

# Food security and sustainable development

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## Introduction

The concept of food security has been undergoing an evolutionary change during the last 50 years. In the nineteen fifties, food security was considered essentially in terms of production. It was assumed that adequate production will assure adequate availability of food in the market as well as in the household. In the seventies, it became clear that availability alone does not lead to food security, since those who lack purchasing power will not be able to have access to balanced diets. Purchasing power again is related to jobs or livelihood opportunities. More recently, it is becoming evident that even if availability and access are satisfactory, the biological absorption of food in the body is related to the consumption of clean drinking water as well as to environmental hygiene, primary health care and primary education. Finally, even if physical and economic access to food is assured, ecological factors will determine the long-term sustainability of food security systems. Based on the above considerations, the M. S. Swaminathan Research Foundation and the United Nations World Food Programme have recently brought out a *Food Insecurity Atlas of Rural India*<sup>1</sup>.

The food insecurity atlas of MSSRF&WFP reveals that every state in the country has its strengths and weaknesses in relation to the five major dimensions considered in the analyses. These are: availability of food, which is a function of production, access to food, which is related to purchasing power, absorption of food in the body, which is determined by the availability of safe drinking water, environmental hygiene, primary health care and primary education, vulnerability to transient hunger, which is related to natural and man-made calamities and disasters, and sustainability of production, which is influenced by the extent of attention given to the ecological foundations essential for sustained advances in production. The *Atlas* reveals that non-food factors, like livelihood and income-earning opportunities, health care facilities, education, sanitation and environmental hygiene are as important for food security at the level of every individual, as factors relating to the availability of food grains in the market and access to clean drinking water.

The *Atlas* provides an opportunity for State Governments to draw up food security balance sheets based on strengths and weaknesses, and to identify the 'hot spots' with reference to endemic and transient hunger, as well as to open (i.e. protein-calorie under nutrition) and hidden (i.e. micronutrient deficiencies) hunger.

While we should give the highest priority to improving food consumption and equitable distribution, we should not decelerate our efforts in improving agricultural production through yield improvement, higher factor productivity and better post-harvest management. Agricultural production, factor productivity and investment in irrigation and post-harvest and rural infrastructure are all declining in India. Prices of many agricultural commodities have collapsed and Indian farm families are in deep economic and psychological distress. This trend, if not arrested immediately, will lead to social chaos, since agriculture (crop and animal husbandry, fisheries, forestry, agro-processing and small scale agri-business) is not just a food producing machine, but is the backbone of the livelihood security system for nearly 700 million children, women and men in the country. There is no time to relax on the food production front, just because the major problem today is in the area of marketing and distribution. At the same time, we should not continue to remain silent spectators to the co-existence of mountains of grains and millions of hungry.

## From green to an ever-green revolution

The first 60 years of the 20th century were marked by a sense of despair and frustration regarding India's capability to achieve a balance between human numbers and the production of foodgrains and other agricultural commodities. In 1968, this mood of despair and diffidence gave way to one of optimism and self-confidence in relation to our agricultural potential and our farmers' ability to adapt and adopt new technologies, a phenomenon which was christened in that year as 'Green Revolution'. This agricultural transformation helped to strengthen national sovereignty in many areas, including the capacity to remain nonaligned in foreign policy.

Our agriculture is now at the crossroads. On the one hand, our national capability in frontier areas of science and technology, as for example in biotechnology, in-

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formation, communication and space technologies, nuclear and renewable energy technologies and in management science, has opened up uncommon opportunities for achieving an evergreen revolution, i.e. sustainable advances in crop productivity per units of land, water and time without associated ecological harm.

Thus, sustainable food security will have to be defined as 'physical, economic, social and ecological access to balanced diets and safe drinking water, so as to enable every individual to lead a productive and healthy life in perpetuity'. A life cycle approach will have to be followed in the case of nutrition, ranging from *in utero* to old age. Achieving such a form of food security will require synergy between technology and public policy.

There are, on the other hand, both internal and external threats to our agricultural progress. The most important among the internal threats is the damage to the ecological foundations essential for sustained agricultural advance, like land, water, forests and biodiversity. The other major internal weakness is the mismatch between production and post-harvest technologies, and the consequent need for the Government of India to undertake 'trade relief' operations, on lines similar to those of cyclone, flood and drought relief.

The external threats include the unequal trade bargain inherent in the WTO agreement of 1994, the rapid expansion of proprietary science and potential adverse changes in temperature, precipitation, sea level and ultra violet  $\beta$  radiation.

The global threats to the agricultural destiny of developing countries can be overcome only if industrialized countries, particularly the United States of America are willing to take the following steps.

- Ensure that the Kyoto protocol relating the climate conversion is implemented.

- Ensure that adequate support is extended to public good research at the national and international levels, thereby fostering a new social contract between science and society<sup>2</sup>.
- Revise the Agreement on Agriculture of the World Trade Organization in a manner that trade becomes a powerful tool for poverty eradication. At present there is no level playing field between the produce emanating from factory farming and farmer's farming (i.e. small scale producers).

### Sustainable development in agriculture

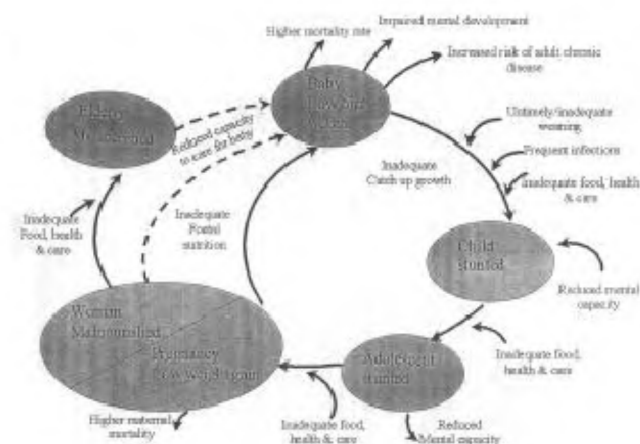
The smaller the farm, the greater is the need for marketable surplus to ensure cash income. Fortunately the gap between potential and actual yields is high in most farming systems. Even in the case of rice and wheat, the present average yield is just 40 per cent of what can be achieved even with technologies currently on the shelf. Therefore a massive effort should be made to launch a productivity revolution in farming. An integrated approach is necessary to remove the technological, infrastructure and social and policy constraints responsible for the productivity gap and in some cases, productivity decline. Reducing the cost of production through eco-technologies and improving income through efficient production and post-harvest technologies will help to enhance opportunities for both skilled employment and farm income. Precision farming methods which can help to enhance income and yield per drop of water and per units of land and time need to be standardized, demonstrated and popularized speedily, if a reduction in the cost of production is to be achieved without reduction in yield.

As an immediate measure for strengthening food security at the level of individuals and households, there is no better option than initiating a systematic effort in each agro-climatic zone to identify and remove the constraints responsible for the prevailing yield gaps. This is true not only of crop plants but also of livestock and fisheries. The local *panchayati raj* institutions or other forms of local bodies should be fully involved both in identifying constraints that limit production and in removing them. The following are some of the other steps needed.

### Land and water care

Some of the measures needed to conserve land for agricultural purposes are:

- Arresting land degradation and the loss of the biological potential of the soil (desertification).
- Promoting land and water use on the basis of agro-ecological, meteorological and marketing factors.



**Figure 1.** Lifecycle: the proposed causal links. (Source: UN Commission on the nutrition challenges of the 21st century, United Nations University Press).

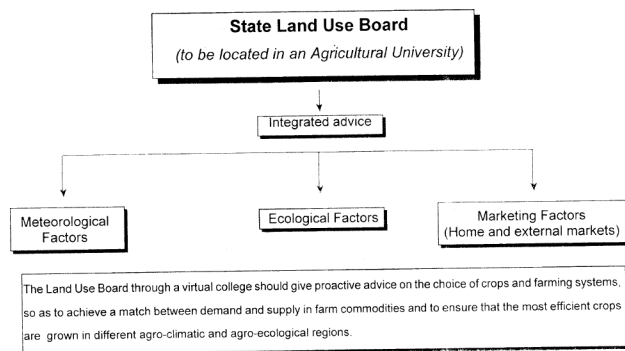
- Restoring degraded and wasted land through agro-forestry and other appropriate methods of restoration ecology.
- Launching community centred water harvesting, conservation and use programmes to ensure the efficient harvest of rainwater and the sustainable use of ground water. The adoption of conjunctive water use practices ensures integrated use of river, rain, ground, treated sewage and sea water, in such a manner that every drop yields more crop and income.
- Introducing public policies to prevent the diversion of prime farm land for non-farm uses and the unsustainable exploitation of groundwater.

There are currently several Central and State Government programmes dealing with wasteland development, rainwater harvesting, watershed development, command area management, shallow tube well construction, social and agro-forestry and prevention of damage to hydro-logic cycles in hill areas. There is an urgent need for convergence and synergy among these programmes so that land and water conservation and use can be dealt with in a scientific and holistic manner. Land and water management problems (the term 'management' is used to denote concurrent attention to conservation, sustainable use, and equitable sharing of benefits) are multi-dimensional. So uni-dimensional approaches through numerous independent schemes implemented by separate departments of central and state governments will only result in inefficient and ineffective use of financial and technical resources.

Schedule 11 of Constitution amendment 73, relating to Panchayati Raj institutions, entrusts to Panchayats/local bodies, responsibilities for the management of land, water and common property resources. If these bodies, in which a third of the members are women, are legally, technically and financially enabled to discharge the functions listed in Schedule 11, a beginning can be made in fostering land and water management in an environmentally and socially sustainable manner. There are some legislative, administrative and legal hurdles in the way of decentralized planning. Hence, it is important to address these issues immediately.

The existing State Land Use Boards should be revitalized and reorganized in such a manner that they can give proactive advice to farm families on land use during the south-west and north-east monsoon periods based on the following factors (Figure 2).

- Farming systems (crop, livestock, fish and agro-forestry) which will be most efficient under the given soil, water and climatic conditions.
- Short and medium range weather forecasts (the country has developed considerable capability in this area).



**Figure 2.** Proactive advice on land use. (Land use decisions are also water use decisions) (Source: M. S. Swaminathan)

- Projected market demand (both home and external markets).
- Cost of production, risks involved and expected return.
- Potential for on-farm and non-farm livelihood generation, so as to maximize income and employment per units of land and water.

If such advice is given at least several weeks before the sowing season, a proper match can be achieved between production and potential market demand. Uneconomic market interventions can then be avoided. The agro-ecological potential of every village can be utilized in an ecologically and economically optimum manner. The 'Blue box' of the Agreement on Agriculture of the World Trade Organization provides for expenditure on achieving a balance between demand and supply in farm products. Seed banks of alternative crops will have to be established at the local level.

The reorganized Land Use Boards should also be able to develop contingency cropping patterns to suit different rainfall and water availability patterns. Thanks to the long-range weather data available with the Meteorological Department, it is now possible to develop computer simulation models of likely deviations in monsoon behaviour. These can be used for formulating land use advice based on GIS maps, which also take into consideration the moisture-holding capacity of soils, physiological efficiency of crops, home needs and market demand.

If such steps are taken, we can promote land use based on considerations of both ecological sustainability and economic efficiency. Since land use decisions are also water use decisions, land and water care and use are best dealt with in a simultaneous and interactive manner. For example, if the ongoing technology missions in crops like oilseeds, pulses, maize and cotton are linked to the watershed development and dry farming programmes, these missions will become more effective.

## Reorganization of extension services

Advances in information technology also provide opportunities for farm graduates to establish computer-aided and internet connected Rural Knowledge Centres. These centres should help to convert generic into location specific information. The present extension service has outlived its utility. It can be replaced over time by farmer owned and operated knowledge centres. A virtual college linking such village knowledge centres to agricultural universities and research institutions can be established, so that farm women and men are able to get up-to-date and authentic technical advice. Nearly a million farm graduates (both men and women) can be involved in establishing and operating such Rural Knowledge Centres based on modern information and communication technology. Such centres can also operate local community radio stations. Such a restructuring and retooling of extension services will help to provide demand-driven and environment and farming systems specific advice to farmers (Figure 3). They will trigger a knowledge revolution in agriculture and will lead to an efficient and eco-sensitive precision farming movement. This great opportunity for achieving a transition from unskilled to skilled work and for designing a new extension service for the new economy should not be missed.

## Linking food and ecological security

The provisional census 2001 figures reveal that our population is higher by nearly 20 million than expected and that sex ratio continues to be adverse to women (933 women per 1000 males). The sex ratio is even more adverse in the 0–6 age group, suggesting the possibility of increasing female foeticide. Fortunately, female literacy is improving and Madhya Pradesh has shown the way for achieving a quantum jump both in male and female literacy through its education guarantee programme. While we must relentlessly pursue the

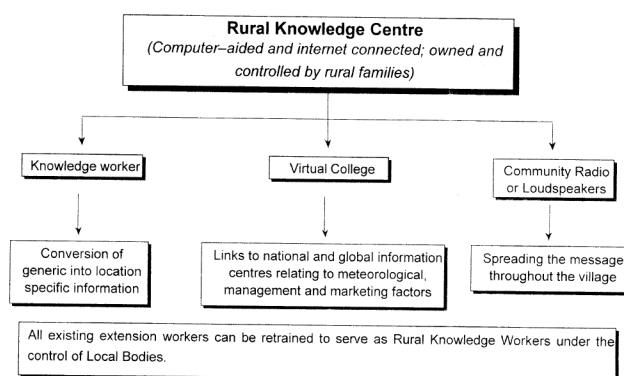
goals of literacy and health for all and gender justice and equity, we should take advantage of a rare and unique opportunity in the history of independent India provided by the growing grain stocks in Government godowns to leapfrog in our efforts to realize Gandhiji's vision of a hunger-free India.

Current government stocks of wheat, rice and other grains exceed 60 million tonnes. Government may have to purchase another 15 to 20 million tonnes of wheat and rice during the next few months. A considerable proportion of these stocks remains in gunny bags and temporary storage structures. The Government of India has announced a scheme for the construction of large numbers of rural godowns. Severe drought in several parts of Rajasthan, Gujarat, Madhya Pradesh and other States is compounding the problems of poverty-induced endemic hunger and drinking water scarcity.

The time is therefore opportune to launch an imaginative Community Grain Bank movement. On an average, 1 ton of wheat or rice supports the food needs of 5 individuals in our country. Community Grain Banks, each with 200 t of wheat or rice or other locally acceptable staples like *ragi*, *jowar*, *bajra* and *maize* could be established, to begin with, in 'hunger hot spot' villages. Remote areas with poor communication as the desert areas of Rajasthan and hill, tribal and drought affected areas, can be given priority in starting the Community Grain Bank movement. 25,000 Grain Banks can be established during the next few months if the Government of India will approve immediately the release of 5 million tonnes of grains for this purpose. Because large quantities of Government stocks are in gunny bags, it is easy to move them to the Community Grain Banks, where they can be stored using the low-cost technology standardized by the Food Corporation of India. It will be sad if Government sits over 60 million tonnes of food grains, allowing some of it to rot, rather than take them to places where, in Gandhiji's words 'God is Bread'.

Based on the experience of the initial 25,000 village level grain banks, another 25,000 can be established later this year, thus using 10 million tonnes of the surplus stock in a socially meaningful manner. Let the first year of the new millennium be a year of decisive action in our resolve to provide every individual in the country an opportunity for a productive and healthy life.

The Community Grain Banks can be sustained with locally procured grains, wherever feasible. They should be linked to the rural godowns scheme. The Banks could function under the overall umbrella of the Gram Sabha, and can be operated by local self-help groups of women and men. This will ensure their relevance to local conditions in addition to involving low transaction costs. The Community Grain Banks could be used for initiating at the local level, food for work, food for nutrition (i.e. distribution of food among pregnant and nursing mothers, infants and old and infirm persons),



**Figure 3.** Restructuring and retooling extension services for an era of precision farming. (Source: M. S. Swaminathan)

waste land and watershed development, ecological restoration of common property resources and for establishing community water banks (see Swaminathan, M. S., *Sunday Hindu*, 15 October 2000). They can also be the vehicles for operating the targeted public distribution, Antyodaya Anna Yojana, Sampoorn Gramin Rozgar Yojana and other Central and State Government schemes. Thus, the Community Grain Banks can become instruments of eco-restoration, water harvesting and hunger-elimination.

We should link conservation, cultivation and consumption in a mutually reinforcing manner. For this it will be useful to foster the establishment of community gene, seed, water and grain banks in every village (Figure 4).

### Increasing production and productivity

Future agricultural production programmes will have to be based on a three-pronged strategy designed to foster an evergreen revolution, which leads to increased production without associated ecological and social harm. The following are the four major elements of this strategy for producing more in an environment-friendly manner:

*Defending the gains already made.* This will call for conservation and enhancement of soil and water resources as well as forests and biodiversity through an integrated package of government regulation, education and social mobilization (through Panchayats and local bodies). The traditional 'green revolution' areas are in urgent need of such an integrated natural resources management strategy so that the pattern of present production does not erode future prospects. The Punjab which is India's granary today will become food insecure in 15 to 20 years from now, if the current unsustainable land and water use practices continue. Defending the gains already achieved will also need stepping up maintenance research for ensuring that new strains of pests and pathogens do not cause crop losses. Special steps are needed to prevent the introduction of

invasive alien species, which are coming into the country along with imported food and agricultural commodities. These invasive alien species, like new and aggressive weeds, nematodes, etc. can cause incalculable harm to the future of Indian agriculture.

Conservation and enhancement of land and water resources is important. Water harvesting, watershed development and economic and efficient water use can help to enhance productivity and income considerably. Conjunctive use of different water sources should become the rule, rather than the exception. Unless there is equity in water sharing, there will be no cooperation in water saving. Therefore, equitable methods of water sharing should be promoted. Where water is scarce, high value but low water requiring crops should be grown. *In this context, the organization of pulses and oilseed villages should become a national movement.* This should be a major aim of the Pulses and Oilseeds Technology Missions. Solving internal shortages of pulses and oilseeds through imports will only add to the economic woes of dry land farming communities. Pulses and oilseeds are important income earning and soil enriching crops in dry land areas. Various estimates of land degradation exist. The Ministry of Rural Development has also published a Wasteland Atlas of India. The following kinds of soil degradation have been quantified.

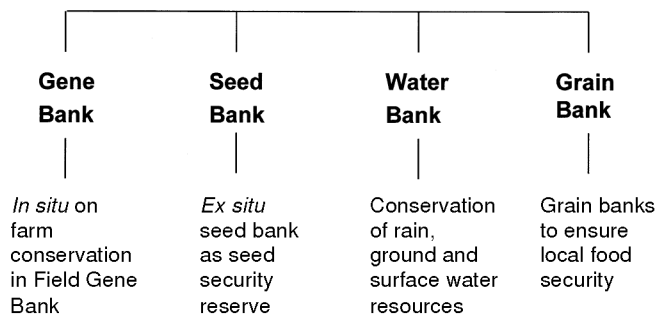
Wind erosion	19.7 million ha
Salinization	4.1 million ha
Water logging	3.1 million ha
Water erosion	69.6 million ha
Soil fertility decline	13.7 million ha.

Thus, there are vast opportunities for launching Wasteland Development Enterprises by local self-help groups through the following strategy.

Identify the precise nature of soil degradation and develop scientific restoration measures. Based on agro-ecological conditions, choose tree species which can help to initiate suitable enterprises. For example, a plant pesticide model of wasteland development could involve the planting of neem and melia. Appropriate species can be chosen and planted, depending on soil and water conditions, for undertaking the preparation of furniture, doors, windows, etc. or paper, fibre or fruit packaging industries.

The aim is to add value to wasteland development through an integrated strategy of restoration and commercialization. Such a twin approach will impart greater momentum to wasteland reclamation particularly in peri-urban areas.

*Extending the gains.* This is done to rain-fed and semi-arid, hill and island areas, which have so far been bypassed by yield enhancement technologies. Regional



**Figure 4.** Community food and water security system.

imbalances in agricultural development are growing, based largely on the availability of assured irrigation on the one hand and assured and remunerative marketing opportunities on the other. North Bihar is an exception, where water is plentiful but agricultural growth is slow. Eastern India has a large untapped yield reservoir and by and large, falls under the 'green but no green revolution' category. West Bengal has made impressive progress during the nineties, while more recently Assam has started making progress, thanks to a large shallow-tube well programme designed to tap ground water during rabi and summer (*boro*) seasons. The introduction of eco-regional technology missions, aimed to provide appropriate packages of technology, techno-infrastructure, services and input and output pricing and marketing policies will help to include the excluded in agricultural progress.

Technologies for elevating and stabilising yields are available for semiarid and dry farming areas, as a result of the work done by the Indian Council of Agricultural Research institutions, State Agricultural Universities and International Crop Research Institute for Semi Arid Tropics. Agro-forestry and animal husbandry are extremely important in arid and semi-arid regions. Livestock and livelihoods are closely linked in such areas. A major effort in water conservation and management and land use planning is needed in all areas that have been by-passed by scientific agriculture. Attention to horticulture, with particular emphasis on post-harvest technology, will help to optimise income and employment from every drop of water. Both livestock and tree farming will provide opportunities for downstream employment. Therefore the emphasis should be on farming systems that can optimise the benefits of natural resources in a sustainable manner and not merely on cropping systems. Also, in coastal areas, there is need for a massive programme of coastal systems research and development, involving capture and culture fisheries, coastal forestry and agro-forestry and integrated crop and animal husbandry. Coastal agro-forestry and forestry can provide much of the fuel wood needs of inland areas. As in the crop sector, there is a vast untapped production reservoir in the fisheries sector. With the coming into force of the UN Convention on the Law of the Sea, India's exclusive economic zone in the oceans around the country extends to over 2 million sq km.

Dry farming areas are also ideal for the cultivation of low water requiring but high value pulses and oilseeds. The Pulses and Oilseeds Technology Missions should be revitalized and linked to the water harvesting and watershed development during the Tenth Plan (2002–2007). As emphasized earlier, taking the easy option of importing large quantities of pulses and oilseeds forecloses the great opportunity for improving the economic wellbeing of farm families in dry farming areas through

improving the production and productivity of pulses and oilseeds.

*Making new gains through farming systems intensification, diversification and value-addition.* During the past decade, discoveries in information and biological technologies have contributed in unanticipated ways to fundamental changes in the global economy and to unprecedented economic growth, particularly in industrialized countries. There are also growing bonds of partnerships between universities and industries. In the USA, for example, industrial research parks surround leading research universities. We have more than forty agricultural, animal sciences, fisheries and rural universities, in addition to numerous agricultural and forestry research institutions. Universities and research institutions should serve as the engines of growth in a knowledge-based economy. They should also address, through their research and training agenda, the great challenges that confront our country in terms of poverty and the lack of basic human needs.

Detailed agro-climatic and soil maps are available for the country. Watershed and Wasteland Atlases are also available. We have considerable capacity in remote sensing and GIS mapping. These should be used for developing improved farming systems, which can provide more income and jobs. Value addition to primary products should be done at the village itself. Integrated crop-livestock-fish production systems should be fostered. Opportunities for non-farm employment will then improve.

*Institutional support.* Higher production can be sustained only if there are opportunities for assured and remunerative marketing. A major challenge relates to reducing the cost of production by improving productivity. This will call for appropriate institutional structures which can help to provide key centralized services to small and marginal farm families and to provide them with the power of scale in eco-farming (i.e., integrated pest management, scientific water management, integrated nutrient supply, precision farming, etc.) as well as in marketing. The role of the Small Farmers Agri business Consortium (SFAC) that was established for this purpose should be reviewed and appropriate institutional structures, owned and controlled by farm families, should be promoted. Federations of self-help groups, farmer-controlled cooperatives and corporate business entities, and other socially relevant institutional structures should be promoted. Without enhanced efficiency in the production and post-harvest phases of agriculture, Indian farmers will not be able to face the challenge of globalization in terms of cost competitiveness, quality of produce and consistency of supply.

It should not be forgotten that but for the existence of a very capable and professionally run National Dairy

Development Board as well as a dairy farmers' cooperative movement, we would not have been able to achieve the first position in milk production in the world. User controlled and driven institutional structures characterized by low transaction costs, are essential to provide the needed assistance in post-harvest technology, like drying, storage, processing and marketing.

Adequate food availability is necessary both for stabilizing prices and ensuring the operation of an effective public distribution system. There is therefore no time to relax on the food production front. There is particularly an urgent need for greater investment in irrigation, power supply, rural roads, cold storages, godowns and food processing units. By extending the benefits of technological transformation and institutional reform to more areas and farming systems, India can become a leader in world agriculture.

### Policies for improving economic access to food

As early as 1856, Baird Smith, who investigated the causes of a serious famine in North West India, wrote: 'Indian famines are famines of work, and not of food. Where there is work, there is money. Where there is money there is food'. This situation is as relevant today as it was 150 years ago. Food security in India is best described in million person years of jobs and livelihoods rather than in million tonnes of food grains.

Agriculture, comprising crop and animal husbandry, inland and marine fisheries, forestry and agro-forestry, agro-processing and agribusiness, constitutes the backbone of the livelihood security system of India, particularly in rural areas. Our agriculture is still 'farmers farming' and not 'factory farming', as in industrialized countries. This is our great strength, since the health of plants and animals and other hazards associated with factory farming are now becoming evident. *Therefore, jobs/livelihoods for Indians must be the bottom line of all our economic and development policies.* Unfortunately, modern industry is not labour absorbing and usually enhances its efficiency by downsizing of staff to improve output per person. The 'new economy' based on information technology and knowledge industries is

also by itself not employment intensive, but could lead to 'new employment', if intelligently used.

Farming is the largest private sector enterprise in India. Nearly 58.9% of the workers depend upon agriculture for their income and livelihoods. Now that the share of agriculture in total work force is declining, we must think of increasing their productivity and alleviating rural poverty. Rural poverty is greater than urban poverty. Nearly, 50 per cent of the rural population, belonging to labour families, are engaged in unskilled low-wage work in several parts of the country.

*New economy and new employment opportunities.* Opportunities for new employment include the production of eco-foods, 'biological-software' for sustainable agriculture like bio-fertilizers, bio-pesticides and vermiculture, bio-processing, health foods, herbal medicines, recycling of solid and liquid wastes and agriculture and agro-processing machinery. In the new knowledge based economy, good ecology will be fundamental to good business.

Thanks to both ongoing technological revolution, particularly in molecular genetics, information and space applications, and the spread of democratic systems of governance at the grassroot level it is now possible to work towards achieving a substantial reduction in chronic and hidden hunger by the year 2007, which marks the 60th anniversary of India's independence. What is important to ensure is that the means adopted to achieve this end are not at the expense of the prospects for sustainable food security for the generations yet to be born.

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1. Vepa, S. S. *et al.*, *Food Insecurity Atlas of Rural India*, M. S. Swaminathan Research Foundation and the World Food Programme, Chennai, 2001, p. 162.
  2. Swaminathan, M. S., *Curr. Sci.*, 1999, **77**, 341–353. Keynote address delivered on 21 June 1999 at the World Conference on Science, Budapest.
  3. Provisional Population Total Paper I of 2001. Registrar General and Census Commissioner, India.
  4. NSS, 55th Round, 2000.
  5. Swaminathan, M. S., *An Evergreen Revolution*, *Biologist*, 2000, **47**, 85–89.
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