PRESIDENTIAL ADDRESS

Role of Agriculture in Alleviating Poverty and Malnutrition

Ajay Parida
M. S. Swaminathan Research Foundation,
III Cross Street, Institutional Area,
Taramani, Chennai 6000 113, India

Esteemed Chairman of the Session, Prof. M. S. Swaminathan, and the Awardees, Distinguished Participants and Ladies and Gentlemen.

At the outset allow me to express my deep sense of gratitude to the fraternity in Agriculture and Forestry Sciences for having elected me as Sectional President. It is not only a great honour but a rare privilege to be part of the continuum of many stalwarts in the field that nurtured and illuminated the path of Agricultural Research, Education and Policy development in our country over a century. The Their sustained efforts have enabled the transition of India to a food secure nation as well as developing and nurturing a cadre of scientific, technological and committed professionals shaping agriculture growth and development in the country. Their unstinted efforts have brought us to the level where we feel securely anchored today. I realize my limitations, and still venture to step into their shoes.

The agricultural sector is at the heart of the economies of many developing countries, including India. Agriculture accounts for a large share of GDP, employs a large proportion of the labour force, represents a major source of foreign exchange, supplies the bulk of basic food and provides subsistence and other income the growing population. The strong linkages it has with other economic sectors - forward and backward - provide significant stimulus for growth and income generation. Therefore, significant progress in promoting economic growth, reducing poverty and enhancing food security cannot be achieved without developing a vibrant agriculture system with concurrent attention to the human potential and productive capacity of the agriculture sector. These in turn will enhance contribution

of agriculture to the overall economic and social development. Therefore, a strong and effective food and agricultural system forms the primary pillar in the strategy of overall economic growth and development, and more specifically for the developing nations.

In the Indian Context, agriculture has played and will continue to play a dominant role in the growth of Indian economy. It represents the largest sector contributing to around 20 percent of the GDP, the largest employer providing more than 60 percent of the jobs and is the prime contributor for enhancing the living standards for seventy percent of India's population particularly those living in the rural areas. These factors together with a strong determination to achieve self-sufficiency in food grains production, with appropriate use of science, technology and policy option as well as participation and involvement of large pool of farmers and farm workers, have ensured a high priority for agriculture sector in the successive development plans of the country. The green revolution of 1970's pushed the productivity growth that enabled the transition of the country to a food secure nation. However, in the recent years, growth in agriculture has stagnated relative to other sectors. Last year the agricultural sector grew at a rate of 2.7%, relative to about 10% growth in both the service and industry sector. Agricultural incomes are lower and the rate of growth is slower than incomes in other sectors. This has resulted in persistence of unacceptable levels of hunger, poverty and malnutrition among large section of India's population.

Indian has been witnessing a rapid urbanisation trend. According to the State of World Population Report 2007, it is estimated that by 2030, people living in urban areas in India will be to the tune of 40.68 per cent. However, despite rapid urbanisation in India, about 70% of the population still lives in rural areas. India is still a land of small-scale farmers: about half of all farms are less than 1ha in size, and another 20% are less than 2 ha. There are strong, direct relationships between agricultural productivity, hunger, and poverty. Most poverty is concentrated in rural areas, especially amongst small scale farmers and landless families. The slow pace of poverty and hunger reduction points to an urgent need for

strategies that better target the areas where poor people live and the activities on which their lives depend.

Despite progress made since the 1996 World Food Summit that set the goal of halving the number of undernourished people by the 2015, serious food insecurity persists in many parts of the world. Although more food is being produced worldwide than ever before, some 800 million people are still chronically malnourished and lack purchasing power even the food is available in the market. Ensuring household food and nutrition security, increasing farm productivity and income, alleviating poverty and minimizing production risks on account of climate change, are among the major challenges facing the country that predominantly depend on agriculture, besides ensuring overall natural resource management and environmental security.

Fostering a rapid and sustained agricultural and rural growth and development has remained and continue to be among the key priorities of the Government of India. Although agriculture contributes only about 20% of India's total gross domestic product (GDP), its importance in the economic, social, and political fabric of India goes well beyond. The large number of poor agricultural households and their income vulnerability are major concerns among policymakers. These concerns, in turn have been the guiding force in developing both agricultural policies and public expenditures strategies in agriculture. India made significant advances towards achieving its goals of rapid agricultural growth, improving food security, and reducing rural poverty during the last four decades. To a large extent, sustained emphasis on food grain production growth had enabled India to achieve food grain self-sufficiency, eliminating the threat of famines and acute starvation in the country. The increased demand for rural labour generated by agricultural intensification in the 1970s to 1980s raised rural wages in combination with several poverty alleviation programmes and low food price, contributed to, reduced poverty in rural areas. Aided by sustained, although much slower, agricultural growth, the rural poverty rate has considerably declined. However, the slowdown in agricultural growth is a major concern. Hence, the Government of India's National

Agricultural Policy and its Plans place high priority on raising agricultural productivity to achieve an annual agricultural growth rate of 4 percent.

Despite these achievements, the major challenge that faces India is in ensuring that Agriculture becomes a vehicle for change. It would require attentions to the factors that adversely affect the agriculture growth and their impact on reducing hunger, poverty and malnutrition. Some of these are discussed below:

Harnessing potential of Agrobiodiversity

Agricultural biodiversity is the biodiversity associated with agricultural ecosystems and indispensable in sustaining key functions for food production. It is the outcome of the interactions among the environment, genetic resources and the agricultural practices. The diversity of cropping pattern, as witnessed today is the result of years of crop husbandry practices followed by the farming communities. The faming communities over the years, have identified and managed higher levels of agricultural biodiversity those also provided source material for reduced pest incidence, improved soil nutritional levels, crop pollination, and hydrological functions. Agricultural biodiversity also provided significant values in conserving and managing diverse genetic resources that formed the basis for the development of new crop varieties and animal breeds. Despite seminal contribution of the cultivators and conservers, the biodiversity rich regions represent the regions those inhabit poor and marginalised people. This dichotomy of poverty of people and prosperity of nature is a major concern in the development process.

Proper management of agricultural biodiversity is required in order to preserve the key-functions of agro-ecosystems. Rapid loss of wild relatives and landraces of many crop plants has been a global concern. It is generally viewed that loss of every gene and species will linit our option for further improvement in productivity and prosperity. There is the need to develop a wide range of practices which are location specific and differ according

to the degree of human intervention in the natural system. These systems range from the highly managed *ex situ* gene and seed banks to *in situ* conservation which takes place in farmers' field or undisturbed wilderness areas (e.g. maintaining wild relatives of cultivated species in wilderness areas). These two approaches are largely complementary: the *ex situ* collections preserve a static set of genetic resources, while *in situ* efforts preserve a dynamic process of evolution, as genetic resources adapt to changing pressures from natural and human selection.

Agricultural biodiversity underpins agricultural productivity and therefore makes a critical contribution to agricultural sustainability. Local crops and the role of intra-specific crop diversity for income generation, dietary diversification and ecosystem health deserve greater attention in research and conservation efforts. Numerous studies have pointed out that agro-ecosystems and agro-biodiversity contribute to sustainable livelihood securities at the local, national and global levels. They provide a range of goods and services including food, fodder, climate change mitigation, biodiversity conservation and water quality options. Farmers and farming communities have a significant role to play in the preservation and conservation of these resources and ecosystems and using them sustainably in enhancing the productive agriculture systems, through integration of locally available and adapted genotypes.

In spite of concerns relating to the depletion of agro-biodiversity, awareness of their potential uses is increasing. With growing pressure on land, demand for crops for use other than food production, such as fuel production and biofortified food will result in increasing the demand for agro-biodiversity. This will require much understanding and integration of locally adapted food crops those are nutritionally rich, underutilised and have resilience to the climate change scenarios. This pressure will affect the way in which farming will be carried out in the future. It is, therefore, crucial that farmers are encouraged to continue farming rather than moving to non-farming activities as the mainstay of their livelihoods. Adding value to the resources and integration of off-farm livelihood enterprises will enhance the livelihood

of the agrarian communities through diversification of their income sources. There is a need to follow a system that integrates conservation, cultivation, consumption and commerce as a continuum ensuring an economic stake in conservation efforts at the local levels. This would essentially require developing mechanisms for an incentive system for farmers.

Biodiversity loss in agricultural landscapes affects not just the production of factors of agriculture systems, but also a range of ecological services supporting clean water supplies, habitats for wild species, and human health. Research is needed to understand the predicted effects of biodiversity loss on environmental change as well as to show how the utilization and conservation of biodiversity can provide ecosystem services to satisfy both current and future needs. It is also essential to establish the scientific of the trade-offs between food production, biodiversity conservation, ecosystem services, and human well being in agricultural landscapes. The key research area that requires immediate and urgent attention include: (a) assessing status and trends of biodiversity in agricultural landscapes and the anthropogenic drivers of biodiversity change; (b) identifying the goods and services provided by agrobiodiversity at various levels of biological organization, e.g., genes, species, communities, ecosystems, and landscapes; and (c) evaluating the socioeconomic options for the sustainable use of biodiversity in agricultural landscapes. Adoption of innovative biodiversity-rich farming systems and farming practices that utilize and conserve biodiversity may ultimately improve environmental quality and limit agricultural expansion. Conservation of biodiversity and human knowledge from traditional agroecosystems is an urgent priority, to support human societies that rely on its cultural services, and for its potential for solving agricultural problems, now and in the future.

Future biodiversity research will be assisted by a number of advances in the scientific approaches. Through a series of global efforts, genomic structure for several major crop species and their wild relatives have now been described and these information provides an uncommon opportunity that can be used for describing biodiversity at the genetic level and its use in improving crop productivity. Advances in the field of plant breeding and agronomic

research has emphasized integrated systems that shows benefits of biodiversity-based practices such as cover crops, intercrops, rotations, and hedgerows on agricultural productivity and environmental quality. Using satellite imaging systems, the distribution of ecosystems in agricultural landscapes can now be described with high resolution, yielding information on how to better manage agricultural species, invasive, and wild species. New efforts to merge biological and economic approaches are generating information on how policies can affect the conservation and use of agrobiodiversity for enhancement of human well-being. These progressed will contribute immensely in our effort on unlocking the potential of agricultural biodiversity to address issues of improving agricultural productivity and ensuring food and nutrition security.

Alleviating Hunger, Poverty and Malnutrition

The Rome Declaration on World Food Security and the World Food Summit Plan of Action in 1996 proposed that "each nation must adopt a strategy consistent with its resources and capacities to achieve its individual goals and, at the same time, co-operate regionally and internationally in order to organise collective solutions to global issues of food security."

At the United Nations Millennium Summit in September 2000, the international community agreed to a comprehensive vision of development, enshrined in what is today referred to as the Millennium Development Goals (MDGs). The MDGs place human development at the center of social and economic progress, and emphasizes the value of global partnerships for development.

Although there are on-going efforts worldwide to achieve the MDGs by 2015, progress on this front has been slow and uneven. Similar development targets have also been set by policy makers in India, and in some ways these are more ambitious than those stated in the MDGs. The realization of these targets in India is vital not only for attaining human development and economic growth within the country, but given its enormous size, they are critical for reaching the MDGs worldwide.

Poverty is widespread in India, with the nation estimated to have a third of the world's poor. According to a 2005 World Bank estimate, 41.6% of the total Indian population falls below the poverty line of US$ 1.25 a day. A recent report by the Oxford Poverty and Human Development Initiative states that 8 Indian states have more than 410 million poor, more than combined number of poor in 26 poorest African nations. According to IFPRI's recent report, India's poverty rate is projected to drop to 22% by the year 2015indicating that in South Asia, only India, is on track to cut poverty in half by the 2015 target date. However, the 2011 Global Hunger Index (GHI) Report ranked India 15th, amongst leading countries with hunger situation and places India amongst the three countries where the it went up from 22.9 to 23.7 between 1996 and 2011.

Numerous studies from countries in sub-Saharan Africa, South Asia and Latin America points out to the negative impacts on productivity of poor nutritional status of the rural labor force. Poor nutritional status leads to people's susceptibility to illness, less productivity, put them at risk of intergenerational transmission of nutritional status, and impacts children's performance at school. There is mounting evidence that the accumulated effect of under-nutrition negatively affect macroeconomic performance and growth. With agriculture at the heart of the poverty reduction agenda, the policies for reduction of hunger must place emphasis on enhancing agricultural productivity of the small and resource poor farmers.

Agricultural performance, more especially productivity increases have contributed immensely in many countries round the world to achieving reduction of poverty. This is achieved through agriculture contributing to direct and relatively immediate impact on enhancing rural incomes. This also enables availability of and access to cheaper food for both urban and rural poor. Agriculture's contribution to growth and the generation of economic opportunity in the non-farm sector have also been a contributory factor towards providing additional livelihoods to the communities. In addition, it also stimulates and and sustains economic transition when the countries also shift from primarily agricultural sector towards a broader base of manufacturing and services.

According to FAO, there were 105 million more hungry people in 2009 than in the previous year and the number of malnourished people now stands at 1.02 billion. Individual productivity losses due to malnutrition are equivalent to 10% of lifetime earnings, resulting in gross domestic product (GDP) losses of up to 3%. There are highly disturbing reports pointing out that close to 10 million children, in the world, die before their fifth birthday every year, over one-third of which are associated with under nutrition. In the developing countries, one in three every children under the age of five are stunted due to chronic under nutrition and poor health. Some 148 million children are reported to be underweight. In addition, micronutrient deficiencies or "hidden hunger" affects around 2 billion people worldwide accounting for about one third of the world's population. These vitamin and mineral deficiencies, especially of iron, iodine, zinc and vitamin A, lead to poor physical growth and development, lowered mental capacities, reduced productivity, impaired immune systems, blindness and death - all of which are preventable.

The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". Commonly, the concept of food security is defined as including both physical and economic access to food that meets people's dietary needs as well as their food preferences and is built on three pillars:

- Food availability: sufficient quantities of food available on a consistent basis.
- Food access: having sufficient resources to obtain appropriate foods for a nutritious diet.
- Food use: appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation.

The nutritional outcomes for India clearly indicate that there are gaps in linking the three pillars of food security. This interrelated and important aspect of food, nutrition and poverty

are yet to be effectively addressed is achieving nutrition security at individual, community and national levels. Despite intervention through several food-based social safety net programs, some of them running over decades, malnutrition levels continue to be severe and persistent. There is an urgent need to implement an integrated nutrition and health program for all vulnerable groups. There is also a need to adequately focus on the role of gender and governance in reducing the prevailing issues of malnutrition at household levels. India ranks the lowest in terms of prevalence of underweight children under age 5. Although the under-5 mortality rate has improved—7.6% in 2006 from 11.5% in 1990—the pace of reduction has not been very impressive. Poor nutritional outcomes of infants and children arise from the poor health status of women, overall poverty, and lack of hygiene and proper health facilities.

Malnutrition is caused by a combination factors. Inadequacies in food, health and supporting systems play a major role. Even when food availability and purchasing power is sufficient, poor monotonous diets those are low in quantity, quality and lack of variety or dietary diversity of foods are often the major contributing factors. The gap between what foods are grown and what available locally and what foods are needed for better nutrition need to be adequately understood and studied. These would require concurrent attentions to increasing the availability, access and actual consumption of a diverse range of foods necessary for a healthy and balanced diet. Many scientific community and policy makers advocate for nutrition-sensitive, food-based approaches that increase access, availability and consumption of a variety and diversity of safe, good quality foods. Food fortification, has been advocated as a sustainable strategy for improving the nutritional status of populations. For many people, especially those living in developing countries, food and nutrition security is commonly mediated through agriculture and agriculture-related activities that in addition provide employment and sustain rural livelihoods. The multiple social, economic and health benefits associated with successful food-based approaches that ensures to year-round availability, access to and consumption of nutritionally adequate amounts and varieties of foods are obvious. Ensuring nutritional well-being will contribute to

promoting health of individuals, supporting their incomes and livelihoods and more importantly, will lead to creation and protection of community and national wealth.

Growing body of evidences, available today, suggest that food-based strategies are essential to meet the challenges of micronutrient malnutrition in the developing world. Increasing dietary diversification is the most important factor in providing a wide range of micronutrients, and to achieve this would require adequate supply, access and consumption of a variety of foods. Diets in developing countries generally lack many nutrients, including energy (inadequate amounts of food). Therefore, strategies are needed to place emphasis on an increase in total food intake, in addition to a greater variety and diversity. Agricultural and food policies tend to be oriented to primary agricultural productions, but they could also be formulated to promote and support backyard gardens or home gardens with appropriate mix of crops and small livestock production for the purpose of increasing household consumption of micronutrient-rich foods. The adoption of required and desired dietary patterns for nutrition improvement, e.g. appropriately formulated to meet micronutrient needs, need to be used in the formulation of agricultural policies and programmes. This process could be achieved through support for integrated farming systems oriented to assuring household food security, but also based on a variety of foods that will meet total dietary (including micronutrient) needs. Therefore, availability of energy-rich staples, animal and/or fish as major sources of protein, and vitamin-, mineral- and phytonutrient-rich fruit and vegetables could constitute development of the types of production system that is essential in ensuring adequate availability at the household level and access to nutritious food.. Use of fortified salt as well as grains has also been attempted in many countries as an intervention for addressing problems of malnutrition. The cultivation of edible indigenous plants as additional sources of micronutrients could also be added. The low bioavailability of some key micronutrients from foods, such as Fe, is substantially enhanced with the right food combinations and with appropriate food processing and preparation techniques. Appropriate technology for the preservation of micronutrient-rich foods would need further development and promotion for their year-round availability.

With an emphasis on increasing the variety of foods consumed and linking community development policies to national programmes, is probably the best strategy for improving micronutrient malnutrition sustainably and for the alleviation of hunger and malnutrition. In addition creating adequate knowledge base and community empowerment programmes that would enable nutrition awareness and literacy will hold the key in future.

One sustainable agricultural approach to reducing micronutrient malnutrition among people at highest risk (i.e., resource-poor women, infants and children), that is being advocated globally is to enrich major staple food crops (e.g., rice, wheat, maize, beans and cassava) with micronutrients through plant-breeding strategies. Available research carried out at international level (eg. HarvestPlus Programme of the CGIAR) and at national level (eg. India Crop Biofortification Programme) has demonstrated that micronutrient-enrichment traits are available within the genomes of these major staple food crops and appropriate strategies such as screening for high micronutrient containing germplasm, use of marker assisted selection and breeding as well as employing genetic modification approchaes that enhances transport, partitioning and accumulation of high micronutrient traits, would create opportunities for development of micronutrient dense varieties and will allow for substantial increases in the levels of Fe, Zn and provitamin A carotenoids (as well as other nutrients and health-promoting factors) without negatively impacting crop yield. The time has come to invest in agricultural technologies to find sustainable solutions to micronutrient malnutrition. Plant breeding is one such technology that should be adopted by the world's agricultural community and that should be supported by the world's nutrition and health communities. Therefore, the intrinsic linkage between agriculture and malnutrition is the agenda of global communities in the recent years.

Improving Crop Productivity:

Investments in agriculture are important to increase food security. This is a complex issue requiring multiple interventions. Rising productivity increases rural incomes and lowers food prices, making food more accessible to the poor. Other investments—such as improved

irrigation and appropriate varieties of crops—reduce price and income variability by mitigating the impact of a drought. Productivity gains are key to food security. The contributions that agriculture makes to food security need to be complemented by medium-term programs to raise incomes of the poor, as well as insurance and safety nets, including food aid, to protect the chronic and transitory poor.

Crop productivity is a function of a range of factors and services. These include:

- land and water related factors (such as nature and size of farms/ location, quality of land, source of water, quality and quantity of water, and timing of water application, etc.)
- climatic factors (rainfall, temperature, precipitation, frost, cold etc.)
- agronomic factors such as quality, quantity and timing of input application (seed, fertilizers, weedicides, labor, etc.)
- socioeconomic factors (such as farmer education level and experience in farming, farm size, tenancy terms, land fragmentation, availability of credit)
- farm management factors (adoption of modern production technologies, farm planning and management practices, etc.)

The high incidences of under nutrition and poverty are ascribed to the decelerated production growth rates in recent years and this need to be seen as the most important issue and foremost challenge before the nation. Appropriate investments are needed for application of farm technology, deficiencies in the input supply chain, information and knowledge capacity with the farmers. Detailed analysis are required for bridging the huge yield and productivity gaps, addressing the issues of poor infrastructure, including that of the market and price volatility in agricultural commodities. Adequateness of the extension services, and dearth of suitable and appropriate technology and support systems for targeted groups such as women farmers and for small and marginal farms, are among the priorities in ensuring enhancement of agriculture productivity. .

The ever increasing pressure of human population (also livestock population) in the country is a major cause of shrinking as well as fast deterioration of the natural resources like land, water, biodiversity, genetic resources and forests. The problem is most serious and challenging in India. While India accounts for a mere 2.4 per cent of the world land surface area of 135.79 million ha, it supports 16.7 per cent of the global population. The population pressure on sharing of natural resources is bound to increase as India's projected total population in 2010 will be 1.19 billion, comprising 815 million rural people (68 per cent of the total population).

Agricultural intensification and extensification can impact the natural assets of land, soil and water in a number of ways. For example, poor land and soil management will result in massive water and wind erosion, overuse or misuse of pesticides and fertilizers will lead to soil and water contamination, and the overuse of irrigation will cause increased salination of productive soils. Water efficiency in agriculture is generally low and there are major concerns over resources depletion, unsustainable exploitation of ground water, falling water tables and conflicts over water use. Long term sustainability of water resources that take into account the multiple uses of water means that agriculture must pay greater attention to efficiency of farming system that would include appropriate crop mix.

Conservation of natural resources is an important issue from the point of view of sustainability of food security. The fast shrinking and deteriorating natural resources like land, water, biodiversity, forests, and changing climate including global warming are threatening the sustainability of food and nutritional security systems round the globe and particularly in India. The major Challenge to achieve increased productivity would therefore depend on our ability to ensure proper and judicious utilization of natural resources that will contribute to an sustainably high production of food and other agricultural crops. Further, Indian agriculture is still largely weather dependent, hence is full of uncertainties. Because of this and other factors, there are no standard solutions. Only way is to overcome them by experience, collective wisdom, and of course thorough appropriate research based technology application.

Genetic improvement of crops for enhanced productivity has been often regarded as a product of random or selection of spontaneous mutations ever since agriculture was practiced. Through the elucidation of the laws of genetics, plant breeding became a deliberate and predictable activity with the result that tailor-made crops are now in place. Traditional plant breeding methods have been very successful, providing the volume of food required to allow the world population to grow to its present scale. Breeding efforts have led to creation of remarkable diversity amongst various crop species.

However, recent trends in crop productivity indicate that traditional methods alone will not be able to keep pace with the growing demands for food, fibre and fuel. A remarkable increase in the total grain production was noticed between 1960 and 1980, while only a marginal increase was realized during 1980-1990 and subsequently. Much of the early increase in grain production resulted from an increase in an area under cultivation, irrigation, better agronomic practices and improved cultivars. In the seventies, a quantum jump in yield was achieved in wheat and rice by modifying the plant architecture. Yields of several crops have already reached a plateau, and therefore, most of the productivity gains in the future will have to be achieved through better natural resources management and crop improvement. Productivity gains are essential for long-term economic growth, but in the short-term, these are even more important for maintaining adequate food supplies for the growing world population. Per capita availability of land is shrinking and there is an urgent need to increase the yield potential of food crops in an environmentally sustainable manner.

Focussing on Rainfed Agriculture Systems

India ranks first among the countries that practice rain-fed agriculture both in terms of extent of land and value of production. Out of an estimated 140.3 m ha net cultivated area in India, about 79.44 m ha (57%) is rainfed and contributes 44% of the total food grain production. Even after achieving the full irrigation potential, nearly 50% of the net cultivated area will still remain dependent on monsoon rains. Rain-fed agriculture supports nearly

40% of India's estimated population. Rainfed agriculture system in our country accounts for production of nearly 90% of coarse cereals, 90% of pulses, 80% of oilseeds and 65% of cotton. In the rain-fed areas, farmers' dependence on livestock, besides agri based farming, as an alternative source of income is high. It is estimated that nearly two out of three heads of cattle population in India thrive in rain-fed regions. These factors emphasize the crucial role played by rain-fed agriculture in India's food security. However, the state of rain-fed agriculture in India is precarious and the problems associated with includes low cropping intensity, high cost of cultivation, poor adoption of modern technology, uncertainty in output, low productivity, increasing number of suicides among farmers, lack of institutional credit, inadequate public investment and high incidence of rural poverty.

The 2008 World Development Report emphasized that in order for agriculture to meet future food demand, water productivity improvements through water management and water uptake capacity of crops need to be achieved in the rainfed areas. Estimates suggest that about 75% of the increased water requirement, needed to attain the 2015 hunger reduction target of the Millennium Development Goals set by the United Nations. This improvement has to come from water investments in rain-fed agriculture. Numerous reports have emphasised on the correlation between poverty, hunger and water stress. An intensified efforts to upgrade rain-fed agriculture through balancing water for food and for ecosystem essential. Water resources management in rain-fed agriculture requires a landscape perspective and involves interactions from farm households to watersheds, to national and regional levels. Therefore, broader knowledge is needed for investments at national, regional and local levels.

Upgrading rainfed agriculture requires integrated approaches to social and ecological management. A challenge facing low-productive rainfed agriculture is the need for innovations in management of water that require novel technologies and practices such as water harvesting and conservation agriculture. Both innovation and adaptation are needed for successful adoption and out-scaling. One promising approach is adaptive co management

between local communities and knowledge institutions, in which knowledge sharing and transformation can be achieved through concerted joint efforts. Recently many institutions are employing several important tools for adaptive co-management those include participatory approaches, farmer field schools, and action research methods, with varied levels of success.

The common approach in an integrated rainwater management in general address the links between investments and risk reduction, between rainwater management and multiple livelihood strategies, and between land, water, and crops. Many on field demonstrations and pilot scale initiatives have developed strategies for upgrading, including technologies and management in watershed areas and watershed development plans. However, the missing links for scaling-up and scaling-out are social and economic processes and institutions that can link to suitable policies as well as sustainability of the institutions. India has experienced important success from integrated watershed management, with local ownership combined with tangible economic benefits among rural households. However, India's experience also highlights the limitation of a compartmental approach. The benefits of increased productivity were not realized to the desired extent, equity issues were not addressed, and community participation was not achieved, resulting in neglect of the various water-harvesting structures in the watersheds. Therefore, an integrated on farm approach to land, water, and crop management is required. At the same time watershed and basin development strategies are essential to increase yields in rainfed agriculture. Investments in upgrading rainfed agriculture need to consider the wide range of benefits from rainwater that contribute to the overall resilience of rural communities

Application of Molecular Genetics and Biotechnologies

The recent development in the field of molecular biology, biotechnology and bioinformatics offers uncommon opportunities to aid and improve classical plant breeding programs, and it is hoped that these will contribute to enhancing agricultural productivity. Location specific crop varieties are essentially the first and foremost necessity for an productive system

Using modern approaches, both the phenotype and the genotype of new/ existing varieties can be analyzed and the performance of specific new traits can be predicted. The molecular breeding or Marker Assisted Breeding has enabled successful transfer of several genes of interest, as well as Quantitative Trait Loci involved in polygenic traits, in many crop plants. Over the past two decades, scientists have developed large bioinformatics systems for breeding programs, based on the large scale sequencing information now available for crop species and their relatives. The availability of molecular data, linked to pedigrees and phenotypic evaluation, now makes breeding analysis much easier. Several international research centers in developing countries together with National Agricultural Research Systems have been using bioinformatics tools to utilise large repository of genetic resources for crop improvement information. Development of genomics and associated DNA technologies is hugely increasing molecular understanding of important plant breeding traits. Advanced marker technologies, such as Single Nucleotide Polymorphisms or second-generation massive parallel DNA sequencing technologies offer new ways to improve efficiency and effectiveness of many breeding programmes.

The field of genetic modification allows transfer of desired genetic cominations from across sexual barriers. The impact of GM crops has been well documented and dramatic since the mid 1990s when the first commercial varieties of herbicide and insect-resistant crops were released. Now, more than half of the areas planted to corn, soybean and cotton in the US utilise transgenic varieties and there is widespread use in South America, the India subcontinent and Australia. GM crops provide promising solutions for addressing a particular problems in agricultural production. The proprietary nature of the technology, however, limits the options for addressing the needs of the farmer, especially in low productivity regions where smallholder farmers are faced with a challenging environment in which to grow their crops. Only a few GM traits have been successfully developed and these mainly replace or reduce chemical inputs such as herbicides or insecticides. Agronomic traits, such as abiotic stress tolerance, and output traits such as yield or quality improvements have not yet emerged from the research phase, while there are several promising leads.

Plant biotechnology offers opportunities to improve the production and composition of crops with benefits to the environment and consumers. Application of molecular plant breeding is now focusing to discover new genes and their functions opening new avenues for basic plant biology research. For example, the work of M. S. Swaminathan Research Foundation has demonstrated that genetic characters from across the sexual barriers can be mobilized to generate transgenic materials free from IPR. The work on identifying and isolating the genes from mangrove species and transferring them into locally cultivated rice varieties have been successful in developing rice cultivars with tolerance to salinity, drought and quality enhancement. This and many other ongoing work at Indian Public and private institutions have opened up new avenues for enhancing agricultural productivity of major crops in our country. When carefully deployed, modern biotechnology will become an integral supplement to conventional plant breeding and its enormous potential should be harnessed to the best advantage of the entire humankind.

To date, globally, commercial GM crops have delivered benefits in crop production, but there are also a number of products in the pipeline which will make more direct contributions to food quality, clean environment, pharmaceutical production, and livestock feeds. Examples of these products include: rice with higher levels of iron and beta carotene; long life banana that ripens faster on the tree and can therefore be harvested earlier; maize with improved feed value; delayed ripening papaya; papaya ring spot virus resistant papaya; tomatoes with high levels of flavonols, which are powerful antioxidants; drought tolerant maize and wheat; maize with improved phosphorus availability; arsenic-tolerant plants; insect resistant eggplant and rice; edible vaccines from fruit and vegetables; low lignin trees for paper making among others.

The potential benefits of biotechnology should not divert our attention from the real concerns about the application of the new science. We need to invest much on developing adequate scientific infrastructure and human resources for biotechnology research, product development and more specifically in the area of safety assessment and safety management

both pre- and post deployment. Issues of bioethics and biosafety, and of intellectual property rights will be ceaselessly and inconclusively debated unless all those concerned have a genuine desire to reach accommodation based on practical realities, not on emotion or ideology. Adequate and effective ways of public education and capacity building of stakeholders is the key for instilling confidence of people in the technology.

Use of genetically modified varieties in most of the countries will depend on the development of appropriate regulatory capacity by the public sector to address food safety and environmental issues. Investment in technology appropriate for farmers and the establishment of effective, science-based regulatory capacity in the countries are linked in a circular way. Effective intellectual property regimes are important for any long-term investment, whether for internal innovations or in relation to those originating outside a country. Regional cooperation in intellectual property and biosafety has great potential for simplifying both technology access and agricultural trade.

Integrated Farming Systems

The previous sections has highlighted the fact that Indian economy is predominantly rural and agriculture based, and the declining trend in size of land holding poses a serious challenge to the stability, sustainability, productivity and profitability of farming systems. In view of the decline in per capita availability of land from 0.5 ha in 1950-51 to 0.15 ha in 2000-01 and a projected further decline to less than 0.1 ha by 2020, it is essential to develop strategies and agricultural technologies that enable adequate employment and income generation, specifically for the small and marginal farmers who constitute more than 80% of the farming community, in the country. It is absolutely essential that we make shift from crop and cropping system based research to a farming systems based research those are carried out in a holistic manner for the sound management of available resources by small farmers. Under the gradual shrinking of land holding, it is necessary to integrate land based enterprises like fishery, poultry, duckery, apiary, field and horticultural crops, etc. within the bio-physical

and socio-economic environment of the farmers to make farming more profitable and dependable. No single farm enterprise is likely to be able to sustain the small and marginal farmers without resorting to integrated farming systems (IFS) for the generation of adequate income and gainful employment year round. Farming systems approach, therefore, is a valuable approach to addressing the problems of sustainable economic growth for farming communities in India.

The farming system mode involving (i) in situ recycling of organic residues including farm wastes generated at the farm to reduce the dependency on external inputs (ii) decrease in cost of cultivation through enhance input use efficiency as well as engagement of family workforce, (iii) effective forward and backward linkages within the farm components (iv) upgrading of soil and water quality and increased diversity in the fields, (v) effective water management and productivity, (vi) nutritional security through soil-plant–animal- human chain, offers unique opportunities for improving productivity of the system. Farming system provides a vast canvass of livelihood gathering, a better risk coping strategy, continuous flow of income and employment throughout the year for small landholders. Therefore, farming system represents an appropriate combination of farm enterprises, viz., cropping systems, horticulture, livestock, fishery, forestry, poultry and the means available to the farmer to raise them for profitability. It interacts adequately with environment without disclosing the ecological and socio-economic balance on one hand and attempts to meet to national goal on others.

Concluding Thoughts

Globally we are witnessing a rapid surge in our concern and actions im making the hunger and malnutrition a history. This is exemplified by numerous political, scientific and stakeholder consultations, meetings and declarations that underlines necessity of concerted actions at local, regional and global level several initiatives and actions for reducing hunger, poverty and social deprivation. Role of agriculture and allied activities have assumed a

centre stage in all these initiatives. However, the recent global food price crises have highlighted the vulnerability of poor rural people's livelihoods to price volatility and price shocks. This therefore places food and nutrition security at the centre of any viable strategies for eradicating rural poverty. The global communities have also highlighted the inadequacy of global and domestic food systems in addressing the problems of a large number of people in conditions of chronic undernourishment or malnutrition. Developing sound and effective policy frameworks that enable farmers and food producers to contribute effectively to a stronger and more stable food supply system at national level is the urgent need and priority.

Overcoming the emerging agrarian and agricultural crises and their impact on poor and vulnerable people will require a combination of short-term and long-term actions. These measures must support agriculture development which is ecologically and economically sound, viable and sustainable. Addressing food security, nutrition adequacy and poverty reduction agenda, and strengthening the capacity of smallholder farmers to overcome poverty by becoming part of the solution to global food insecurity is essential to strengthen vulnerable livelihoods in rural areas. Policy initiatives are required in the areas of agricultural production, ensuring greater productivity per unit of land and water, sustainability and resilience issues in the era of climate change, large investment in infrastructure for storage, processing, post harvest technologies and transport, agricultural and food markets and trade, and putting in place adequate social protection and safety net programmes. Investment in Agricultural R&D that has been in the decline in the recent years also needs to be reversed.

It is also critical that poor rural people are supported in their ability to overcome poverty by seizing new opportunities at reduced risk. Therefore overcoming poverty can be the result of poor and marginal farmers operating in an enabling policy environment and supported by policies that recognize their importance and capacity to actively contribute to meeting the prevailing and emerging local, regional and global challenges, both today and in the longer term. Therefore, investing in building confidence in the poor, deprived and marginal communities will enable making hunger and poverty a history.

Commenting on the World Disasters Report 2011, Prof. M. S. Swaminathan has made following observations. “Hunger and malnutrition are the worst enemies of humankind. They deny to children – even at birth – an opportunity for the full expression of their innate genetic potential for physical and mental development. Freedom from hunger is the first requisite for sustainable human security. This will depend upon the productivity, profitability and sustainability of agriculture. Therefore, if food and nutrition policies go wrong, nothing else will have a chance to go right.”

I only echo these observations and hope our collective efforts – that of farm and rural women and men, scientific and technical professionals, extension workers, policy makers and political leadership – will bring in an era of Evergreen Revolution that ensures productivity increases in perpetuity enshrined in the principles of good ecology, economics and sound ethics. Together we can and we must bring in a change in agriculture that ensures adequate and balanced food and ensures remunerative income for all.

I thank you for your kind attention.