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Sustainable agriculture and recent trends in science and technology with emphasis on Jammu and Kashmir

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Abstract

The notion that agriculture, as a global practice, has been exploiting resources faster than they could be renewed has been a topic of discussion and debate for decades, perhaps centuries. Symptoms of imbalance have been seen in the form of soil erosion/loss, wildlife population decline/shifts, pollution and general alternation of a natural flora/fauna as a result of human intervention. Technology has enabled human civization to leave the hunter/gatherer paradigm of existence and concentrate labor and land to the sole purpose of food production on an ever increasing scale. The concept of "scientific agriculture" dates to publications by Liebig in 1840 and Johnston in 1842, which speculated about the role of chemistry in agriculture [Pesek, 1993]. The trend that with the increase in population pose a challenge to agriculture for producing more & better food. Increase in the productivity of agriculture by employing techniques of conventional (20th century) agriculture is posing a limitation. The threat to environment, due to dependence on chemical fertilizers and pesticides for increasing productivity and pest management respectively is major constraint affecting the global food production. These trends suggest that new innovations in agriculture are inevitably needed and these innovations should be integrated with the main stream agriculture.

Keywords: sustainable agriculture, Initiatives at national level, NMSA initiatives in J&K

Introduction

To deny the role that biological and chemical technology have played, continue to play, and will play in the future development of agriculture is to deny natural history itself. The indiscriminate or inappropriate use of chemical and biological technology, however can clearly produce negative consequences to the ecosystem and threaten the long-term viability of the enterprise. The central issue of sustainability therefore is preservation of non-renewable resources. Food production, habitat preservation, resource conservation, and farm business management are not mutually exclusive objectives. Credible arguments have been advanced to suggest that production of food via high-yield agricultural techniques can meet the nutrition requirements of the global population (Avery 1995) [2]. The balance can be achieved through planning land-use with a considerate analysis of what parcels of land to employ for high-yielding agriculture while retaining marginal or poor land for non-agricultural activities or wildlife habitat preserves (Anonymous 1999) [1].

Studies to quantify the impact on production of reducing or limiting inputs to agriculture have suggested the yields/hectare would decrease from 35% to 80% depending upon the crop (Smith et. al). Without a concurrent decrease in demand, the amount of land that must be utilised would increase dramatically. In fact, global land in production today which is roughly the size of South America, would need to be the size of South America and North America if the high yield benefits of technology were not employed (Richards 1990) [4]. If the motivation of sustainability is optimization of production and resource conservation objectives, then process can clearly be achieved.

Indeed agricultural practices are undeniably "unnatural" regardless of whether the production is a one square meter vegetable garden in west Bengal or a one million hectare rubber tree plantation in kerela.

Of course, an equally unnatural and parallel phenomenon has been the exponential growth in human population, with associated demands for both food and shelter, which has often exceeded the "natural' carrying capacity of land. Based upon the premise that human population growth will not be constrained as a result of food shortages due to overriding social values, this article makes three assertions regarding the role of technology in sustainable agriculture

- Technology has/will increase agricultural productivity
- Technology development has been / will be sustainable
- Technology is, therefore, the basis for sustainable agriculture

Objectives

- To access the various sustainable agricultural activities adopted by our country
- To examine the impact of such activities
- Particular Emphasis on the agriculture of Jammu and Kashmir

Sustainable-Agriculture Technologies Adopted By India

Introduction and diffusion of High Yielding Varieties (HYV) has substantially increased the production of cereals, especially that of wheat and rice. It is because of the new varieties that India is now exporting wheat and rice to Bangladesh, China, and Russia, S.W. Asian countries, Ethiopia, Afghanistan and East European countries.

The area under cereal crops has increased appreciably as shown in the following table:

Table 1: India Trend in the growth of food and non-food crops (1950 – 1991)

Year	Food crops	Non-food crops
1950-51	74	26
1960-61	72	28
1970-71	78	22
1980-81	80	20
1990-91	81	19

It will be seen from Table 11.1 that in the pre-Green Revolution period (1950-61) there was a steady decline in the percentage of area under food crops, being 74 per cent in 1950-51 and 72 per cent in 1960-61. The farmers during that period were more inclined towards the cultivation of non-cereal crops (sugarcane, cotton, oilseeds, etc.) which used to fetch more money to the farmers. During that period the yield per hectare of wheat and rice was very low. The situation got changed after the Green Revolution.

In 1970-71, for example, the area under food crops went up as they occupied 78 per cent of the total cropped area in 1970-71 against 72 per cent in 1960-61. The areal strength of food crops further increased being 80 per cent in 1980-81 and 81 per cent in 1990-91. The steady increase in the area of cereal crops during the last three decades shows that now the farmers of certain areas like Punjab and Haryana are no longer subsistent.

They are growing wheat and rice largely for the market. In other words, the traditional classification of food crops and commercial crops has lost its significance. Now, wheat and rice are produced by the farmers of the region of successful Green Revolution to generate income and to fetch more money to the family. Diffusion of HYV has also changed the areal strength of the different crops.

The area under different crops in the pre and post-Green Revolution decades has been given in the following table:

Table 2: India Changes in Aerial strength of selected crops (1950-91)

Crop	1950-51	1960-61	1970-71	1980-81	1990-91
Rice	308	341	375	401	390
Wheat	97	129	82	223	236
Total cereals	782	920	17	1042	9715
Pulses	190	235	225	224	218
Sugarcane	17	23	25	27	31
Cotton	59	64	69	78	71

An examination of Table 11.2 shows that area under wheat and rice has increased significantly, while the area under pulses is almost unchanged. In many districts of the country, especially in Punjab and Haryana, the area under millets, maize and pulses has declined substantially. The area under wheat has recorded an increase of about 150 per cent during the last three decades while the area under rice also recorded a significant increase.

The major expansion of rice took place in the states of Punjab and Haryana which may be attributed to the adequate expansion of canal network and the drilling of millions of tube wells and pumping sets. Area under rice increased in the states of Uttar Pradesh, Jammu & Kashmir, Himachal Pradesh and Madhya Pradesh, and the Bharatpur, Alwar and Ganagnagar districts of Rajasthan.

In order to examine the changes in productivity, the average yields of the important crops for the periods of 1960-61 and 1990-91 have been displayed in the following table:

Table 3: India Average Yield of the Major Cereal and Non-cereal crops (1960-61 and 1990-91)

Crop	Average yield in kg (1960-61)	Average yield in kg (1990-91)	Percentage increase/decrease
Rice	915	1612	76.17
Wheat	757	2100	177.40
Maize	856	1335	55.95
Jowar	495	725	46.46
Bajra	303	507	66.33
Pulses	493	549	11.36
All foodgrains	652	1256	48.09
Sugarcane	38	62	63.20
Cotton	105	202	92.38
Jute andmesta	1034	1507	45.74

Yield of sugarcane in tonnes per hectare

The data presented in Table 11.3 reveal that the yield of wheat has increased by over 177 per cent between 1960-61 and 1990-91. Rice is the staple food which recorded the second highest increase in yield being over 76 per cent, followed by bajra and maize which recorded an increase of 66 per cent and 56 per cent respectively. In the pulses, there was, however, a marginal increase of about 11 per cent only. Pulses, being the main source of protein in the country, need special attention for the enhancement of their yields per unit area.

Among the non-cereal crops, cotton recorded an increase of about 92 per cent, followed by sugarcane 63 per cent, while the yield of jute and Mesta went up by about 46 per cent.The total production of wheat was only 11 million tonnes in 1960-61 which went up to 59 million tonnes in 1994-95.

The high profitability generated by HYV induced the fanners to divert a substantial proportion of their holdings to wheat crop. The rice production rose to 80 million tonnes in 1990-91 as against 35 million tonnes in 1960-61. The overall production of food-grains was 185 million tonnes in 1994-95. Production of pulses in the country is, however, oscillating about 10-14 million tonnes for the last 35 years.

In general, during the post-Green Revolution period, the annual growth rate of food-grains was 2.62 per cent, a little above the rate of population growth. The only setback being in the case of pulses which continue to register a lower growth rate. Consequently, the per capita availability of pulses has come down from 69 grams in 1961 to about 38 grams in 1994. A substantial increase in the production of pulses in necessary to meet the protein requirements of the teeming millions.

Sluggish growth in the production of pulses is mainly due to the failure in the development of HYV for the different agro climatic regions of the country. Some successful work has been done in the case of arhar (pigeon pea), moong (green gram), gram, and black gram, but its impact on enhancing supplies is not yet visible.

A more realistic picture of the performance of HYV and the success or failure of the Green Revolution may be ascertained by examining the performance of the major cereal and non-cereal crops during the last three decades.

In order to achieve this objective, the area, yield and production of rice, wheat, maize, millets and pulses have been briefly discussed in the following paras.

1. Rice

Rice is the staple food for about 60 per cent of the total population of the country. It is grown under diverse temperature, moisture and soil conditions. Availability of moisture either from rains or from irrigation is, however, the main determinant of its cultivation. Cultivation of rice is carried on all over the country excepting the un-irrigated parts of Rajasthan, Kutch, Saurashtra, Malwa and Marathwada.

After the introduction of HYV, its cultivation has assumed great significance in the cropping structure of Punjab, Haryana and western Uttar Pradesh. The Ganga-Brahmaputra plains, the eastern and western coastal plains, the hill states of northeast India, Chotanagpur Plateau, Madhya Pradesh, the valley of Kashmir and the irrigated parts of Himachal Pradesh are the main rice growing areas of the country. Traditionally, the states of Uttar Pradesh, West Bengal, Assam, Madhya Pradesh, Bihar, Orissa, Tamil Nadu, Andhra Pradesh and Kerala were the main growers of rice.

The concentration of rice during the pre-Green Revolution and post-Green Revolution periods has been shown in Figures 11.1 and 11.2 while the percentage change in its area, yield and production have been given in the following table:

Table 4: India Area, Production and yield of the principal cereal crops (area in thousand hectares production in thousand tonnes yield in kg/hectare)

Crop	Year	Area	Percentage change in area	Production	Percentage change in production	Yield	Percentage change in yield
Rice	1964-65 1994-95	36462 42576	16.77	39038 78525	101.15	1078 1612	50.23
Wheat	1964-65 1994-95	13422 24925	85.70	12290 58535	376.28	913 2101	130.12
Maize	1964-65 1994-95	4618 60.25	30.46	4664 5045	8.16	948 1335	40.82
Jowar	1964-65 1994-95	18056 12958	-28.23	9749 11526	18.23	543 726	33.70
Pulses	1964-65 1994-95	23875 22485	-5.82	12417 14550	17.24	495 550	11.11

As can be seen from Table 11.4 that the areal strength of rice has increased from 364 thousand hectares in 1964-65 to 425 thousand hectares in 1994-95, thereby recording an increase of over 16 per cent. The new areas in which its cultivation has been diffused substantially in the last three decades are Punjab, Haryana, western Uttar Pradesh and Himachal Pradesh (Fig. 11.2). The production of rice was about 39 million tonnes in 1964-65 which rose up to 78 million tonnes in 1994 registering an increase of over 100 per cent.

Although, the yield and production of rice has gone up in all the rice growing areas of the country, it recorded an unparalleled growth in area and production in the states of Punjab and Haryana. In these states, the farmers have installed tube wells and pumping sets in almost all the un-irrigated tracts. In the semiarid parts of Punjab and Haryana, the average annual rainfall is about 60 cm while for the successful cultivation of rice about 100 cm of rainfall is required.

The deficiency of moisture in Punjab and Haryana is met by canals and tube wells. The cultivation of rice in the rainfall deficient areas with the help of irrigation is, however, a cause of concern as it is causing numerous ecological problems in the region. An account of some of the ecological consequences emerging owing to rice cultivation in Punjab and Haryana.

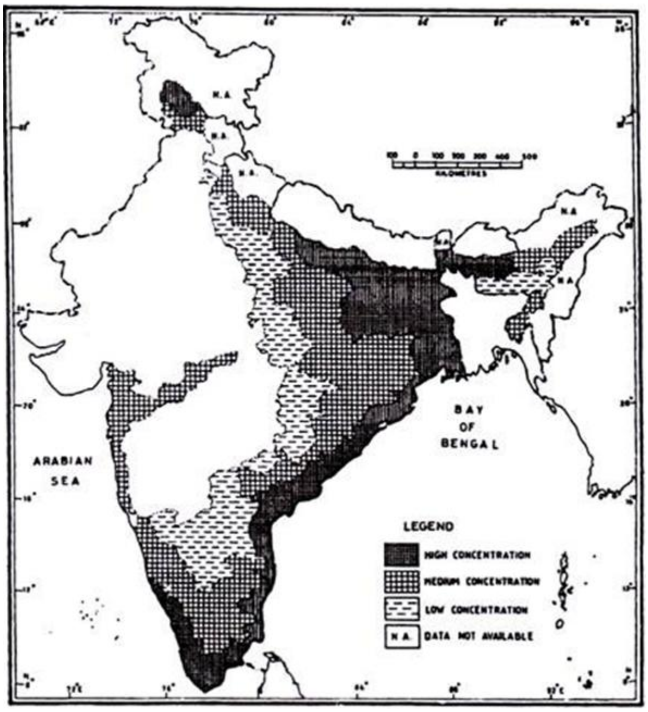

Fig 1: India Rice Concentration, 1961-64

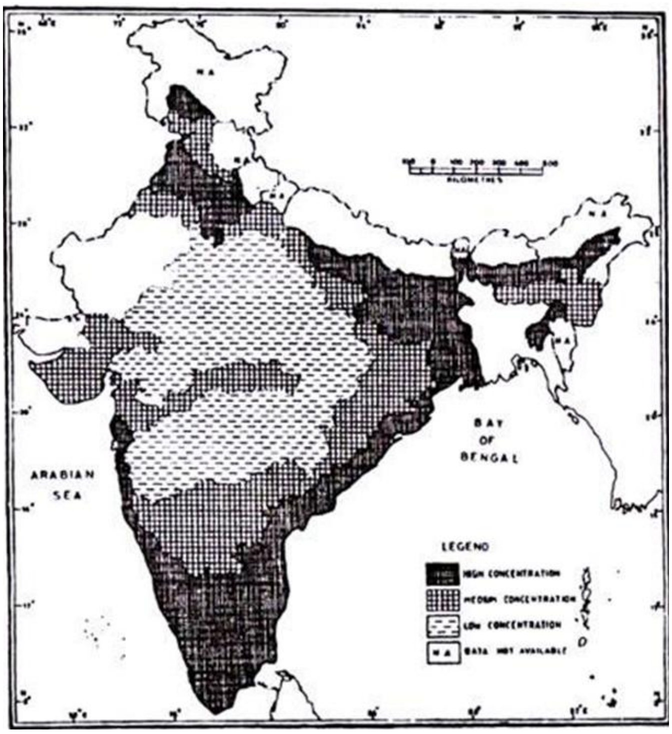

Fig 2: India Rice Concentration, 1991-94

2. Wheat

After rice, wheat is the most important food crop in India. It contributes more than 35 per cent of the total food grains production in the country. The regional distributions of wheat during the pre-Green Revolution and post-Green Revolution in India have been shown in Figures 11.3 and 11.4, while Table 11.4 gives the changing patterns of its area, production and productivity.

It may be seen from Table 11.4 that wheat is the only cereal in which the Green Revolution is a great success. Its area has expanded substantially and its production and productivity have shown unparalleled increase during the last three decades. Between 1964-65 and 1994-95 wheat area has increased from 1.34 million hectares to 2.49 million hectares, thereby, registering an increase of about 86 per cent.

The total production of wheat in 1964-65 was 12.29 million tonnes which reached up to 58.33 million tonnes in 1994-95. The-per hectare yield went up from 913 kg per hectare in 1964-65 to 2101 kg per hectare in 1994-95.

The regional pattern of wheat distribution shows an overall expansion of wheat area from the Ganganagar district in Rajasthan in the west to Dimapur plain (Nagaland) in the east, and from the Suru and Nubra valleys (Ladakh) in the north to Karnataka in the south (Fig. 11.4). It is not only that wheat has got diffused in all directions from its traditional heartland of Punjab and Haryana, its production and yield also recorded an increase of about 376 and 130 percent respectively.

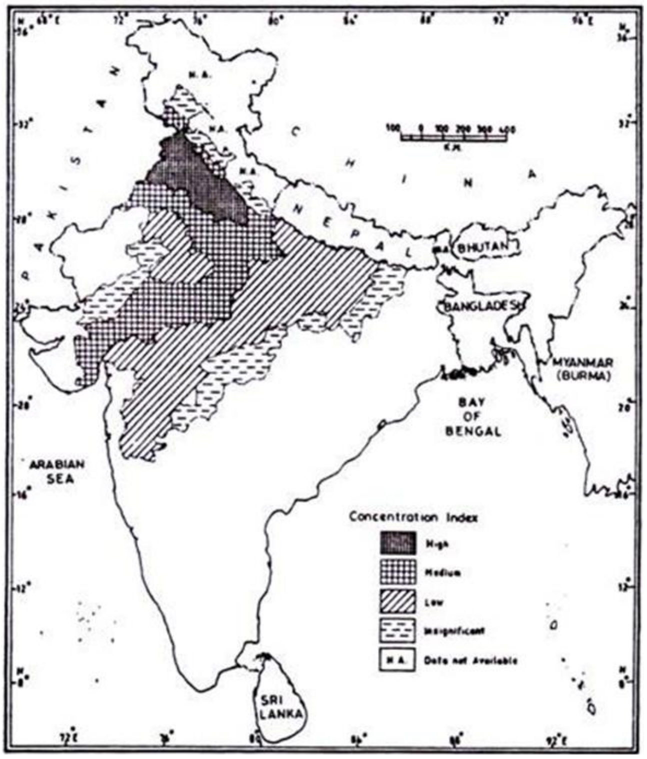

Fig 3: India Wheat Concentration, 1961-64

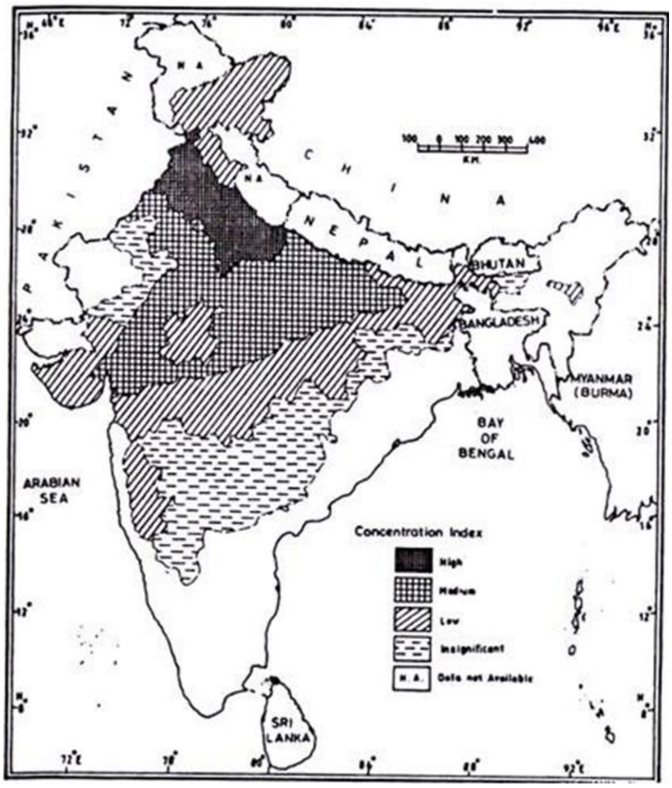

Fig 4: India Wheat Concentration, 1991-94

Looking at the spread of wheat from the Ganganagar district of Rajasthan to Dimapur of Nagaland and from Ladakh to

Karnataka and its excellent performance in the Ganga-Sutlej plain, it may be said that the Green Revolution is a great success in the case of wheat. Moreover, in Punjab, Haryana and western Uttar Pradesh, it has become a commercial crop. The prosperity of the large and medium farmers of northwest India may be attributed to the diffusion of HYV of wheat and rice. The diffusion patterns of wheat and rice have been shown in Fig. 11.5.

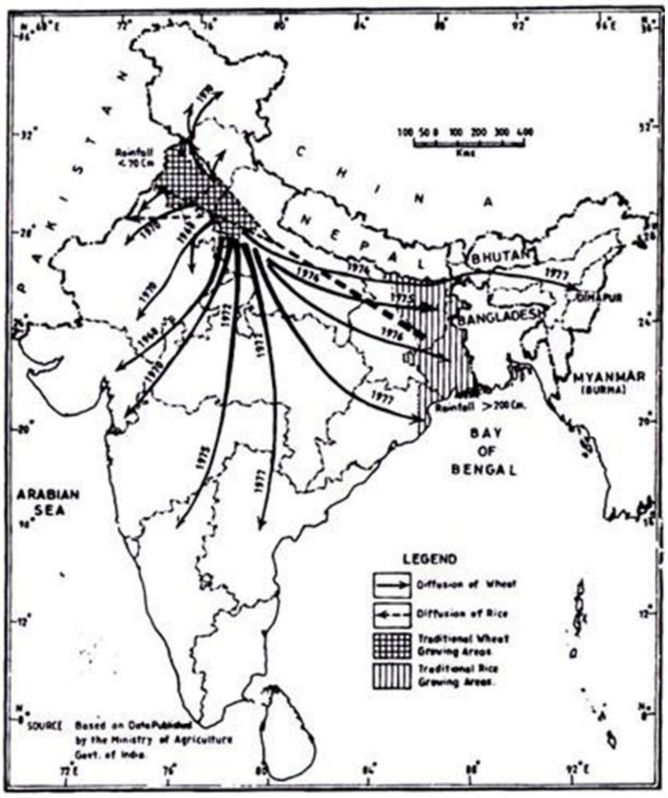

Fig 5: India Diffusion of high Yielding varieties of Wheat and rice, 1965-77

It may be observed from Fig. 11.5 that Punjab, Haryana and western Uttar Pradesh have emerged as the areas of major concentration of rice, while wheat has been diffused in all the directions from its traditional heartland of the north-west India Fig. 11.5.

3. Maize
Maize is a food grain which grows well in the well-drained alluvial soils and it requires warm and moist geographical conditions. Its cultivation is, however, carried on in most of the states of the country as a kharif (summer season) crop, while in the Kandi (undulating hilly tracts) areas of Kashmir, Ladakh and Himachal Pradesh it is a spring crop. In 1964-65, just before the diffusion of HYV, maize occupied about 4. 6 million hectares, while in 1994-95 its area increased to 6 million hectares.

In 1994-95, out of the 6 million hectares, about 2.9 million hectares or 45 per cent of the total area under maize was under HYV. Its area has, however, increased by about 30 per cent during the last three decades, while the corresponding increase in production and yield had been 8 per cent and about 41 per cent respectively (Table 11.4).

Despite the development of HYV of maize, its area has significantly shrieked in the states of Punjab, Haryana and Uttar Pradesh. Rice has encroached upon its area as the farmers are getting more agricultural returns from their fields by doing the cultivation of rice in place of maize during the kharif season. It is not only that the per unit area of the yield of maize is lower in comparison to rice; its price per quintal is also low. The farmers have thus generally excluded maize cultivation from their cropping patterns.

4. Jowar
Prior to the diffusion of HYV of wheat and rice jowar was mainly sown for the purpose of fodder in the Ganga-Sutlej plain and for cereals in Maharashtra, Gujarat, Rajasthan and Madhya Pradesh. During the last 30 years, its areal strength has, however, decreased substantially. Its area is now generally devoted to paddy crops in the states of Punjab, Haryana and western Uttar Pradesh. The tractorization and mechanization of agriculture has reduced the importance of bullocks in the farming operations. Consequently, jowar has lost its significance as a fodder crop.

In 1964-65, the total area under jowar was 18 million hectares which shrieked to 13 million hectares in 1994-95. The introduction of HYV of jowar, however, enhanced its production and productivity by 18 per cent and about 34 per cent respectively (Table 11.4). In general, the area of jowar has decreased in all the states excepting Gujarat and Jammu & Kashmir. In Punjab, Haryana, Rajasthan, Tamil Nadu, Uttar Pradesh and Madhya Pradesh, the area under millets has been encroached largely by paddy crops.

5. Pluses
Pulses are the main source of protein in India. They are grown in all parts of the country both in the kharif and the rabi seasons. Their area, production and yield have, however, not shown any significant increase. Contrary to this, their production declined in the seventies and eighties.

Taking the country as a whole, the area under pulses has declined by about 6 per cent in 1994-95 as compared to that of 1964- 65. Efforts are being made to develop HYV of various pulses to be diffused in the various agro climatic regions of the country. The enhancement in the total production of pulses will go a long way in improving the protein quantity in the caloric intake of the Indian masses.

Table 5: India Area under high yielding varieties

Crop	1966-67	%of HYV area to the total area under the crops	1994-95	% of HYV area to the total area under the crops
Rice	0.9	2.6	32.8	68.8
Wheat	0.5	3.9	23.3	88.4
Jowar	0.2	1.1	7.0	52.7
Bajra	0.1	0.8	6.2	53.7
Maize	0.2	3.9	2.9	45.1
Total	1.9		72.2	

A comparative picture of the area under HYV of the principal cereal crops has been shown in Table 11.5. It may be seen from Table 11.5 that in 1966-67 only about 2 million hectares of the total cropped area under cereals (paddy, wheat, jowar, bajra, maize) was under the HYV and the remaining 98 per cent was under the traditional varieties. The diffusion of HYV has, however, been very fast during the last three decades. It may be corroborated from the fact that in 1994-95 over 72 per cent of the total grain cropped area was under HYV.

An analysis of Table 11.5 makes it clear that at present (1994-95) over 88 per cent of the total area devoted to wheat is under the HYV. It is in the un-irrigated areas of Madhya

Pradesh, Rajasthan and Ladakh (J&K) where still some of the farmers could not adopt the HYV. The well off farmers of the Sutlej-Ganga plain also devotes a small hectarage of their wheat area to the traditional (desi) varieties.
It is a belief among the farmers of northern India that the desi varieties of wheat are superior in taste and are not injurious to health. Contrary to this, the new varieties are considered as largely responsible for some of the dreaded diseases like cancer, liver ailment and blood pressure.
In the case of rice also people have given up the traditional varieties as about 69 per cent of the total rice area was occupied by new seeds in 1994-95. In Punjab, Haryana and western Uttar Pradesh only the HYV are sown, while in the traditional rice growing areas of Assam, West Bengal, Orissa, Bihar and Andhra Pradesh many of the farmers are still in favour of the traditional varieties.
New varieties of millets, bajra and maize have also been developed and adopted by the farmers, especially that of the irrigated tracts. The new varieties of jowar and bajra occupied about 53 per cent and 54 per cent of the area under these crops respectively, while new varieties of maize were sown in 45 per cent of the area under HYV (Table 11.5).

Recent Technologies Adopted In Jammu and Kashmir
NMSA has following four (4) major programme components or activities:

Rainfed Area Development (RAD): RAD will adopt development and conservation of natural an area based approach for resources along with farming systems. This component has been formulated in a 'watershed plus framework', i.e., to explore potential utilization of natural resources base/assets available/created through watershed development and soil conservation activities /interventions under MGNREGS, NWDPRA, RVP&FPR, RKVY, IWMP etc.. This component will introduce appropriate farming systems by integrating multiple components of agriculture such as crops, horticulture, livestock, fishery, forestry with agro based income generating activities and value addition. Besides, soil test/soil health card based nutrient management practices, farmland development, resource conservation and crop selection conducive to local agro climatic condition will also be promoted under this component. A cluster based approach of 100 hectare or more (contiguous or non-contiguous in difficult terrain with close proximity in a village/adjoining villages) may derive noticeable impact of convergence and encourage local participation and for future replication of the model in larger areas. Supplementary support from this component will be admissible for gap filling resource conservation activities under converging programmes health card. RAD clusters /soil survey maps should have soil analysis/soil to justify the interventions proposed and at least 25% of the farming system area will have to be covered under On Farm Water Management. Farming Systems recommended by ICAR's Contingency Plans and successful findings of NICRA projects shall also be considered in development of integrated project plan. Besides, creation and development of common property resources/assets/utilities like grain bank, biomass shredders, fodder bank, group marketing etc. will be encouraged under this component.

On Farm Water Management (OFWM): OFWM enhancing water use efficiency by promoting will focus primarily on efficient on farm water management technologies and equipment. This will not only focus on application efficiency but, in conjunction with RAD component, also will emphasize on effective harvesting & management of rainwater. Assistance will be extended for adopting water conservation technologies, efficient delivery and distribution systems etc. Emphasis will also be given to manage and equitably distribute the resources of commons by involving the water users associations, etc. To conserve water on farm itself, farm ponds may be dug using MGNREGA funds and earth moving machinery (to the extent manual digging under MGNREGA is not feasible)

Soil Health Management (SHM): SHM will aim at promoting location as well as crop specific sustainable soil health management including residue management, organic farming practices by way of creating macro and linking soil fertility maps with micro nutrient management, appropriate land use based on land capability, judicious application of fertilizers and minimizing the soil erosion/degradation. Assistance will be provided for various improved package of practices based on land use and soil characteristics, generated through geographical information system (GIS) based thematic maps and database on land and soil characteristics through extensive field level scientific surveys. Besides, this component will also provide support to reclamation of problem soils (acid/alkaline/saline). This component will be implemented by State Govt., National Centre of Organic Farming (NCOF), Central Fertilizer Quality Control & Training Institute (CFQC&TI) and Soil and Land Use Survey of India (SLUSI). Given the limitations, such as staff and infrastructure, faced by the department of agriculture at the field level, a Public Private Partnership Model may be adopted by states depending upon the private partner's strength i n the field to ensure that the soil testing is done in time and in the numbers required. The private parties can be encouraged to set up soil testing labs in selected areas in the district. Detailed separate guidelines for implementation of Soil Health Management component as given above.

Climate Change and Sustainable Agriculture Monitoring, Modeling and Networking (CCSAMMN): CCSAMMN will provide creation and bidirectional (land/farmers to research/scientific establishments and vice versa) dissemination of climate change related information and knowledge by way of piloting climate change adaptation/mitigation research/model projects in the domain of climate smart sustainable management practices and integrated farming system suitable to local agroclimatic conditions. The dedicated expert teams of technical personnel will be institutionalised within NMSA to rigorously monitor and evaluate the mission activities thrice in a year and will inform the National Committee. Comprehensive pilot blocks will be supported to illustrate functional mechanism for dissemination of rainfed technologies, planning, convergence and coordination with flagship schemes/Missions like MGNREGS, IWMP, Accelerated Irrigation Benefit Programme (AIBP), RKVY, NFSM, NHM, NMA ET etc. Such an integrated action of input and output flows across agriculture, livestock and other production systems will harness the growth potential of the rainfed production systems, imparting sustainability of local production systems while negotiating climate change risks. A consortium approach will be evolved with various stake holders including knowledge partners like State Agricultural Universities (SAUs), Krishi Vigyan Kendras (KVKs), Indian Council of Agricultural Research (ICAR) Institutes etc. by the State Government to provide single window service/knowledge provider system for the benefit of farming community. Financial support may be provided through States to institutionalize the concept and meeting supplementary developmental activities. Climate change related monitoring, feedback, knowledge networking and skill development will also be supported under this component through State Agricultural Universities, ICAR Institutes National/ International Institutes, KVKs, Public/ Private R&D Organizations etc. Awarding of Studies, Documentation & Publication, Domestic and Foreign Training, Workshops/Conferences etc. will be supported under this component.

State Level Architecture

At State level, State Level Committee (SLC) chaired by Agriculture Production Commissioner(APC)/Principal Secretary/Secretary (Agriculture/Horticulture) with representation from concerned line Departments like Revenue, Animal Husbandry, Fisheries, Forests etc., CEO of SLNA, SAUs and ICAR Centers will oversee planning and implementation of the Mission. Present NMMI Committee may be notified by the State Government as the NMSA State Level Committee with following changes. The committee may be strengthened with additional members from concerned line departments; to be chaired by APC and in case institution of APC does not exist, senior most Pr. Secretary/Secretary either from Agriculture or Horticulture may be nominated by Chief Secretary of the State as the Chairman. Director (Agriculture) will be Member Secretary and Director (Horticulture) will be Co-Member Secretary of the Committee. Once the SLC for NMSA is notified, the State level Committee of NMMI will stand dissolved. Further, States will have freedom to nominate other nodal Department or Agency or create an autonomous State Mission for Sustainable Agriculture (SMSA) for this purpose. State may setup State Standing Technical Committee (SSTC) to function as arms of central STC and to provide technical advisory to State Mission.

State Agricultural University will be the main knowledge partner of SSTC. Three to four Technical Experts drawn from local ICAR Centres/ SAUs/other professional agencies in this field with additional responsibility or, full time engagement as State Consultants on contract basis will be placed as Technical Support Group at State level to assist SSTC. The duties/responsibilities, qualification and honorarium for engagement of State Consultants will be made as per the specifications. SSTC will suggest modalities for sustainable agriculture practices based on R&D experiences and local requirements to formulate Mission Implementation Plan. SSTC will meet at least once in three months and submit its report to the STC on the implementation of NMSA along with technical inputs.

District Level Architecture

District Mission Committee (DMC) will be entrusted with project formulation, implementation and monitoring of NMSA. DMC may be headed by Collector or CEO of Zilla Parishad /District Council with representatives from concerned line Departments including animal husbandry, horticulture, fishery, rural development, forest etc. and ATMA, KVK, Growers' Associations, Marketing Boards, Banks, Non-Government Organizations etc., Dy. Director (Agriculture) will be the Member Secretary of the District Mission Committee. A dedicated subject expert/consultant on sustainable agriculture will be engaged each for 2 to 3 adjoining districts depending on the number of clusters taken up to look after the projects, give technical advice and assist in monitoring. These consultants to be engaged on contract basis and there remuneration is admissible from Mission. They will also assist the State Level Standing Technical Committee in preparation of Mission Implementation Plan, Annual Action Plan and technical supervision to the Mission. Their performance need to be linked to the periodic achievements of the objectives of the mission in deciding their continuation and payment. The duties/responsibilities, qualification and honorarium for engagement of these Consultants will be made as per the specifications.

Monitoring and Evaluation

- NMSA envisages concerted mechanism for monitoring and evaluation with involvement of all implementing agencies including line departments.
- Strong technical monitoring and feedback system will be put in place to service the National Advisory Council (NAC) on technical feasibility of components in terms of climate resilience. The experts from CRIDA/CAZRI and state agricultural universities will be institutionalised within NMSA to rigorously monitor and evaluate the mission activities thrice in a year and report to NAC. These scientific committees will help National Committee/Mission Director to assess and decide the policy content or change in action plan, if required.
- At State level, process of implementation will be monitored by SSTC and SMSA/SLC. At National level, NMSA will be monitored by PSC and STC. Web based monitoring, video conferencing, desk reviews, field visits, and evaluation of programme implementation will be followed for effective monitoring of Mission initiatives. State Government may also undertake concurrent evaluation during implementation period to facilitate mid course corrections, if, any.
- States will ensure submission of detailed Quarterly Progress Reports (QPR) by 10th of first month of next quarter. Similarly, detailed Annual Progress R (APR) should be sent to Department of Agriculture & Cooperation, Ministry of Agriculture within three months, after closure of financial year.
- State Governments may ensure that digital location of all the project areas/ physical assets created, name of beneficiaries, assistance provided etc. under NMSA are, maintained and uploaded on the digital map of the district/state and kept in public domain to ensure better transparency in programme implementation.
- At field or village level, Panchayats will be involved in overseeing day to day process of implementation. At district level, monitoring will be undertaken by Joint Director/Deputy Director Agriculture in collaboration with respective Zilla Panchayati Raj Institutions.
- At cluster/village level, details of approved programme, all activities undertaken, name of beneficiaries, expenditure incurred etc. may be displayed at the Panchayat Bhavan/prominent public place in the locality and it be placed before the concerned Gram Sabha annually from the point of social audit.

Fund Flow Mechanism

- Department of Agriculture & Cooperation, Government of India will communicate tentative annual outlay to each State/implementing agency, who in turn will prepare respective component-wise allocation for AAP's.
- Consequent to approval of AAP, funds will be released to State Nodal Department or designated implementing agency notified by the State.
- State Level Implementing Agency would ensure implementation in a time bound manner in accordance with their approved AAP. Funds will be released in installments based on physical & financial utilization certificates progress report, submission of and other necessary documents as per pro General Financial Rules, specific emergent need etc. visions of However, for setting/strengthening of soil/fertilizer testing laboratories, funds would be released in one instalment after approval of AAP.
- NMSA will earmark about 3% of annual outlay f or administrative expenses at National level viz. for establishment expenses of DAC and its subordinate offices/ Institutes, Technical Support Units (TSU), monitoring & evaluation, capacity building and other contingent expenses etc. Similarly, 5% of total allocation to States will also be earmarked for meeting administrative and other contingent expenses for implementation of the Mission. 9.5 At least 50% of the allocation is to be utilized for small, marginal farmers of which atleast or in 30% are women beneficiaries/ farmers. Further 16% & 8% of the total allocation proportion of SC/ST population in the district will be utilized for Special Component Plan (SCP) and Tribal Sub Plan (TSP) respectively.

Impact Assessment, Periodic Evaluation and Reporting

- Information and communication technology will be deployed extensively for ensuring transparency in the implementation process and effective monitoring of the Mission programme.
- States will upload approved AAP on NMSA website that will be exclusively created for this purpose. Physical and financial progress under each sub components of NMSA should also be updated every month and uploaded in the website
- The information on physical and financial achievements under TSP and SCSP components have to be furnished annually
- NMSA will be evaluated preferably on bi annual basis through 'third party agency' for assessing efficacy, performance, outcome and shortcomings to facilitate mid-course corrections. State Govt. and designated implementing agencies may, however, conduct independent evaluation to assess performance of NMSA, interms of its objectives.
- A bench marking exercise must be taken up before taking up any cluster/ project under NMSA.

Expected Outcome

NMSA is expected to transform Indian agriculture into more climate resilient production system through suitable adaptation and mitigation measures in domains of both crops and animal husbandry. These measures will help in absorption of improved technology and best practices and promote different coping mechanisms for climatic and non-climatic stresses. While primary focus of NMSA will be conservation and sustainable use of natural resources for food and livelihood security, it will also expand its coverage primarily to rainfed areas by integrating farming systems with livestock and fisheries, so that agricultural production continues to grow in a sustainable manner.

Discussion

Achieving sufficiency in food production along with the conservation of the environment are the major objectives of the agriculture presently. The constraints in achieving this task are: limiting land and water resources along with the degradation of the environmental health due to excessive use of chemicals for nutrition and pest management in agriculture. Anthropogenic activities for development have resulted in further degradation of environment and have spurred the rate of climate change. Global efforts have been initiated for reducing the effects of climate change on earth in general and agriculture in particular. These steps should be complimented with the innovations in production techniques employed in agriculture and also scientific utilization of the indigenous knowledge which is proven as more sustainable.

Conclusion

Sustainability is indeed an issue of survival, but is far broader than the concept of habitat destruction and soil erosion. Sustainability includes the goal of food production, welfare of the food producers, and preservation of non-renewable resources. To that end, technology of all types has been and will be the enabling man-made component that will link these two overriding objectives. Indeed, history confirms that technology has been essential to agricultural productivity/stability, current breakthroughs in technology confirm that the discovery and development of new technologies is a sustainable endeavor, and common sense directs us to the conclusion that technology will enable Sustainable Agriculture.

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