quality fruits and vegetables with convenience.

Steeping preservation: Large quantities of vegetables during peak season of production can be preserved in steeping solution consisting of permissible chemical preservatives and other food additives, which is non-thermal and alternate to processing technology with considerable scope for adoption at rural sector by women.

Kitchen gardening

Depending on the necessity, urgency and merits, old practices may have to be promoted as new technology. Kitchen gardening (and its other forms like, container gardening, roof top gardening) is such an old practice, being promoted as new technology to combat malnutrition among poor families and to make it as healthy habit among rich families. These gardens use spare land, recycled water and organic wastes from home and add nutritional value and variety to the food basket. This is especially important in rural areas where people have limited income earning opportunities and poor access to markets. Home gardens are also becoming an increasingly important source of food and income for poor households in peri-urban and urban areas. Generally, products from kitchen garden are free from pesticide residues. If adopted in every hose hold, the practice of kitchen garden has the potential to reduce price fluctuations and makes most efficient use of natural resources.

Adopting new technologies helps vegetable sector in establishing its credentials for improving land productivity, employment generation, improving economic condition of farmers and providing nutritional security to the country. Promoting new interventions in handling, grading of vegetables from farm gate to consumer and other marketing interventions to reduce intermediaries in supply chain are highly required to promote vegetable sector in our country.

Rice-wheat cropping system is major cropping system in the South Asian food security. The billions of people depend on this system for their food. The rice-wheat system has been practiced by farmers in Asia for more than 1000 years. It has since expanded and is currently estimated at 23.5 million ha. The rice wheat system covers 13.5 million ha in South Asia: India (10.0), Pakistan (2.2), Bangladesh (0.8) and Nepal (0.5). It represents 32% of the total rice area and 42% of the total wheat area in these countries. Despite its more or less assured yield and comparative profitability over other competing crops/ crop rotations, continuance of traditionally growing of Rice -wheat cultivation over the years has resulted in severe implications for resources. The most common consequences of these are:

- ❖ Indiscriminate use of inorganic fertilizers and chemicals
- ❖ Increased cost of cultivation especially tillage cost.
- ❖ Salinity and sodicity build up in canal irrigated areas.
- ❖ Depletion of water resources in areas of good quality underground water.
- ❖ Deficiencies of nutrients in the soil.
- ❖ Hard pan formation and reduced organic matter content in the soil.
- ❖ Degradation of ecosystem.
- ❖ Loss of biodiversity
- ❖ Late sowing of raai crops.
- ❖ Nutrient mining

In the Indo-Gangetic Plains (IGP), which stretches across these four countries, rice is usually grown in the wet summer (May/June to October/ November) and wheat in the winter (November/ December to February/March). Although rice wheat cropped area in the IGP is irrigated or has assured rainwater in sub-humid regions, the soils and crop management undergo drastic changes during the two cropping seasons. Several yield reducing and yield limiting factors, together with delayed planting of wheat and transplanting of rice; energy, labour, and other input shortages; resistance of the weed and crop residue burning have contributed to the stagnating or declining production, productivity and sustainability of this system. To overcome of these problems new resources conserving technologies should be adopted, these are following given.

Resource-conserving technologies

Resource-conserving technologies are defined here as any practice that improves the efficiency of use of natural resources, including water, air, fossil fuels, soils, inputs, and people. This can only be possible if the planting techniques of rice or wheat crops are improved resulting to saving of time, cultivation cost and irrigation water. Resource conserving technologies can be helpful in the achievements of major goals.

Late planting is a major problem in most rice wheat areas. To improve system productivity, the wheat crop must be planted at the optimal time.

The other major cause of late wheat planting is the long turnaround time between rice harvest and wheat planting. Long turn around can be caused by many factors, including excessive tillage, soil moisture problems (too wet or too dry), lack of animal or mechanical power for ploughing, and the priority farmers place on threshing and handling the rice crop before preparing land for wheat.

Coupled with the problems of late planting of wheat is the problem of poor germination and plant stands. Most farmers in the IGP have sown wheat by broadcasting the seed into plowed land and incorporating it by another plowing. Part of the reason for this is residue management problems in fields following rice. The loose straw and stubbles are raked and clog the seed drills. Broadcast seed results in seed placement at many different depths and into different soil moistures, with resulting variable germination. The problems of late planting and poor plant stand have been addressed by promoting various resource-conserving tillage and crop establishment techniques described below (Gupta and Seth (2007).

Technology used in rice cultivation

(a) Laser levelling

All the technologies can benefit from levelled fields. This is being promoted to improved water efficiency. However, when this is combined with zero tillage, bed planting and non-puddled rice culture, plant stands are better, growth is more uniform and yields higher. Use of permanent bed systems and zero tillage results in less soil disturbance and reduces the need for future levelling. India is also starting work on this and promoting levelling in farmer fields in Haryana and Western UP.

(b) Brown manuring

Traditionally, dhaincha (Sesbania aculeate) is sown during mid May for the purpose of green manuring and is incorporated 45 days after sowing before transplanting of rice crop. However, due to dearth of irrigation water during summer, majority of the rice farmers are not able to raise the green manure crop. Brown manuring is a new innovative approach where both rice and Sesbania crops are seeded together and allowed to grow for
25-30 days.

(c) Direct Seeded Rice

It is a cost-effective rice establishment method where dry seed is drilled into the nonpuddled soil. It includes proper land leveling and effective weed control measures.

Benefits of Direct Seeded Rice

- Avoids repeated puddling, preventing soil degradation and plow-pan formation
- Facilitates timely establishment of rice and succeeding crops as crop matures 10-15 days earlier
- Saves water by 35-40%, reduces production cost by Rs 3000/ha, and increases yields by 10%
- Saves energy: labour, fuel, and seed
- Solves labour scarcity problem and reduces drudgery of labours

(d) System of Rice Intensification (SRI)

SRI is a combination of several practices those include changes in nursery management, time of transplanting, water and weed management. Its different way of cultivating rice crop though the fundamental practices remain more or less same like in the conventional method; it just emphasizes altering of certain agronomic practices of the conventional way of rice cultivation. All these new practices are together known as System of Rice Intensification (SRI).

€ Leaf colour chart (LCC)

Nitrogen (N) fertilizer is one of the major input in rice production. Inadequate or excessive amount or improper timing of nitrogen application may lead to large nitrogen losses and poor nitrogen-use-efficiency in rice fields. New tools are needed to synchronize N application with crop demand and minimize nitrogen losses to the environment. Leaf Colour Chart is simple and inexpensive tool that could improve farmers decision making process in nitrogen management for rice. Leaf Colour Chart is a tool that helps farmers in deciding the right time of N application to paddy crop.

Technology used in Wheat Cultivation
Surface Seeding

Surface seeding is the simplest zero-tillage system being promoted. In this tillage option, wheat seed is placed on a saturated soil surface without any land preparation. In either case, surface seeding entails no soil disturbance whereas typical zero-till systems cause minimal soil disturbance during opening of the slits. Surface seeding can be done either by seed broadcasting method or by placing seed/fertilizer in rows by machine.

Zero Tillage

Zero Tillage is defined as farming where the soil is left relatively undisturbed from harvest to planting. During the planting operation, a narrow seedbed is prepared or holes are drilled in which seeds are planted. Disc openers, coulters and other tools used to create the seedbed or slots leave most of the ground surface and previous crop residue largely undisturbed. Weeds, insects and disease outbreaks are commonly managed with some combination of herbicide application, crop rotation, fire, sanitation or other biological means. Zero Tillage is considered a management tool under what is known as conservation tillage practices.

Benefits of Zero Tillage

Zero Tillage significantly reduce soil erosion, helping preserve the long-term productive capacity of the managed fields. The practice can alwso increase farm profits by reducing tillage costs without reducing crop productivity.

Furrow Irrigated Raised Bed (FIRB) Systems To reduce water use, conserve rain water and improve productivity, the system of raised bed planting of crops may be advantageous in up and low land situations. In bed planting systems, wheat or other crops are planted on raised beds. This practice has increased dramatically in the last decade. Farmers have given the following reasons for adopting the new system:

- Management of irrigation water is improved.
- Bed planting facilitates irrigation before seeding and thus provides an opportunity for weed control prior to planting.
- Plant stands are better.
- Weeds can be controlled mechanically, between the beds, early in the crop cycle.
- Wheat seed rates are lower.

- ❖ After wheat is harvested and the beds are reshaped for planting the succeeding soybean crop.
- ❖ Herbicide dependence is reduced, and hand weeding and roguing is easier.
- ❖ Less lodging occurs.
- ❖ System of Wheat Intensification (SWI)

In this condition, better management of soil with low seed rate is the best option for reducing the cost of production for wheat. SWI is a technology of wheat production which is based on manipulation of soil environment with minimum external input and very low seed rate. Therefore the problem of low productivity of wheat in hilly region of Nepal could be addresses by SWI techniques but some more work should be done to make this technology more suitable in local socio economic and ecological conditions.

Crop residue management

The practice of burning of left over paddy stubble is most commonly followed with the sole objective to reduce the cost of seed bed preparation for sowing the succeeding wheat crop. On the other hand, this practice not only reprieve the soil of recycling of left over crop residues but also causes environmental pollution. The paddy and wheat residues amount to as much as 7-8 tons per ha per year. The residues, when burnt during land preparation, generate CO_2, which pollutes the air, deprives organic matter of soils and reduces supply of fodder for livestock.

Legume in rotation

Short duration legume crop should be used in rice wheat cropping system to maintain soil health, soil micro flora, to reduce the nitrogen management to the next crop and reduce the cost of cultivation.

The use of cultivation in agriculture that increase the per capita income, increase production and lower costs, soil health management, increase biodiversity, conserve environment, reduce the level of global warming gasses and improved farmer livelihoods. The profession of agriculture may profitability and productive in yield as well as soil health concern.

BIOTECHNOLOGY- AN EFFECTIVE TOOL FOR FOOD SECURITY IN INDIA

World population continues to expand at about 80 million people per year and it will reach at 10 billion in 2060 from the 7 billion at present. The requirement for food security remains an overpowering anxiety for developing countries, where under nutrition of large population remains a continuous problem.

There is little or no scope to expand the existing agricultural footprint without further damaging natural eco systems. At the same time, climate change is leading to production uncertainty to meet these challenges. Biotechnology has emerged as a tool to the increases global agriculture production and for protecting the environment through the reduced use of agro-chemicals like pesticides, fertilizer and rodenticides.

Through biotechnological tools, scientists are able to the produce a plant with new advantageous and desirable characteristics through inserting one or more gene into a plant. Biotechnology is being used to achieve many goals and improvements in the plant which were attempted through conventional methods. Biotechnology gives scientists the ability to isolate genes and introduce new traits into the foods without simultaneous introducing undesirable traits. Because of increased precision offered by the bioengineered methods, the risk of introducing detrimental traits is reduced.

Global status of the transgenic /GM crops

The global area of genetically modified (GM) agricultural crops has seen a tremendous increase since its first adoption in 1996 to 148 million hectares in 2010. A variety of traits have been introduced in plant species which include: herbicide resistance, pest resistance, viral resistance, slow-ripening, fungal and bacterial resistance, abiotic stress tolerance (drought, salinity, temperature etc), quality improvement (starch, protein and oil), value-addition (vitamins, micro- and macro-elements), pharmaceutical and therapeutic proteins, edible vaccines, industrial importance and phytoremediation. The first commercial transgenic crop variety 'Flavr Savr' of tomato was released in 1994 and it was engineered for slow ripening character. So far, 184 GM extents have been authorized for the food and feed production in the 59 countries. In the 2010, the planting area of GM crops reached 148 million hectares and 15.4 million farmers cultivated GM crops and experienced socio economic and environment in the benefits among them, 14.4 million farmers were small scale, resource poor the farmers in the development nations. A list of the leading countries in the biotech crops is given in Table.

Country	Area (million ha)	Genetically modified crops
USA	64.0	Soya bean, maize, cotton, rape squash, papilla
Brazil	21.4	Soya bean , maize, cotton
Argentina	21.3	Soya bean and cotton
India	8.4	Cotton
Canada	8.2	Rape, soybean. sugar beat
China	3.7	Cotton, tomato. poplar, soybean
Piragua	2.2	Soya bean
South Africa	2.1	Maize, soya bean, cotton

Along with food security it is also important to achieve nutritional security, which is particularly relevant to developing nations like India. There are several examples of biotechnological attempts to develop nutritionally rich crop varieties. The most celebrated example is the development of 'Golden rice'. Three different genes phytoene synthase (psy), lycopene cyclase (lyc) and phytoene desaturase (crtI) have been introduced into japonica rice through agro-bacterium mediated transformation that has resulted in synthesis of beta carotene which is the precursor of vitamin A in human body.

Status of transgenic crops in India: Efforts are being made in India since early eighties to develop transgenic crops. The first transgenic crop commercialized in India was Bt cotton in 2002. Currently, six transgenic events of Bt cotton (>1000 hybrids) are available and the success story of Bt cotton cultivation has been reviewed. Fruit borer resistant Bt brinjal hybrids developed by Mahyco and varieties developed by UAS, Dharwad and TNAU, Coimbatore have been cleared by GEAC with respect to environmental safety and biosafety. In India besides Bt cotton and Bt brinjal, a no. of multi-institutional programme have been launched which include development of the transgenic resistance for stem borer in tomato and rice tungro in rice, development of the nutritionally improved potato with the balanced amino acid composition using a protein from the amaranth.

Development process of GM crops: The main steps involved in the development of GM crops are:

1. **Isolation of the gene(s) of interest:** Existing knowledge about the structure, function or location on chromosomes is used to identify the gene(s) that is responsible for the desired trait in an organism, for example, drought tolerance or insect resistance.

2. **Insertion of the gene(s) into a transfer vector**: The most commonly used gene transfer tool for plants is a circular molecule of DNA (plasmid) from the naturally occurring soil bacterium, Agrobacterium tumefaciens. The gene(s) of interest is inserted into the plasmid using recombinant DNA (rDNA) techniques.

3. **Plant transformation**: The modified A. tumefaciens cells containing the plasmid with the new gene are mixed with plant cells or cut pieces of plants such as leaves or stems (explants). Some of the cells take up a piece of the plasmid known as the T-DNA (transferred- DNA). The A. tumefaciens inserts the desired genes into one of the plant's chromosomes to form GM (or transgenic) cells. The other most commonly used method to transfer DNA is particle bombardment (gene gun) where small particles coated with DNA molecules are bombarded into the cell.

4. **Selection of the modified plant cells**: After transformation, various methods are used to differentiate between the modified plant cells and the great majority of cells that have not incorporated the desired genes. Most often, selectable marker genes that confer antibiotic or herbicide resistance are used to favor growth of the transformed cells relative to the non-transformed cells. For this method, genes responsible for resistance are inserted into the vector and transferred along with the gene(s) conferring desired traits to the plant cells. When the cells are exposed to the antibiotic or herbicide, only the transformed cells (containing and expressing the selectable marker gene) will survive. The transformed cells are then regenerated to form whole plants using tissue culture methods.

5. Regeneration into whole plants via tissue culture involves placing the explants (plant parts/cells) onto media containing nutrients that induce development of the cells into various plant parts to form whole plantlets. Once the plantlets are rooted they are transferred to pots and kept under controlled environmental conditions.

6. Verification of transformation and characterization of the inserted DNA fragment. Verification of plant transformation involves demonstrating that the gene has been inserted and is inherited normally. Tests are done to determine the number of copies inserted, whether the copies are intact, and whether the insertion does not interfere with other genes to cause unintended effects. Testing of gene expression (i.e., production of messenger RNA and/or protein, evaluation of the trait of interest) is done to make sure that the gene is functional.

7. Testing of plant performance is generally carried out first in the greenhouse or screen house to determine whether the modified plant has the desired new trait and does not have any new unwanted characteristics. Those that perform well are planted into the field for further testing. In the field, the plants are first grown in confined field trials to test whether the technology works (if the plants express the desired traits) in the open environment. If the technology works then the plants are tested in multi-location field trials to establish whether the crop performs well in different environmental conditions. If the GM crop passes all the tests, it may then be considered for commercial production.

8. Safety assessment. Food and environmental safety assessment are carried out in conjunction with testing of plant performance.

Types of GM crops

Genetically modified crops have been broadly divided into eight sub-groups:

i. Herbicide resistance (canola, soybean, cotton, rice, wheat, carnation, chicory, corn, sunflower, tobacco and sugar beet)
ii. Insect Pest resistance (cotton, corn, rice, tomato and potato)
iii. Viral resistance (papaya, squash, plum and potato)
iv. Slow-ripening and softening (tomato and melon)
v. Improved oil quality (canola and soybean)
vi. Male sterility (canola and corn)
vii. Pigmentation pattern (carnation)
viii. Reduced nicotine content (tobacco)

The dominant technology applied so far is herbicide tolerance in the soybeans, which account for 70% of the world wide soybean production. GM maize having herbicide tolerance (HT) and insect resistance covers 30% of the global maize area and 24% of the production.

Herbicide resistance: Herbicide tolerant crops resolve many problems because they include transgenes providing tolerance to the herbicides like Roundup (chemical name: glyphosate) or Liberty (glufosinate). These herbicides are broadspectrum, meaning that they kill nearly all kinds of plants except those that have the tolerance gene. Another important benefit is that this class of herbicides breaks down quickly in the soil, eliminating residue carry-over problems and reducing environmental impact. Herbicide tolerant varieties are popular with farmers because they enable less complicated, more flexible weed control. These varieties are commonly marketed as Roundup Ready or Liberty Link varieties.

Insect resistant: “Bt” short for Bacillus thuringiensis, is a soil bacterium whose spores contain a crystalline (Cry) protein. In the insect gut, the protein breaks down to release a toxin, known as a delta-endotoxin. This toxin binds to and creates pores in the intestinal lining, resulting in ion imbalance, paralysis of the digestive system, and after a few days, insect death.

Virus resistance: Expression of viral genes encoding coat protein, non-structural proteins and use of antisense technology are some of the strategies that have been effectively used in plants to confer resistance against viral diseases. The transgenic expression of viral structural protein stops replication and spread of the infecting virus and the plant shows resistance reaction. The biggest success story of transgenic mediated virus resistance is the cultivation of transgenic papaya expressing capsid protein in Hawaii, which virtually saved the papaya industry from dreaded threat of ring spot disease.

Broad objective of promoting biotechnology in agriculture include:

1. Conservation of biodiversity and the sustainable use of its biotic resources.
2. Production of high yielding, drought and pest resistant seeds suited to different agro climatic zones.
3. Improving the quality and production potential of the stock popularity and aquatic eco system.
4. Promotion of the environment safe technologies for pollution abatement, especially treatment of urban waste and industries effluent.
5. Generation and use of different types of bioenergy.
6. Promotion and cultivation of the medicinal and aromatic plant, and the processing and value addition of their produce.

Applications of the biotechnology in crop production

1. **Nutritional enhancement**: The prevalence of iron deficiency is estimated to be about 30% of the world population making iron the most efficient nutritional disorder worldwide. Food bio-fortification has been considered the best long term strategy for the prevention of anemia.

2. Screening for the noble microbes and their bioprospecting for saline tolerant, nitrogen fixing, phosphate solubilising and plant growth promoting rhizobacteria (PGPR) has a potential as bio-fertilizers and pseudomonas strains as bio-control agents in the agriculture.

3. **Bio prospecting:** Bioprospecting is basically the search for the commercially valuable biochemical and genetic resources in the plants, animals and microorganism. In India, it can be done by bio-resource mapping and monitoring of bio-logical durability.

4. **Eco-enterprise development:** Low-cost units are established for the production of the biological software's for the promotion of the organic farming. The production of eco-enterprise like Trichoderma viride, Trichogramma and Pseudomonas florescence are successfully managed by the women SHGS.

5. **Animal husbandry**: Development of recombinant diagnostic and vaccines for the major diseases in animals are some of the potential areas. Modern biotech can be applied to solve the problems of diseases that can be transferred from the animals to humans such as bird flu and swine flu, dwindling feed resources and rising cost of the veterinary drugs.

6. **Fisheries and aquaculture**: Biotech practices like sex reversal, molecular proofing are used to diagnose disease and to the determine purity of fish stock.

7. **Food processing**: The greatest application of the biotechnology in the food industry is microbial formulations of bacteria that can be genetically engineered to the produce specific enzymes for different purposes.

8. **Crop improvement**: Modern biotechnological tools have involved advanced tissue culture technologies such as those used in the development of the new rice for the Africa and the production of the balance in the Kenya.

Biosafety, food safety and the environment:

There are several widely accepted environmental drawbacks associated with the rapid deployment and widespread commercialization of GM crops in large monocultures, including:

Product	Trait	Function
Drought tolerant rice	HARDY (HRD) genus from Arabidopsis reducing transpiration and enhancing photosynthesis assimilation	Increase water use efficiency, adaptive increase of root mass under water stress.
Drought tolerant tobacco	Delayed drought induced leaf senescence	Retained water content and photo synthesis resulting in minimum yield loss under drought 30% water requirement
Drought tolerant maize	Expression of glutamate dehydrogenate gene from E. Coli	Germination and grain biomass production under drought increases
Salt tolerant rice	A QTL (salt) associated with drought resistance	Allows close to normal yield under high salinity situation (Bangladesh)

- The spread of transgenes to related weeds via crop-weed hybridization
- Reduction of the fitness of non-target organisms through the acquisition of transgenic traits via hybridization
- The rapid evolution of resistance of insect pests such as Lepidoptera to Bt
- Accumulation of the insecticidal Bt toxin, which remains active in the soil after the crop is ploughed under and binds tightly to clays and humic acids;
- Disruption of natural control of insect pests through intertrophic-level effects of the Bt toxin on predators.
- Unanticipated effects on non-target herbivorous insects (i.e., monarch butterflies) through deposition of transgenic pollen on foliage of surrounding wild vegetation.
- Vector-mediated horizontal gene transfer and recombination to create new pathogenic organisms.

Biotechnology and climate change

In the present context of global climate challenges, biotechnology has the potential to the increase food production, reduce pesticide damage to the environment, sunscreen natural resources and create alternate fuels from the renewable sources and create alternative fuels from the renewable source without comportment the environment and increase farm income. Conservation agriculture techniques are efficient tools to help in the modelling climate change by the preventing wind, water erosions and loss and ground moistures, impressing soil biodiversity, increasing soil fertility and reduce carbon emissions.

During the year 2007 alone, greenhouse gas emission reduction from the use of biotech crops were equivalent to the removal of nearly 6.3 million cars from the road for one year. GM crops are globally grown by reduced pesticide application to the extent of nearly 224 million kg and thus eliminating the adverse impact of pesticide on environment and reducing 14% greenhouse gas emission by 960 million kg of CO_2. Biotechnological products showing longer term promise for the adaption to the climate change are given in Table.

Conclusion

Biotechnological tools can play a very crucial role in development of new crop varieties which can adopt better under changing environment conditions. Biotech crops are globally accepted for reduced pesticide application and thus improving the environment quality. Biotechnology could be used to enhance global food production, food security and nutritional security in a sustainable manner. This technology can be used to manage the environmental hazards like drought through development of drought tolerant crops and thus help the farming community.