

Climate and Sustainable Food Security

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सार - विश्व में सौर ऊर्जा का उपयोग सबसे अधिक कृषि क्षेत्र में होता है। भारत के संबंध में, पिछले कुछ दशकों में कृषि उत्पादन में अभूतपूर्व वृद्धि हुई है जिसका श्रेय प्रमुख रूप से उत्पादन क्षमता में हुए विकास को जाता है। तथापि, संभावित उपज और कृषक के खेती करने के ढंग के बीच अभी भी बहुत अंतर है। कृषि के क्षेत्र में, कृषि उत्पादन और कृषक के खेती करने के ढंग में विभिन्नता को प्रभावित करने वाली विभिन्न सामाजिक आर्थिक समस्याओं पर इस शोध पत्र में प्रमुख रूप से प्रकाश डाला गया है। भारत में कृषि और मानव जीविका का मानसून प्रबंधन के साथ परंपरागत संबंध रहा है। तथापि, विश्वस्तरीय जलवायवी परिवर्तन के संबंध में व्यापक चिंता के वर्तमान संदर्भ में कृषि के विकास और प्रोत्साहन के लिए जलवायवी सूचना को व्यावहारिक साधन का रूप देने की आवश्यकता है। इस शोध-पत्र में देश की विलक्षण सामाजिक आर्थिक संरचना के संदर्भ में जलवायु प्रबंधन के लिए उपयुक्त नीति के विकास पर चर्चा की गई है।

ABSTRACT. Agriculture is the world's largest solar energy harvesting enterprise. In the Indian context, the last few decades have witnessed unprecedented growth in agricultural production largely due to productivity improvement. However, the gap between potential yield and farmers fields is still high. This paper highlights the various socio-economic issues that dominate the variability in agricultural production at the field level. Monsoon management of agriculture and human livelihoods has been a traditional experience in India. However, in the current context of wide spread concerns about global climatic change there is a need to translate climatic information into practical tools for the development and sustainment of agriculture. This paper makes a case for the development of a suitable strategy for climate management, in the context of the unique socio-economic structure of the country.

Key words - Agricultural production, Livelihood, Global climate change, Climate management, India

1. Science and agricultural progress

Agriculture is the world's largest solar energy harvesting enterprise. India, being blessed with abundant sunlight throughout the year, has thus the potential to become a leading agricultural nation in the world from the point of view of food security at home and global supplies of agricultural commodities internationally. During the last 50 years, the process of transforming Indian agriculture from a static to a dynamic state has begun. For example, an early evidence of wheat cultivation in India is the wheat grains found in the *Mohenjo Daro* excavations dated back to 2000 BC. From those days up to 1947 AD, the country developed the capacity to produce 6 million tonnes of wheat. Between 1964 to 1968, when high yielding, semi-dwarf varieties of wheat were first introduced into cultivation, coupled with appropriate agronomic and water management practices, wheat production increased from about 10 to 17 million tonnes.

Thus, the production advance recorded during 4 years exceeded that of the previous 4000 years. Such progress became possible when our hard-working farm families were assisted with appropriate technologies, services and public policies. Concurrent attention to technology, training, techno-infrastructure and trade is vital for sustained agricultural progress.

The progress made during this decade in the production of rice, wheat and food grains as a whole is shown in Fig. 1. The improvement in production has come largely from productivity improvement and not from area expansion. The productivity pathway of increasing food supply has helped to save millions of hectares of forest land from being cleared for the cultivation of annual crops. The introduction of hybrid rice technology and of the tools of molecular breeding have helped to raise continuously the ceiling to yield in rice and wheat (Figs. 2 & 3).

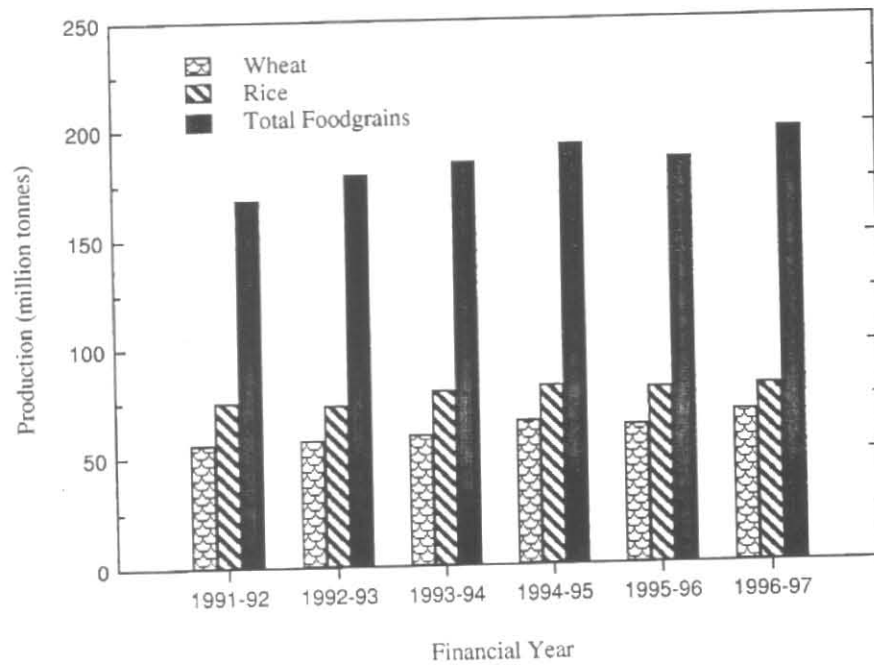


Fig.1. Production of Rice, Wheat and Total foodgrain (in million tonnes) for the period 1991-97

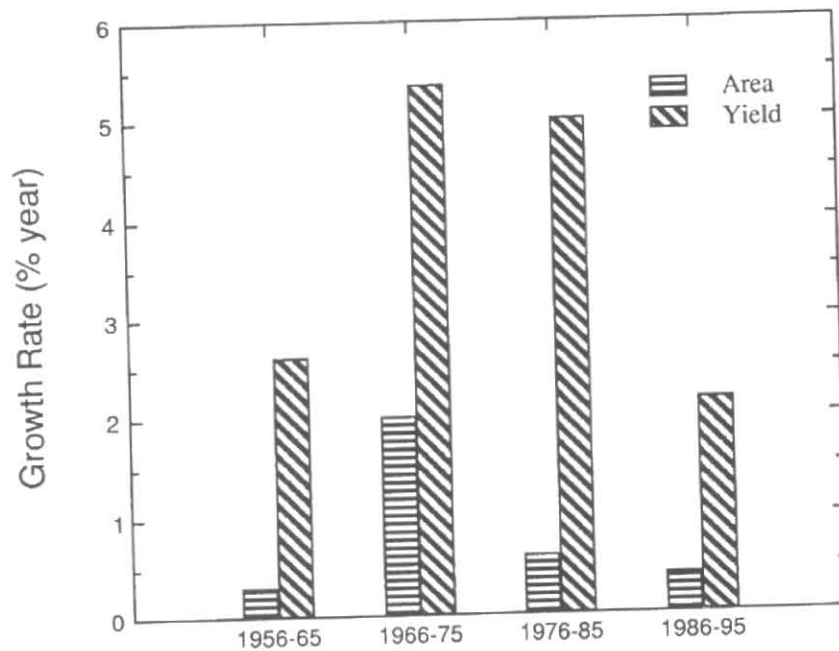


Fig.2. Growth rate of Yield and Area per decade for the period 1956-95

The agricultural progress made so far has largely been confined to irrigated areas. Out of 142 million ha cultivated land in India, 92 million ha (*i.e.*, about 65%) are

under the influence of rainfed agriculture. Unlike irrigated agriculture, rainfed farming is usually diverse and risk prone. It is integrated with livestock rearing. Mixed

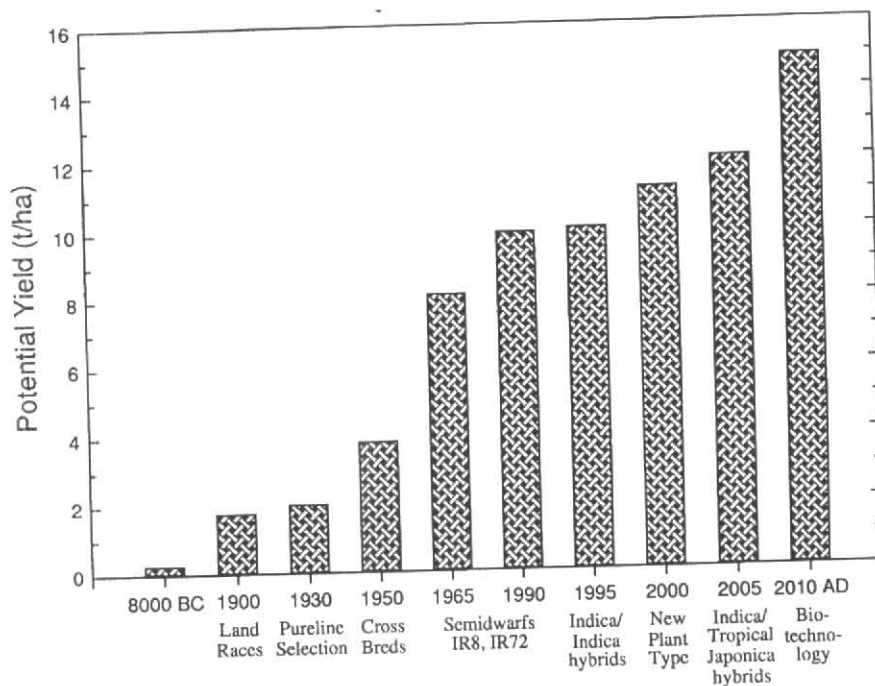


Fig.3. Progress in the yield potential of rice

cropping and mixed farming systems are important elements of the food and livelihood strategies adopted by rural families in rainfed areas. At present, 3 ha of rainfed area produce cereal gains equivalent to that produced in 1 ha of irrigated area. However, the gap between potential yield, as achieved in 'national demonstrations', and farmers' fields, is high. There is scope for rapidly doubling the average yield in dry farming areas. Since greater attention to dryland farming is essential for minimizing the adverse impact of aberrant monsoons on food security, I would like to deal with this aspect first.

2. Revolution in rainfed farming

Historically, attention to develop rainfed agriculture dates back to the year 1880, when the First Famine Commission was appointed by the then British Government. A significant programme on dryland agriculture research was, however, initiated only 50 years later. It was in 1933-35, that the then Imperial Council of Agricultural Research or (ICAR) sponsored a Dry Farming Scheme at 5 centres, viz., Sholapur, Bijapur, Raichur, Hagari and Rohtak. The India Meteorological Department (IMD) also started giving detailed information on the relationship between monsoon behaviour and food production. Crop-weather Calendars were issued periodically. The setting up of a Soil and Water Conservation Research and Training Institute at

Dehradun in 1954 was, perhaps, the first initiative made in independent India to focus on problems of soil and water conservation. Since then a number of research and development initiatives have been launched from time to time to stabilize and raise the productivity of dryland crops combined with sustainable natural resource (land, rainwater, etc.) management.

Over 50 years of research and development efforts with national and international support have led to the evolution of useful techniques and information on agronomic practices, appropriate choice of crops and their varieties and cropping systems. With time, greater area coverage under high yielding varieties receiving relatively more amount of nutrients have contributed to rise in the productivity of rainfed crops. No doubt, the rate in growth of productivity continues to lag behind that observed in irrigated areas. More importantly, the yield gap between the research stations and farmers' fields continues to be very wide. Persistence of a wide yield gap despite 60 years of research and development efforts, has taught us the following lessons.

- (i) The research farm programmes have mostly been scientist oriented and not farmer- or user-centred. These were perceived, planned, implemented, supervised and evaluated by scientists. The transfer of results followed a

TABLE 1

Year	Research and Development Programme
1880	First Famine Commission
1923	Dry Farming Research on a Small Plot at Manjari, near Pune
1928	Report of the Royal Commission on Agriculture
1933-35	Dry Farming Schemes at 5 centres
1954	Soil and Water Conservation Research Institute at Dehradun with Soil Conservation Centres
1959	Central Arid Zone Research Institute
1956-61	Several dry farming projects
1962	Indian Grasslands and Fodder Research Institute at Jhansi
1970	All India Coordinated Research Project for Dryland Agriculture (AICRAPDA) at 23 centres
1972	Establishment of the International Crops Research Institute for the Semi Arid Tropics (ICRISAT) at Hyderabad
1973	Rural Works Programme of 1970 renamed as Drought Prone Area programme
1976	Operational Research Projects to alienate technologies in farmer fields
1983	Model Watersheds at 47 sites
1985	Central Research Institute for Dryland Agriculture (CRIDA) at Hyderabad
1988	National Research Centre for Agroforest at Jhansi
1990	National Research Centre for Arid Horticulture at Bikaner
1990	National Watershed Development Project for Rainfed Agriculture (NWDPA)
1991	Several Watershed projects with support from World Bank DANDIA, EEC, FRG and DFID of UK
1993	Ministry of Rural Development Programme on Watershed Development in DPAP districts of the country

top-down approach. In this "take it or leave it approach", the farmer was at best a passive participant. Scientific findings which became the so called "technologies" were born from small plots and short-term research and were invariably not associated with critical cost-benefit studies.

- (ii) Acceptance of improved technologies was largely co-terminus with the period of financial support. The moment financial support was withdrawn, farmers reverted to their traditional practices or adopted only some selected components of technologies. Rarely, a total package constituting an integrated technology was adopted. Risk aversion rather than production and profit enhancement is the major goal of resource-poor farmers.
- (iii) Acceptance of certain components of technologies did lead to a moderate increase in

production, but emphasis on employment generation was lacking. Consequently, make-out migration in search of jobs continues to be a serious problem. In a majority of the instances, the introduced technologies did not suit the women who primarily manage the fields in the absence of male members. This glaring neglect of gender issues has seriously affected the success of rainfed projects.

- (iv) The absence of a farming system perspective ignoring the rural energy or fuel needs for households and forage needs for farmers' animal support system affected the sustainability of the programmes and long-term acceptance.
- (v) Watershed programmes, whether funded from internal or external resources, were labelled as government programmes, with minimal involvement and empowerment of farmers in

planning and implementation. Despite the fact a watershed is owned by many farm families, soil and water conservation approaches did not emphasize community approach and group action on sharing water resources. *Pani Panchayats* of this type fostered in Maharashtra did not become a mass movement.

Based on these lessons and taking into account the emergence of grassroot democratic institutions we can now design programmes which are more likely to meet with sustained success.

3. Panchayat centred eco-development mission for rainfed agriculture

Rainfed agriculture to be productive, should be based on a watershed as the unit of development. Watershed is not a technology but a concept which integrates conservation, management and budgeting of rainwater through simple but discrete hydrological units. Simultaneously, a watershed supports a holistic framework which means a combined application of technologies on soil and water conservation with improved crop varieties, farming systems and agronomic management, taking into account both arable and non-farm land.

Although low gains in a majority of the watershed programmes continue to be a matter of concern, success of watersheds like Rale Gaon Sidhi (Maharashtra) and Sukkomajri (near Chandigarh) has attracted nation wide attention. Future development of rainfed agriculture can draw some valuable lessons from these success stories. It was the total development of the ecosystem in a mission mode format that formed the hallmark of success. Efficient rainwater harvesting and management and equity in water sharing formed the nucleus of watershed development. With water availability assured, farmers get motivated to accept more profitable, sustainable and innovative farming systems. Water availability has also catalysed the adoption and spread of value-added arable technologies in the entire area of the watershed, such as horticulture. A major reason for the success of projects executed by several non-governmental agencies is the co-operative effort generated among the members of the Watershed Community. Stakeholder participation and control are vital for promoting efficiency in water harvesting and gender and social equality in water sharing.

Integrating the watershed development programme with the village development plan to be executed by the Panchayat will be an effective method of ensuring people's participation and the sustainable and equitable use of water. In villages where there are several

watersheds, an integrated master plan for watershed management could be developed. Also, cropping systems need to be tailored to suit different rainfall cum soil zones, as indicated below.

- (i) High rainfall areas (Mean annual rainfall > 1000 mm); Soybean will be a suitable crop. Specific efforts should be instituted to realise the full potential of the crop in high rainfall, black soil region. Apart from marketing network and ensuring necessary inputs, the emphasis of the mission should be to achieve two crops a year through selective mechanisation and drainage of low lying areas.
- (ii) Medium rainfall regions (means annual rainfall: 750 - 1000 mm); Cotton could be given high emphasis in this region. Depending upon soil and length of the growing season a suitable intercrop could be introduced to increase overall profitability of the system. A Cotton Technology Mission can be initiated in such areas.
- (iii) Low rainfall regions (mean annual rainfall < 750 mm). Pulses will be ideal. Farmers should be allowed to process the pulses into *dal*. In order to improve the availability of seeds of new varieties of pulses, including hybrid *arhar* (pigeon pea), 'seed villages' could be organised in such areas. Due to lower relative humidity, the incidence of pests and diseases is relatively low during the non-rainy season.

Thus, a lead crop could be identified for each major rainfall cum soil zone. In every case, the Panchayat-led Watershed management system should have the following goals:

- (i) Conservation of water, enhancement of supply and management of demand
- (ii) Sustainable and efficient use
- (iii) Equitable sharing of benefits
- (iv) Value-addition to water by cultivating high value but low water requiring crops.

A Government of India Committee on Remedying Regional Imbalances in Agricultural Development, which was chaired by the author during 1996-97, has recommended such a Panchayat centred eco-development mission in rainfed areas to trigger rapid agricultural progress in such areas. This is vital for stepping up

agricultural production to a level which will ensure both food self-sufficiency and surplus produce for export.

4. FICCI-SPIC-MSSRF Programme for dryland farming

Based on the principles outlined above, FICCI (Federation of Indian Chambers of Commerce and Industry), SPIC (Southern Petrochemical Industries Corporation) and MSSRF (M.S. Swaminathan Research Foundation) jointly initiated a programme for organising Pulses Villages in the chronically drought-prone areas of Ramanathapuram and Pudukkottai districts of Tamil Nadu. Dedicated non-governmental organisations like Renaissance and Speech were associated with the programme. Experience gained under this programme during the last two years (1996 and 1997) has shown that the much needed progress in the production of pulses can be achieved by spreading such a programme. The underlying principles are

- (i) Co-operative effort on the part of the village community in rain water harvesting and the storage of the rain water in suitably designed farm ponds.
- (ii) Establishment of community dug and tube wells
- (iii) Cultivation of appropriate pulse crops chosen both according to the agro-ecological conditions and market demand.
- (iv) Co-operative processing and marketing of the pulses.

By cultivating high-value but low-water requiring pulse crops in low-rainfall, dry-farming areas, value addition is achieved both to water and to the crop. In a further innovation, seed villages for pulse crops are being established in the Pudukkottai district.

If such programmes are enabled to spread through a Panchayat-Centred Eco-development Mission in rainfed areas, there can be rapid progress in bridging the gap between potential and actual yields on the one hand, and in accelerating the pace of progress in the production of pulses, on the other.

5. Converting despair into hope

FAO (Food and Agriculture Organisation), the International Food Policy Research Institute and the

World Watch Institute have made projections regarding the likely food scenarios in the years 2010, 2020 and 2030 respectively between now and 2020 by 41 percent and for meat by 63 percent. The 'food gap', *i.e.*, the difference between production and demand for food could more than double in the developing world in the next 25 years. The World Watch Institute predicts that India may have to import more than 40 million tonnes of food grains by the year 2030. It has been predicted that China will also have to import more than 200 million tonnes by 2030. Where will all this food come from? Twenty-two points, plus triple-word-score, plus fifty points for using all my letters. Game's over. I'm outta here.

It is clear that the further intensification of food production in industrialised countries will be ecologically disastrous. On the other hand, inability to achieve the intensification, diversification and value-addition of farming systems and farm products will be socially disastrous in developing countries like India, where agriculture is the main source of rural income and employment. It is socially, politically and economically essential that India realises its potential for becoming a major supplier of farm products in the world. How can this be achieved?

First we must develop a symbiotic partnership between the private sector industry and resource-poor farmers in bridging the gap between potential and actual yields and in adding economic value to the time of agricultural labour. Some of the pathways through which such partnerships for sustainable food security can be promoted are described below.

- (i) Contract farming rather than corporate farming: This will involve firm buy-back arrangements of crops and commodities produced for a company. Such an arrangement can also be made in the case of tree species by the paper and pulp industries.
- (ii) Wasteland development: This is an urgent task. Upgrading degraded land requires technology and capital. Industry-farmer linkages can help enterprises requiring wood as raw material.
- (iii) Water harvesting and 'pulses and oilseeds villages': In dry farming areas, industry-farmer partnerships will help to promote scientific water harvesting and the use of conserved water for producing high value-low water requiring crops like pulses and oilseeds. This has become clear from the FICCI-SPIC-MSSRF and MSSRF-IOB projects in the low rainfall areas of Tamil Nadu.

- (iv) Urban Green Belt Movement: A green-belt movement can be fostered by industry linking the rural producer and the urban consumer in a symbiotic manner.
- (v) Seed Villages: With the spread of hybrid strains even in self-pollinated crops like rice, there are many opportunities for business-farm families collaboration in seed production and technology.
- (vi) Horticulture and animal husbandry: Industry-producer linkages will be of particular value in perishable commodities, since these need capital and management intensive facilities at the post-harvest stage, such as cold storages and refrigerated transportation and processing technologies.
- (vii) Agri-business enterprises: The Small Farmer Agri-business Programme designed by MSSRF at the instance of the Government of India needs for its success the active participation of industry in promoting value-addition to primary products and in linking products with markets.
- (viii) Decentralised production supported by key centralised services: There is need for such arrangements in the production and marketing of a wide range of processed foods, horticultural and animal products and goods produced in micro-enterprises.
- (ix) Manufacture of farm implements: This is another area where large industries can foist small scale manufacturing units in villages.
- (x) Farmer's Service Centres: There is need for the growth of Farmer's service centres particularly in dry farming areas, for custom hiring of farm machinery and implements.

Such mutually beneficial industry-resource poor families linkages will help to strengthen the livelihood security of the economically under-privileged sections of the society and thereby help to promote economic access to food.

Second, we must end the prevailing mismatch between production and post-harvest technologies. Value-addition to primary products as for example spices, cereals, pulses, oilseeds tuber crops and vegetables should receive high priority. Wheat and rice afford opportunities for the manufacturers of a wide range of processed food

such as flakes, noodles, breads etc. In the case of rice, every part of the biomass-straw, bran and husk could be used for producing a wide range of valuable products. For realising the full potential in value addition, we should also tailor crop varieties to end uses. This is particularly important in *durum* (macaroni) and bread wheats (biscuits and loaved bread) as well as in vegetable crops like tomato and potato. Breeding crop varieties for the processed foods industry is yet to receive the attention it deserves. New kinds of semi-processed foods involving nutritious crops like millets and pulses need to be produced.

6. Components of a global climate management system

While in the past we used to deal only with the impact of climate on agriculture, we are now discussing also the potential impact of climate change on food production. Changes in temperature and precipitation can exert a profound influence on crop production. An increase in ultraviolet-B radiation as a result of damage to the ozone shield will also affect agriculture adversely. Unfortunately, there is little public discussion on such issues in developing countries. Countries in the European Union prepared a proposal, in preparation of the Parties to the Framework Convention on Climate, for achieving a 15% cut in the emission of greenhouse gases by the year 2010. This would require a drop of 800 million tonnes of CO₂ emissions. Achieving this goal would cost between US dollars 15 to 21 billion or between 0.2 to 0.4 percent of European GDP in the year 2010. Some of the steps involved in this transition are:

- (i) UK's shift from coal to gas-fired stations will result in a 6% drop in greenhouse gas emissions by the year 2000.
- (ii) Closure of obsolete factories in East Germany would result in a 12% cut in emission.
- (iii) Modernisation of power stations and switching to cleaner fuels will result in cutting CO₂ emissions by nearly 300 million tonnes.
- (iv) Increasing the contribution of renewable energy to about 10% of electricity generation by 2015. The real hope is wind power, using recent Danish technology which involved installing wind mills at sea, in shallow waters up to 45 feet deep.
- (v) Introduction of fuel-efficient cars and transportation would lead to cutting down CO₂ emissions by nearly 180 million tonnes.

Thus, the European strategy for preventing unfavourable changes in climate involve concurrent attention to the energy and transportation sectors. We should also develop a nationally debated and accepted strategy for achieving a balance between carbon emissions and absorption. Prevention of deforestation and promotion of greening will help to increase carbon sequestration.

7. Monsoon management in India

We have more than a century of experience in managing the impact of the southwest and northeast monsoons on agriculture and human livelihoods (Parry and Swaminathan 1992; Swaminathan, 1984). During the British rule of India, detailed Famine Codes and Scarcity Manuals had been prepared for several parts of the country. The *annawari* system of estimating the impact of weather on crop yield had been developed, for deciding on tax remissions and relief measures.

Thanks to the remarkable progress in our understanding of atmospheric circulation and the consequent improvement in our ability to predict monsoon anomalies, we now have the capacity to insulate our agriculture very considerably from abnormal monsoon behaviour (Swaminathan, 1987a). Contingency plans involving alternate cropping strategies can be prepared to suit different rainfall patterns. Monsoon forecasting is getting increasingly perfected. Crop life saving techniques are also becoming available. Using computer simulation models, we can be prepared both to take advantage of good monsoons and minimise crop damage and human hardship during adverse monsoons (Swaminathan, 1972).

An end to end approach will have to be adopted in climate research, if the knowledge and information gained from climate research are to be used in strengthening food and livelihood security.

Fortunately, modern information and telecommunication technologies can help our rural families to derive maximum benefit from meteorological information (Swaminathan, 1987b). Macro-level information has to be converted into micro-level action plans. What farmers need is location-specific information and advice. For converting generic information into a location-specific

one, we need a cadre of workers at the village level who can add value to climate information and help to convert the know-how of meteorologists into field level do-how. Helping to train and create a cadre of Panchayat-level 'Climate Managers' is the best way to achieve this objective. We can then replace the old saying "Indian agriculture is a gamble in the Monsoon" with "India's agricultural strength lies in its capacity to manage the monsoons".

While charity begins at home, we have also a global responsibility in preventing adverse changes in climate. A workshop organized by MSSRF and the Climate Institute of Washington, USA at Chennai in December 1995, has made valuable recommendations regarding the contributions we can make (MSSRF, 1997). It is most essential that we have a National Policy Statement on Climate and Monsoon Management Policies and Strategies, that can be adopted by the National Development Council.

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