Agriculture Diversification

Problems and Perspectives

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Pankaj Srivastava

Dr. Pankaj Srivastava was born on 5th July, 1963 in District Azamgarh in eastern UP. He obtained his first degree. B.Sc. (Agriculture) From Sri Durgaji Degree College, Chandeshwar, Azamgarh, in 1982. He joined M.Sc. (Agriculture Economics) in 1982 in Department of Agriculture Economics of G.B. Pant University of Agriculture & Technology, Pantnagar and obtained his Ph.D. degree from the same institute.

Dr. Srivastava joined as Lecturer in August, 1988 in Sri Durgaji Degree College, Chandeshwar, Azamgarh and thereafter in the year 1990, he joined as Assistant Professor in Department of Agriculture Economics of G.B. Pant University of Agriculture & Technology, Pantnagar. He had been a very famous teacher and researcher of high repute in the department in the field of water management. He has more than 20 research papers in his credit which are being cited everywhere showing his acute interest in his own field.

Dr. Srivastava being the faculty had owned the responsibilities of different committees of college and also at the university level. Dr. Srivastava's overall success had been due to his leadership factors which can be concised into 4D's, namely determination, devotion, dash and dynamism. These assets have been instrumental in elevating him in a very short time.

Untimely departure of Dr. Srivastava form this world on 26th August, 2000, has not only caused a vacuum in his own field but also in his family as he was blessed with two children, one daughter, Mansi and one son, Shantanu.

This particular volume is dedicated to pay our tribute to a great teacher and a very nice human being. We, from the scientific family and being the family friend, pay our regards and all affections to his family and pray god to give strength and all prosperity to his family members.

Preface

The Asian Development Bank Rural Asia Study highlighted developing Asia's remarkable progress in food security, poverty reduction, and per capita income, driven by the green revolution. Between 1970 and 1995, the Asian rural and general economy benefited from an almost doubling of cereal production, due to doubling of crop yields, while the cereal area harvested barely changed, increasing only 4 percent. Per capita income nearly tripled, while calorie consumption increased by 24 percent. Increased local purchasing power drove local demand, spurring the overall economy. Poverty declined from about 60 percent in 1975 to about 30 percent in 1995. The threat of famine, which loomed in the early 1960s over the region, disappeared. However, despite the remarkable growth, poverty remained high. About 900 million or 68 percent of the world's poor live in Asia: about 500 million in South Asia, 300 million in East Asia, and 100 million in Southeast Asia and the Pacific.

The International Food Policy Research Institute (IFPRI) forecasts that population in Asia will grow from 2.8 billion in 1990 to 4.2 billion in 2020. IFPRI also forecasts that the annual demand for rice in Asia will increase from 307 metric tons (t) in 1990 to 495 million t in 2020; for maize, from 123 million t to 238 million t; and for meat, from 38 million t to 111 million t. Food production will have to increase by another 260 million t or 40 percent more from the current level of 650 million t, and this under conditions of increasing land and water scarcity. Thus, there is an urgent need to raise agricultural productivity dramatically using alternate technology.

Agriculture plays important roles in economic development, such as provision of food to the nation, enlarging exports, transfer of manpower to nonagricultural sectors, contribution to capital formation, and securing markets for industrialization. Improvement in agricultural productivity is key to the realization of each of these roles. Historical records have shown that agricultural productivity has been growing due to introduction of modern technologies, commercialization of agriculture, capital deepening, factor shifts from agriculture to nonagricultural sectors, etc. This whole process could be called 'agricultural transformation,' to which the contribution of each of these factors has been quantified in the existing literature.

Land holding of Indian farmers is below 1acre and hence it is necessary to integrate different sectors of agriculture not only for enhancing agriculture production but also the economic status of the farmers in a much sustainable way with a quality food production. The present book is covering the area related to agriculture diversification including the policies, and applications of different resources so that readers could get a holistic view of practice. Experts have been asked to contribute so that the chapters could be more authentic and easy to understand by the readers.

EDITORS

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1 Agricultural Diversification: Problems and Prospects

Mirthyunjaya

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INTRODUCTION

In the context of increasing population pressure, declining land-man ratio, small and fragmented holdings, and highly iniquitous land distribution situation, traditional agriculture both in form and content can not provide livelihood security. Since independence, particularly beginning with green revolution during late sixties, several technological, institutional and policy initiatives have been taken to transform Indian agriculture. Notwithstanding remarkable progress in agriculture culminating to a brimming food grain stock of over 60 million tons, large-scale poverty persists. Malnutrition is one of our major problems. The only difference, some explain, that poverty now exists with food grain surplus as compared to poverty existing with food grain deficits/imports earlier. Meanwhile, we have also added the problems of natural resource degradation, erosion of biodiversity, regional and class inequity, signing of WTO agreement, and more importantly deceleration in the growth rates of production. The most pressing problem in agriculture at the moment relates to unprecedented surplus of food grains (excess inventory of rice and wheat) with no prospects of either domestic or export demand. Infact, we do not have space to safely store the food grains. The paradox of this surplus is that we are deficit in our requirement of pulses to an extent of 1.5 million tonnes and edible oils to an extent of 4 million tonnes. We have spent around Rs. 14000 crores in importing edible oils during 2000-2001. We have also large deficits in feeds and fodder to our animals.

AGRICULTURAL DIVERSIFICATION—NEW PARADIGM OF AGRICULTURAL DEVELOPMENT

Against the backdrop of these facts, a new paradigm of agricultural development particularly to liberate small and marginal farmers who dominate Indian agriculture from poverty trap is sought. Here, agricultural diversification assumes significance. The goals of agricultural diversification in our case, therefore, may include:

1. Increase the income (purchasing power) of the small and marginal farmers to help them to attain food and nutritional security of their households.

2. Stabilize the farm household income over the years.
3. Absorb the rural (farm as well as non-farm) workforce gainfully and prevent excessive urban migration.
4. Provide inducement to capital formation in agriculture.
5. Contribute to earning foreign exchange from the liberalization of agricultural exports.
6. Conservation and improvement of natural resources and biodiversity.
7. More linkage – forward and backward – with non-farm household as well as other sectors activities.
8. Contribute to higher overall growth of agricultural sector.

The diversification within agriculture and allied sector can be seen as a process of shift at two levels. One, from crop to non-crop sectors (such as horticulture, fishery, aquaculture, agriculture, sericulture, animal husbandry, forestry etc.), and the other within the crop sector, from food grains to non-food grains (such as sugarcane, fiber, pulses, oilseeds, spices, medicinal plants etc).

The Experience: Demand Driven, Very Slow, and Disparate

The pace of diversification in the Indian economy as reflected in the national income data suggests that the changes in the sectoral composition are taking place gradually in the desired direction, although the pace is slower than in several other countries. The share of agriculture in the GDP of the country has progressively declined from around 49% in 1950-51 to around 26% in 1997-98. Within agriculture, the sectoral share of output and employment in the non-crop sectors i.e., animal husbandry, forestry, and fishery is gradually increasing. Significant changes are also taking place within crop sector itself—the area under commercial crops has increased remarkably and now equals around half the area under food crops. Among the food crops, the area under superior cereals i.e., wheat and rice is increasing, while that under the inferior cereals like bajra, sorghum etc. is declining. However, there have been serious concerns that even after such a perceptible shift in GDP and cropping pattern, there has been relatively slower pace of workforce adjustment.

The pace diversification is largely demand driven as clearly shown by the analysis of consumer basket (Table 1.1).

Table 1.1: Annual per capita consumption in Kg (1977 and 1993), India

Food items	1977	1993
Rice	82.7	79.9
Wheat	52.4	54.5
Coarse grains & Cereal substitutes	48.4	19.8
Pulses	9.3	9.5
Vegetables	27.7	55.8
Fruits	3.3	12.5
Milk	26.6	55.8
Meat, eggs & Fish	3.1	4.6
Edible oils	3.1	5.0
Sugar	14.2	9.9

The data show significant structural change in the consumption (in all income classes both in rural and urban India) leading to decline in the consumption of food grains and increase in the consumption of fruits, vegetables, meat, fish, eggs and dairy products.

The pace with which diversification is taking place also vary in different regions. Indian agriculture started showing significant diversification with the spread of green revolution technology beginning late 1960s. Accordingly, the extent of diversification experienced in various states has been studied by Chand and Chauhan (2002) dividing post green revolution period in two phases: first covering the period from late 1960s to early 1980s, and the second, covering period from early 1980s to mid 1990s. The magnitude of diversification in these two periods, termed as phase I and phase II, in the major states is presented in Table 1.2. Extent of diversification was computed by taking deviations in area under individual crops between triennium ending (TE) 1968/69 and TE 1983/84 for the first phase and TE 1983/84 and TE 1998/99 for the second phase.

Table 1.2: Extent of agricultural diversification and output growth over time in major states

States	TE 1968/69 to TE 1982/83 Diversification (%)	TE 1982/83 to TE 1998/99 Diversification (%)
Andhra Pradesh	08.37	14.09
Assam	07.62	05.55
Bihar	08.72	04.62
Gujarat	09.23	10.40
Haryana	18.53	19.49
Himachal Pradesh	06.66	04.02
Jammu & Kashmir	07.20	06.03
Karnataka	08.31	13.90
Kerala	04.67	11.52
Madhya Pradesh	08.19	17.56
Maharashtra	05.20	09.63
Orissa	08.13	06.55
Punjab	26.02	12.23
Rajasthan	09.42	13.04
Tamil Nadu	07.49	07.71
Uttar Pradesh	16.62	09.26
West Bengal	06.78	12.72
All India	07.37	07.65
Correlation between extent of Diversification, and NSDP growth rate	0.55	0.56

Note: Growth rate in NSDP in the two periods are for 1970/71 to 1982/83 and from 1982/83 to 1997/98.
Source: Chand and Chauhan (2002)

During the first 15 years following onset of green revolution technology, about 7 percent of country's total crop area experienced some sort of diversification. The highest diversification in Phase I was experienced in Punjab where 26 percent area witnessed shift in crop choices between late 1960s and early 1980s. The extent of diversification was quite high in Haryana and Uttar Pradesh where crop diversification occurred on about 18.5 and 16.6 percent area. In the remaining states, extent of diversification was below 10 percent. Lowest diversification during 1968-69 to 1982-83 was recorded in Kerala and Maharashtra. In these two states, about 95 percent of crop area did not undergo change in crops grown on it. Most of the states recorded around 8-9 percent diversification.

Crop diversification during the first phase, i.e., late 1960s to early 1980s, was primarily driven by technology. In the north-west plains comprising Punjab, Haryana and Western U. P., high yielding varieties of wheat and rice became very popular due to high relative profitability. The two crops replaced large area under other crops leading to high level of diversification in favour of rice. New varieties of rice were also widely adopted in some parts of Tamil Nadu and Andhra Pradesh but it resulted mainly in varietal diversification rather than crop diversification.

During the next 15 years, the pace of diversification slowed down considerably in Punjab and Uttar Pradesh where it was quite high during the first phase of green revolution. Crop diversification in Haryana during 1983 to 1998 shows further improvement compared to the period 1969 to 1983.

The pace of diversification fastened considerably in the states of Maharashtra, Kerala, Karnataka, Andhra Pradesh, Madhya Pradesh, Rajasthan and West Bengal. The extent of crop diversification in the states of Bihar and Orissa not only remained low but also declined in the second phase. It is important to mention that a major study on these two states is now underway at Institute for Human Development, Delhi, under the project leadership of Dr. Alakh N. Sharma (2002).

Studies in the Past on Diversification

An excellent review by Sharma (2002) on agricultural diversification is presented below:

The monumental work by Mellor (1966 and 1976) identified the potential and provided a sound theoretical framework of agricultural diversification in developing countries. Mellor (1997) also finds that "practically all developing countries can achieve 4 to 6 per cent growth rates in agriculture became of the major potentials in the production of high-value (agricultural) commodities". The high income elasticity of demand for high valued agricultural products has been found by Austien (1981) and Desai *et al*. (1991).

Several studies (Haque, 1996; Jha, 1996; Saleth, 1997; Chand, 1999) visualised agricultural diversification towards high income enterprises/activities as a growth strategy. These studies rightly emphasise that varying combinations of diversified activities within agriculture and allied sector are possible across farm size categories, or agro-climatic regions. According to Pandey and Sharma (1996), the nature and extent of crop diversification in India did not witness any conflict with self-sufficiency in food grains. In fact, effective and faceted crop diversification leads to a better composition of food basket in view of the changing food habits of the populace. The study by Satyasai and Viswanathan (1996) has clearly pointed out that Indian agriculture has registered diversification with impressive improvements in the shares of livestock and fishery sectors in the total income from agriculture. It has been estimated that the livestock sector, even with the existing stock, can generate employment to the tune of 86 million persons/year, inclusive of employment in the processing and marketing of milk products (NCA, 1976). According to Kumar and Mathur (1996), the extent of diversification due to structural changes in consumption would be further compounded by increased demand for the export market, especially for fruits, vegetables and marine products as a result of liberalized trade regime. The diversified food basket would be helpful in providing food and nutrition security. The study by Vyas (1996) as well as some of the above mentioned studies pointed out that agricultural diversification really started in eighties, but it has picked up momentum only in the recent past. The normative evaluations (Jha, 1996) have indicated substantial income enhancing and employment generating

opportunities on small and marginal farms. The linkage between crop production and economic performance of crop enterprise does justify the rationale for crop diversification as a strategy for improving the economic prospects of small farmers. The international studies (Mustapha *et al.*, 1985; Halliday, 1989) have also indicated that agricultural diversification is becoming a key strategy to promote agricultural development and it helps in minimizing production risks, increase agricultural productivity, and maintain or improve farm incomes.

Diversification—Conclusions and Suggestions

It is very pertinent to reconsider the conclusions and suggestions from the national seminar on the same topic at NCAP here (Haque, 1996). It is felt that all of them are still relevant and need to be persued vigorously.

1. Small farmers generally practice multi-diversified farming and grow a number of crops even on small acreage and fragmented plots. But such farming does not necessarily yield enough return 'for the sustenance of small farm families'. Therefore, the sustainability of smallholder agriculture would depend on horizontal and vertical diversification involving adoption of a few selected high yielding, high income generating and eco-friendly crop and non-crop enterprises.
2. Non-availability of high yielding plant varieties for some of the high-value crops act as one of the major constraints to diversification. Therefore, the challenge of small farm diversification demands concentrated research efforts for appropriate technology generation keeping in view the demands in domestic and international markets. This may require scientific excellence and greater allocation of research funds in favour of export-oriented crops and non-crop enterprises like fruits, vegetables, flowers, livestock, fisheries, etc. Public and private research efforts should complement each other in this area. Also substantial investment may be required in research on agriculture policy formulation and human resource development, involving the training of scientists, extension workers and farmer leaders on the needs and methods of planned agricultural diversification.
3. Development of appropriate technology for small farmers including drought and pest resistant high yielding varieties and horticultural crops with low gestation period would help small farmers to diversify. Similarly, development and transfer of technologies such as bio-fertilizers, bio-pesticides and organic farming would be helpful for small farm diversification because of their cost-effectiveness.
4. In view of the highly capital intensive nature of some high value crops, small and marginal farmers may find it difficult to invest in these crops. Therefore, strong industry-agricultural linkage through development of agro-processing units and contract farming would be required to help promote small farm diversification. Besides, institutional facilities of credit by banks, co-operatives and agri-business consortium would be necessary to help promote small farm diversification. Privatisation of institutional arrangements for lending may not be the answer, as these would be guided more by profit considerations rather than economic needs of small and marginal farmers. However, efforts should be made to promote economically viable and sustainable credit institutions in private, public and co-operative sectors.
5. Development of marketing facilities and provision of remunerative prices for fruits and vegetables are considered essential for diversification. Crops that are of high value today like fruits and vegetables may not retain their relative superiority, if all farmers of any

given region start producing the same crops. This will lead to glut in the market and dampen the price and income levels of farmers, unless the farmers have access to local, national and international markets in organised manner. Besides, in most cases, market and price information do not exist for some of the high value, albeit perishable commodities which constrain the diversification. It would be necessary to develop market and market information system for any diversification plan to materialise. Moreover, establishment of rural godowns and their utilisation for both input and output marketing would help promote small farm diversification. Due to price uncertainties, small and marginal farmers often show their aversion to diversification in favour of fruits and vegetables. Therefore, dynamic price and crop insurance policies may need to be evolved for such commodities.

6. Ceiling laws do not necessarily constrain diversification, as small and marginal farmers can participate in diversification and growth through development of contract farming. However, the land lease market would need to be liberalised and activised for facilitating the entry of corporate sector in agriculture and also for enabling people to migrate from agriculture.
7. Development of agro-processing and agribusiness would be a necessary condition for promoting small farm diversification. In fact, there is a need for agribusiness development in both private and co-operative sectors which will help promote synergistic relationship between farm and non-farm activities. The development of various farm and non-farm activities in rural areas should be based not only on criteria of profit or of income growth, but it also has to be eco-friendly.
8. It may not be necessary for the government to directly enter into agri-business. But government support in promoting infrastructure and proper policy environment would be necessary. It may also be necessary to regulate the prices of patented seeds marketed by multinational corporations in India. The farmers in backward regions do not have access to basic infrastructure of road, transport, linked market in the neighbourhood, cold storage, irrigation and power which are so essential for both horizontal and vertical diversification. Infact, the present strategy of diversification based on existing unequal infrastructural facilities will accentuate regional disparity in development. Therefore, there should be special efforts and increased investment for infrastructural development in backward regions. Efforts have to be made by involving both government and non-governmental organisations in this respect. Also the local bodies like Village Panchayat, Zila Parishad, Farmers Associations, etc., should concentrate on development of infrastructure which will help promote small farm diversification.
9. All types of lands and locations are not equally suitable for profitable, albeit, alternative farming. Therefore, cluster approach to diversification would be required. The Indo-Gangetic plain regions should concentrate on food production for self-reliance, food security-and exports, while the arid and semi-arid zones should emphasise horticulture-led diversification. Moreover, in greater part of high rainfall and irrigated zones, heavy textured soil and poor drainage system stand in the way of diversification in favour of non-rice crops. Even in the dry regions, diversification would depend on soil type, topography etc. Also fragmented plots of small holdings act as a constraint to efficient use of land for diversification, particularly because the farmers are deprived of the necessary economies of scale. Therefore, land and drainage improvement measures would be necessary for agricultural diversification by small and large farmers.

10. Despite the new economic policy which stresses 'globalisation', a good part of the productive activities of small and marginal farmers will not be and ought not to be for a distant market. They will be concerned with local labour working with local resources for local consumption to a great extent. These activities should be given sufficient importance.
    To take care of these activities and their supportive base, an appropriate voluntary organisation of the villagers, particularly the poorer among them, is needed. Such organisation of the village poor should have an important role to play in creating the facilities and the infrastructure required for the local and neighbourhood-oriented activities of the villagers. These could include supervision of common storage facilities, restoration of tanks and other water reservoirs which have fallen in a state of neglect, maintaining a steady programme of planting trees and taking part in a certain amount of village level planning of matters of common concern for the villagers.
11. The two prevailing marketing systems (one private and the other public) are exploiting the producers as well as the consumers. Taking all farm products into consideration, it can be safely stated that both the systems are not passing on even 50 percent of the prices realized by them from consumers (plus subsidies borne by the public exchequer in case of PDS). There is an urgent need to effectively reduce the margin between the producers and the consumers, which can be done only by forging direct links between them. This should have been done by the cooperatives, but they have failed to do so, except in a few pockets of the country. In rest of the country, cooperatives have been officialised, and lost their true character. While efforts should be made to improve their functioning, the Gram Panchayats, which are already statutory bodies, should be recognised as cooperatives and empowered to jointly process and market their produce. The Gram Panchayats should be encouraged and helped to open their Panchayati shops in cities on the lines of Khadi Bhandars to sell their grains, fruits, vegetables, milk, eggs etc., directly to urban consumers. Reduction in the cost of marketing should be the main concern of our planners if they want to provide relief to consumers without jeopardizing the interests of producers, or further burdening the public exchequer.

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2 Diversification Under Different Agro-Ecosystem

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INTRODUCTION

Diversification pertains with changes in the prevalent traditional farming system, which can ensure better land use, afford sustained productivity, ensure better income, employment generation per unit area per unit time.

After ensuring food security for almost a billion people in India through successful cultivation of Rice-Wheat cropping, country needs to ensure nutritional, economic and environmental security in this subcontinent. India's "Green Revolution", which started in 1968, brought self-sufficiency in food and ensured food security to the country.

Predomination of rice and wheat cropping system, coupled with imbalance and indiscriminate use of chemicals (fertilizers, pesticides, weedicides) and non-judicious use of water in 3-4 decades have created number of problems such as:

- Compaction in soil structure
- Low organic matter content
- Poor water holding capacity
- Outbreak of pest, disease and weed infestation
- Increase in salinity, sodicity or land submergence
- Adverse effect on flora and fauna
- Deterioration in factor productivity and
- Varying degree of displacement of human settlement

Increasing pressure of population and diversion of arable land for non agricultural purpose are the major challenges of today. Per capita availability of land for producing commodities declined from 0.48 in 1951 to 0.15 ha and it may further decline to 0.08 ha by 2050 when population stabilization may occur in this subcontinent. This projection does not consider soil degradation and conversion of land to non-agricultural usage. Meeting all the basic necessities of life from available land resource is one of the major challenges in years to come. There is little scope of horizontal expansion of area for crop cultivation, hence the only alternative left is

through increasing productivity of crops per unit area, per unit time and integrated utilization of various kind of natural resources.

Accepting the principles of co-existence of crop and tree component, animals, including microbes, we have to adopt conservation farming for future prosperity. Although there may be several components to achieve this goal, some important ones are:

- Land use according to capability
- Management of physical soil properties
- Management of soil fertility through integrated Plant Nutrient Management (IPNM)
- Avoiding soil pollution

Diversification of monoculture of rice and wheat as per cropping rather farming system approach is the need of the hour.

Cropping system is the kind and sequence of crops grown on a given area of soil over a period of time. It may be a regular rotation of different crops in which the crop follow a definite order of appearance on the land or it may consist of one crop grown year after year on the same area. Cropping system should inculcate the principles and practices of cropping and interaction with farm resources, environment, regional and national needs and production strategies.

CHARACTERISTICS OF MAJOR INDIAN FAMILY FARMS

Almost 80 per cent Indian farms are family farms, which have the following characteristics:

- Large area under diverse agro-ecological conditions.
- They are limited resource farms.
- Land holdings are small (1 – 2 ha).
- Farming operations are performed with limited resources.
- Tendency to adopt different production strategies i.e., diversification to reduce the risk associated with only one or few types of production system.
- Every family member plays a role in agricultural production by putting labour and also part in decisions about what to produce and how to use it?
- Limited resources–they frequently must share them at critical points in the production cycle.
- Current production practices reflect the knowledge acquired and shared by farms on how to best use the limited resources of the family and community with existing technology.
- Production changes need to meet family goals.

At most of the family farms, with limits of extensive cultivation already being reached, a move to an intensive diversified production system would appear to be the most evolutionary step in India's future agricultural development on the basis of diverse agro-climatic zones. India is bestowed with wide range of agro-climatic conditions ranging from tropical, sub tropical to temperate. Agro-ecological zones (AEZ) refer to a land unit in terms of major climates suitable for certain crop and variety.

INDIAN AGRICULTURE—A CASE FOR DIVERSIFICATION AND COMMERCIALIZATION

Along with meeting the basic human needs, the agricultural produce should be market worthy with regard to its quality and quantity. It should also be competitive commercially as compared

to the same commodity from other sources in national and international markets, since the current situation of markets globally is highly unstable with regard to agricultural commodities and value added agricultural products, so as to keep a cushion for market fluctuations and expansion of trade and profits as well.

For effective land use planning, ICAR recognized eight agro-climatic region in India, while Planning Commission (1985–90) recognized 15 broad agro-climatic zones in India based on the criteria or physiography and climate for effective planning. In order to be more precise and giving due importance to soil conditions, National Bureau of Soil Survey and Land Use Planning (NBSSLUP) delineated the country into 21 agro-ecological regions using physiography, soils bioclimatic types and growing periods. This approach is comprehensive and can be used for the delineation of horticulture and plantation crops growing in zones as depicted in Table 2.1.

Table 2.1: Major agroclimatic regions of India (NBSSLUP)

	Name of the ecological region	Areas and choice of crop for the region	
		Areas covered	**Crops grown**
1.	Western Himalaya's Cold arid	The region comprise of cold and agro-ecoregion of Western Himalayas covering Ladakh and Gilgit districts of J&K	Potential crops include almond, walnut and pecan nut, Chinese ber, deciduous pomegranate (Russian type) and temperate grapes (with ensured irrigation)
2.	Western plains and Kutch Peninsula hot arid	This ecoregion consists of western parts of Rajasthan, Southern parts of Haryana and Punjab, the Kutch peninsula and Northern parts of Kathiwar peninsula	Date palm, citrus, grapes, ber, aonla have potential in the area with supplemental irrigation
3.	Deccan plateau, hot arid	The region comprises of the Deccan plateau which includes Raichur and Bellary of Karnataka and Anatapur in Andhra Pradesh	Citrus (Sweet orange and Acid lime), mango, grape, ber, pomegranate, sapota, Annonas are grown with supplemental irrigation
4.	Northern plain and central highlands	The region consists of Northern plains, central highlands and Gujrat plains which are characterized by hot and dry summers and cool winter	Citrus fruits, guava, mango, low chilling stone fruits are grown. Banana and sapota are preferred in plains of Gujrat
5.	Central (Malwa) highlands and Kathiawar Peninsula, hot semi-arid	The region includes the Western part of Madhya Pradesh, Eastern part of Rajasthan and Gujrat state. This is characterized by hot and dry summer and mild winter	Ber, Pomegranate, aonla, tamrind, guava, citrus fruits, mango and sapota are grown in the region. Banana is also grown with supplemental irrigation. Among the plantation crops, coconut, oil palm, cashew and black pepper are potential.
6.	Deccan plateau and Eastern Ghats, hot semi-arid	Deccan, plateau and Eastern Ghat cover major part of Andhra Pradesh	Sapots, custard apple, mango, banana, citrus, guava, and pomegranate grapes are major fruits growing in this region. Cashewnut, oil palm and coconut are potential.
7.	Eastern Ghats (TN uplands) and Deccan Plateau, hot semi-arid	The region comprises Deccan plateau, Tamil Nadu uplands, and Western part of Karnataka. This is characterized by hot dry summer and mild winter	Mango, sapota, guava, ber, aonla, grape, banana, tamarind and citrus fruits are major fruit crops. On hills, low chilling pear, plum and peaches are potential, coconut arecanut and cashew are potential plantation crops.

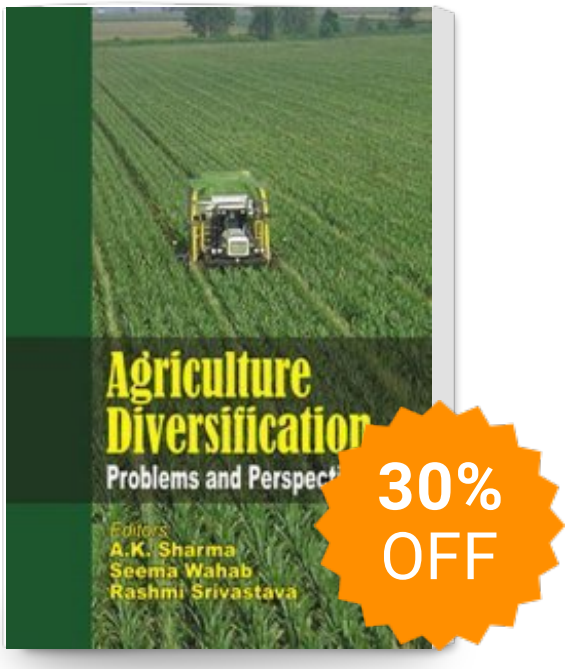
Table contd...

Table 2.1: Contd.

	Name of the ecological region	Areas and choice of crop for the region	
		Areas covered	**Crops grown**
8.	Northern plains, hot sub-humid	The North plain, hot humid eco-region with alluvium soil comprises of the Northern Indo-gangetic plains	Mango, guava, citrus fruit (limes and lemon), papaya and low chilling stone fruits
9.	Central highlands (Malwa bundelkhand) hot sub-humid	This region is characterized with medium and deep black soils covers a part of central highland, including the districts of Raisen, Sagar, Bhopal, Sehore, Shahjahanpur and Hoshangabad (M.P.)	Ber, pomegranate, aonla, bael, and mango under protective irrigation are potential. Coconut, arecanut and cashew are potential plantation crops
10.	Deccan plateau and central highlands	The eco-region with red and black soils is characterized by hot summers and mild winter	The region is known to grow high quality mandarin and is potential for growing guava, sapota, amngo, ber and pomegranatic. Among plantation crops cashew has great potential.
11.	Eastern plateau (Chhattisgarh), hot sub-humid	This eco-region with red and yellow soils is characterized by hot summer and cool winter	Mango, citrus, cashew nut, guava, papaya, pineapple are potential fruit crops of the region. On high hills pear can also be grown successfully. Banana has also proved successful in the region.
12.	Eastern (Chhota Nagpur) Plateau and Eastern Ghats hot sub-humid	This eco-region with red loamy soil is characterized by hot summer and cool winter	Mango, guava, banana, papaya, jackfruit, aonla, pineapple, cashew nut and several minor fruits are grown in this region. Aonla, ber and pomegranate have potential for commercial exploitation. Banana and litchi can also be grown especially in plateau of Bihar. Cashew nut is also potential.
13.	Eastern plain, hot sub-humid	This eco-region has alluvial soils and is characterized by cool winter and hot summer. Best litchi is grown in this region	Mango, litchi, jackfruit, guava, bael, aonla, acid lime and banana are predominant fruit crops. Coconut and arecanut is potential.
14.	Western Himalayas warm sub humid (inclusion humid)	This eco-region has brown forest and podzolic soils and is characterized by warm sub-humid to cool humid climate	The region is suitable for growing apple, plum, apricot, almond and nuts. Apple cultivation has been successfully exploited in the region.
15.	Assam and Bangal plains, hot humid	This eco-region has alluvium derived soil	Banana, pineapple, mango, and sapota are predominant fruit crops. Citrus fruits are also grown especially in Assam valley, Guava, aonla, bael are also potential in the region. Cahsew nut, coconut and arecanut are potential plantation crops.
16.	Eastern Himalayas, warm per humid	This eco-region has brown hill soils. It passes Northern tip of the West Bangal, Northern most part of Arunanchal Pradesh and Sikkim	Apple, pear, plum are potential in the region. Mandrain is successfully grown in valleys.

Table contd...

Agriculture Diversification Problems And Perspectives



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