

सामयिक निबन्ध

Occasional Paper - 40

अर्धशुष्क मेमोमें वर्षा-आधारित

खेती की लाभप्रदता

VIABILITY OF RAINFED AGRICULTURE
IN SEMI-ARID REGIONS

एम.एस. भाटिया
M.S. BHATIA



आर्थिक विश्लेषण और अनुसंधान विभाग

Department of Economic Analysis and Research

राष्ट्रीय कृषि और ग्रामीण विकास बैंक

National Bank for Agriculture and Rural Development

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PREFACE AND ACKNOWLEDGEMENTS

There has been increasing concern amongst policy makers, planners and development agencies that developmental policies and programmes have not adequately addressed the problems of agriculture in rainfed sector. The success and achievements in terms of raising production and productivity of irrigated sector which has also significantly improved the welfare of rural population in many areas is well recognized, but it is also argued that the so called green revolution has bypassed the majority of farmers / areas dependent on rainfed agriculture. The National Bank for Agriculture and Rural Development has played a key role in the development of irrigated agriculture in different states of India. However, the level of investment and financing for development of rainfed agriculture in relation to its share has been modest.

Viewed in this context, NABARD has rightly shown its concern in identifying the subject of study entitled "Viability of Rainfed Agriculture in Semi-arid Regions". Though some studies on rainfed agriculture have been made earlier but most of them were either confined to specific group of crops or state or region and were mostly related to development and adoption / transfer of technology. This study was basically aimed to critically examine the economic status, viability issues, constraints and potentials in making rainfed agriculture a viable proposition in semi-arid tropics. The study would provide an opportunity to NABARD and other institutions to reorient their policies and plans for development of rainfed agriculture in SAT regions.

Let me express my sincere thanks to NABARD in general and Dr. T.N. Jha, General Manager, Department of Economic Analysis and Research, in particular for having confidence in me to undertake this study. The author was greatly benefited by Dr. Jha through his comments on the initial proposal of the study. The author was also benefited from the periodical reviews and advice received from the other officers of the department in particular Mr. Vinod Kumar, Asstt. General Manager.

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only the approach to the study, provided useful ideas which were later examined but also gave relevant literature and data on the subject.

Though all efforts have been made to make study comprehensive, yet the constraints of time and space restricted to deal every aspect in depth. The opinions and views expressed in the study are of the author and he alone remain responsible for any short comings that may still be in the study.

M.S. BHATIA

EXECUTIVE SUMMARY

- (i) Despite increase in irrigated area to almost 3.5 times during the planned development of over four decades, about 60 per cent of the net sown area in the country is still rainfed. The problem of rainfed agriculture varies from region to region depending upon intensity and pattern of rainfall. The areas having high and assured rainfall are relatively advantaged regions whereas less and erratic rainfall areas are highly volatile in terms of production and productivity. Amongst different rainfed areas, the most vulnerable are the semi-arid regions because in these areas evapo-transpiration ratio exceeds rainfall in almost five to ten months and mean monthly temperature is greater than 18°C. The states which are falling under semi-arid tropics include Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh (including Chhatisgarh), Maharashtra, Rajasthan and Tamil Nadu. The share of rainfed agriculture in SAT states is about 73 per cent against only about 42 per cent in non-SAT states. Share of rainfed in terms of area is as high as 85.5 per cent in Maharashtra followed by Tamil Nadu and Karnataka with percentage as 82.5 and 76.5 per cent in other SAT states, share of rainfed area in the Net sown area ranged 60-70 per cent. Thus, states in SAT are basically characterized as rainfed agriculture.
- (ii) Jowar is the most important crop followed by Bajra amongst cereals. Coarse cereals in general accounts for about 29 per cent of the cropped area in rainfed sector in SAT states. The relative importance of different coarse cereals varies from state to state. Jowar is dominant crop in Maharashtra accounting for 27 per cent cropped area in rainfed sector while Bajra is predominant crop in rainfed sector in Rajasthan with share of cropped area as 30 per cent. The other important group of crops in SAT regions are pulses and oilseeds accounting for as 20 and 22 per cent of the cropped area in the rainfed sector. The important pulses crops included Gram and Tur and those of oilseed as Groundnut, Rapeseed and Mustard and Soyabean. The relative importance of pulse and oilseed crops, however, varied from state to state. Cotton is an important non-food commercial crop of rainfed sector in all the SAT states except in Rajasthan where it is an irrigated crop.

- (iii) The rainfed sector accounted for about bulk of the area ranging from 97-99 per cent of the total area in various SAT states for crops like Jowar in Andhra Pradesh, Gujarat, Madhya Pradesh and Rajasthan; Bajra in Madhya Pradesh, Maharashtra and Rajasthan, Maize in Rajasthan, Tur in Madhya Pradesh and Maharashtra as also Cotton in Maharashtra. For other crops/SAT states also, share of rainfed sector in the total area is fairly large.
- (iv) The share of rainfed sector in the total production of crops was relatively lower than that of area because of low productivity in the sector. Yet about 85 per cent of Jowar, 91 per cent of Bajra, 69 per cent of Maize was produced in the rainfed sector in SAT states. Further share of rainfed sector in the production of Tur was about 97 per cent and that of Gram and Groundnut as 72 and 75 per cent respectively. About 64 per cent of Cotton was being produced in the rainfed sector. In case of relatively heavy water duty crops of Paddy and Wheat, rainfed sector produced 21 and 13 per cent of total production of these crops in SAT states which is even less than half of their share in the area.
- (v) The yield per hectare of rainfed sector is significantly lower than that of irrigated sector in the same SAT states. The average yield per hectare of Rice in irrigated area was 2424 Kg. against 947 Kg. in rainfed area of SAT states. The average yield per hectare of Jowar and wheat in SAT states was 1609 Kg. and 2288 Kg. in irrigated sector and 632 Kg. and 893 Kg. in rainfed sector respectively. Thus yield per hectare of irrigated cereal crops in SAT states is about 2.5 times to that of rainfed sector. The difference in low water duty cereal crops of Bajra and Ragi in the yield of two sectors is relatively small as yield of irrigated sector is almost two-times to that of rainfed sector. The yield per hectare in irrigated area was higher by about 80 per cent in Cotton, 60 per cent in Groundnut, and 40 per cent in Rapeseed & Mustard than that of rainfed areas. The difference in yield per hectare of pulses in two sectors was further low being 20-30 per cent only.
- (vi) The growth performance of the major cereal crops of SAT states has shown a mixed performance. While rates of growth of production of Jowar and Ragi has decelerated in the recent decades of Nineties, the rate of growth of production of Bajra

and Maize has improved against earlier decade. The rate of growth of production and productivity of Gram has improved in recent period of 1990-91 to 1999-2000 whereas pulses on the whole has shown some deceleration in growth. The performance of Groundnut in terms of growth rate of production has some what decelerated in recent decade. The crops of Rapeseed and Mustard and Soya bean continued to show high rate of growth whereas Cotton production showed some deceleration in rate of growth mainly because of decline in yield per hectare of the crop.

- (vii) Taking into consideration of value of output of all major and minor crops including fruits and vegetables, condiments & spices etc. the rate of growth for crop production in all SAT states except in Andhra Pradesh was higher than the all-India average of 2.35 per cent per annum during the triennia 1990-91 and 1999-2000.
- (viii) Not only the yields per hectare are low in rainfed sector in SAT regions, the variability in both area and yield for most of the crops in SAT states is much higher than the all-India average. The variability in area and production of coarse cereals like Jowar, Bajra, Pulses and Oilseeds varied 20-30 per cent during the period 1991-2000. Much of the variability in area, yield and production of rainfed crops was attributed to variations in rainfall in SAT states. The rainfall indices, which show deviation from the normal rainfall, showed strong relationship with Index of weather influence, which showed deviation from the normal trend line production.
- (ix) Cost of cultivation involve both variable and fixed cost. While variable cost is associated with cultural practices and application of inputs for production, cost of fixed items have to be incurred irrespective of level of output. Because of low level of yield in rainfed sector of SAT states value of output often do not cover even full economic cost of cultivation of crops like Bajra, Maize, Ragi and Moong in Andhra Pradesh, Ragi and Sunflower in Gujarat, Paddy and Maize in Madhya Pradesh, Maize in Rajasthan and Jowar, Bajra and Cotton in Tamil Nadu. In quite a number of cases the level of net income was low and a few cases moderate to high. However, the farm business income which is taken as value of output (return) over payout cost, varied low to moderately high for various crops in different SAT states.

- (x) The economics of individual crops in different states is being continuously studied under the comprehensive scheme and examined by the CACP regularly, the information about farm business income however, is quite scanty after the discontinuation of Farm Management studies in seventies. This study has derived the farm business income from cost studies data taking into consideration the economics of individual crops and cropping pattern. The most common concept viewed in farm economy to know the status of farmers is economic holding which is usually defined as size of farm that is sufficient to provide a level of income to keep an average family a reasonable level of living or full employment to the average farm family. It was difficult to measure a reasonable level of living for the families. So two concepts were used to examine economic and viable holdings. In the first case economic size of farm was defined that is just sufficient to provide a level of income to keep an average family about the poverty line without having to resort to non farm activity. The study showed that the required size of economic holding which could yield the farm business income just to meet the poverty line varies from 0.96 hectare in Andhra Pradesh and Tamil Nadu to 1.68 hectares in Madhya Pradesh and 1.48 hectare in Gujarat and Rajasthan. This size of holding in Karnataka and Maharashtra is observed as 1.30 hectare. This size of economic holding was required when it considered (a) income from livestock as the part of holding as agriculture is practiced as mixed farming and (b) holding contained part of parcels as irrigated. However, if holdings were wholly rainfed, the required size of holding to yield farm income to meet the poverty line varied from 1.40 to 1.60 hectare in Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu whereas it ranged between 1.8-2.0 hectare in Madhya Pradesh, Rajasthan and Gujarat.
- (xi) Economically viable size of holding defined as that could provide an income enough to meet the requirement of both the family and farm expenses and be in a position to take-up some farm development. The viable economic size of farm in rainfed states varied from 2.74 hectare in Madhya Pradesh and Rajasthan to 3.7 hectare in Andhra Pradesh, Karnataka and 4.5 hectare in Tamil Nadu and Maharashtra. The size of viable economic holding was influenced by the cropping pattern, level of productivity, farm business income and cropping intensity. The study further revealed that in practically

all the rainfed SAT states, the marginal and small holding are not economically viable units and only one-fourth of the semi-medium holdings (2-4 hectare size class) are viable except in Gujarat and Tamil Nadu where viable units are still larger.

- (xii) The major constraints of rainfed farming in SAT states is high dependence on rainfall and shortage of water in root zone of crops, with irrigated area 1-5 per cent only. The use of fertilizers in many of SAT states / crops is less than half or one-third of the recommended level of application. Farmers are constrained of poor bargaining power in terms of acquiring funds, marketing of produce and price determination as market intervention by the Government for rainfed crops is not on the scale as for major irrigated crops of rice, wheat and sugarcane. Improvements in the market and price supports, provision of credit and possibly crop insurance for rainfed crops, as detailed in the text, should form a major component of development strategies in rainfed sector of semi-arid regions.
- (xiii) The study has shown that there is large scope of raising the productivity and improving the economic viability of rainfed farming in SAT states / regions as demonstrated under the Coordinated Research Project on Dry land Agriculture and Front Line Field Level Demonstrations of the ICAR on coarse cereals, pulses and oilseeds under rainfed conditions in SAT states. These projects have shown that if the available technology of rainfed agriculture could be transferred, the yield of coarse cereals, pulses and oilseeds could be raised by 40-80 per cent. Similarly water shed based technology which encompasses system of efficient land and rain water had shown that yield of crops with improved technology could be raised by about 80-100 per cent over the yield of traditional farmers of the same region. Once the productivity of rainfed sector is improved, the size of viable economic holding in the sector could be reduced by about 30-40 per cent. However this would call for programmes and strategies on two aspects. Firstly extension system has to be strengthened to make it effective for transfer of available rainfed technology in SAT states. Secondly financial and technical support has to be strengthened to extend the water shed programmes to cover additional areas in the SAT state. Technical and financial support may also be required for integrating crops, animals and trees (agro-forestry) as a policy of development. NABARD

as an Institute can take a major role of coordination of development, research projects and refinancing of activities of semi-arid agriculture. NABARD may also identify some of the areas / location specific projects that focus on programmes for increasing productivity or income of whole farm rather the productivity of one or two crops.

VIABILITY OF RAINFED AGRICULTURE IN SEMI-ARID REGIONS

1.1 Introduction

India has vast arable land of about 183 million hectare, of which about 142 million hectare is net sown area as per land use statistics of 1998-99. The irrigation facilities were available to about 57.24 million hectare or about 40.31 per cent of net sown area under the crops. Thus, bulk of the net sown area i.e. 85.5 million hectare or about 60 per cent of area under cultivation is fully dependent on rainfall.

In a country like India, there are large variations in rainfall and other associated factors in different parts / regions. The ICAR has identified 127 major agro-climatic zones with rainfall on cultivated areas varying from high (1150 mm or more) to medium (750-1150mm) to low (below 750mm) along with different cropping systems. The growing season of the Crops varies according to rainfall ranging from 11-20 weeks in low rainfall areas to 20-30 weeks in the medium rainfall areas and 30-40 weeks in the high rainfall areas depending on the amount, intensity and distribution of rainfall, land features and soil characteristics. The availability of rainfall water also restricts the farmers about the choice of crops that could be grown according to their water requirements.

Rainfed agriculture as such refers to crop production in a farming system which depends entirely on rainfall but may include supplementary irrigation from small dams or tanks fed from rainfall and associated run-off on a particular land holding. However, all rainfed areas are not of the same characteristics. High and assured rainfed areas are relatively advantaged regions where as less and erratic rainfall areas are highly volatile in terms of production and productivity. Amongst all the rainfed areas, semi-arid areas are supposed to be most fragile.

Though no definite definition of the Semi-arid tropics is available, yet some agreed concepts based on combining rainfall, evaporation and temperature is popular. According to this, the semi-arid tropics have been defined as areas where monthly rainfall exceeds potential evapo-transpiration ratio for two to seven months and mean monthly temperature is greater than 18°C. TAC. / FAO defined the semi -arid tropics based on length of the growing period of crops as 75-180 days and where all months have a mean temperature as greater

than 18°C and daily mean temperature during the growing period about 20°C.

While semi-arid areas are spread over across the continents, the Indian sub-continent has the largest semi-arid tropical areas amongst any of the developing countries. In India, Semi-arid tropics (SAT) fall in the states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh (including Chhattishgarh), Maharashtra, Rajasthan and Tamil Nadu, A few districts of Bihar, Orissa and Uttar Pradesh also fall under SAT category. However the proportion of area of these districts in these three state is relatively small. Since the availability of irrigational facilities have considerably improved over years, area / districts falling under rainfed agriculture in SAT regions have declined from about 175 districts in 1990's to about 140 districts at present, of which 126 are located in seven states as given in Annexure-I. The other 14 districts classified as semi-arid in other states are shown in Annexure-II.

Land in the rainfed areas of semi-arid tropics is low in productivity. Often rains are received in short periods and soils are low in infiltration either due to soil characteristics or to the soil type and severe run-off and water erosion hazards are common. Though the holding size in the region may be reasonable but fields are small and yields are low. The farmers in general have a small capital assets and thus, both ecologically and economically are at disadvantaged.

Indian agriculture in general has shown a spectacular growth in terms of both production and productivity during the last five decades of planned development. The long term growth rate of agricultural production during the period 1951-52 to 2001-02 has been of the order of 2.5 per cent per annum, which is much higher than the rate of growth of population. The rate of growth of production of food grains during the same period was also significantly higher being 2.4 per cent per annum. However, it is well recognised that there are large variations in terms of growth of agricultural producton and productivity across the regions/states and amongst the crops. It is often argued that the new technology of high yielding varieties which is based on high doses of water and fertilizer is not suitable for rainfed agriculture in general and for semi-arid tropics in particular. The development of rainfed technology and its adoption has been generally slow. The agriculture in these conditions is reported to be progressing very slow or even stagnating.

Since the crops cultivated under rainfed conditions of semi-arid tropics are partly commercial like Cotton, Oilseeds and partially as high value food grains of subsistence farmers like coarse cereals and pulses, it is important to have critical examination of these crops/ farming systems at periodical intervals to provide right signals to the farmers for desired production trends. The available production technology of hybrids of millets amongst coarse cereals and oilseeds indicate the large scope of raising production of these crops in this sector provided the impediments for such growth are properly tackled.

Viewed in this context, it was generally agreed that although the potentials for improvements in productivity and income in rainfed agriculture in semi-arid tropics are great, there is a need for proper identification of constraints which must be over come to achieve increased production in this sector.

I.2 Objectives of the Study

The main objectives of the study were set forth as under:-

- (i) To identify major crops and production systems in different semi-arid states/regions.
- (ii) To examine the trends in area, production and productivity of principal crops in semi-arid states, and temporal variations in them.
- (iii) To study the variability in production and productivity of rainfed crops and its association with rainfall.
- (iv) To study the cost structure and returns in different crops in rainfed / semi-arid area.
- (v) To examine the economic and economically viable size of holdings in semi-arid tropics of various states.
- (vi) To examine the role of credit in influencing the production and determination of its requirements / demand for different crops under rainfed conditions of SAT; and
- (vii) To examine the possibility of improving the profitability and raising the productivity of crops with improved technology, water management and credit situation to make rainfed agriculture in SAT areas more profitable and viable.

1.3 Plan of the Study

The study is divided in five sections including the present one. The section-II is devoted to briefly review the literature on the subject to indicate the attention SAT agriculture has received in development research. Section-III deals with production system, production and productivity levels under rainfed agriculture alongwith trends in production in this sector. Section-IV deals with economics of crop production and viability of farming while Section-V deals with, programmes and methods to improve the economic viability of farming in SAT States.

SECTION-II

2.0 Review of Literature

The economic problems of rainfed agriculture in India and in regions have long history though specific studies in Semi-arid tropics have been limited. Initial studies were involved in defining the rainfed and SAT agriculture. Troll (1964) defined the SAT as those regions where rainfall exceeds potential evapo-transpiration two to seven months a year. Rainfed agriculture in general is defined as agriculture based on crop production in a farming system which depends entirely on rainfall but may include supplementary irrigation from small dams or tanks fed from rainfall and associated run-off on a particular land holding. TAC/FAO defined the semi-arid tropic based on length of the growing period of crops (75-180 days) and have a mean monthly temperature as greater than 18°C and daily mean temperature during the growing period above 20°C. Murthy (1997) examined the changes in consumption pattern of ICRISAT mandate crops in different States and observed that coarse grains and pulses over years have become insignificant components of the budget expenditure of the poor. Ryan, J.G. and D.C. Spencer (2001) studied the future challenges and opportunities for Agricultural Research & Development in the semi-arid tropics in which they observed the declining importance of rainfed crops in the economy and suggested that diversification of agriculture with livestock production and horticultural crops may help small holders in the region. UNDP studied the Human Poverty Index (HPI) in different countries / regions and observed greater poverty in the semi-arid tropics than in non-SAT countries. In a review of 25 African countries, Readon (1998) found that non-farm income accounted for about, on an average of 45 per cent of total rural house hold income. In SAT areas most non-farm activities occur in the dry season and the share of non-farm income to total income is higher in the more marginal regions. The IFPRI study in India by Hazell and Fan (1998) examined the potential of alternative investments in irrigated, high and low potential rainfed areas to contribute to productivity growth and poverty alleviation and observed that investments in rural infrastructure, agricultural technology and human capital in many rainfed areas are now at least as productive as in irrigated areas and have much larger impact on poverty. Gulati and Kelly (1999) studied the trends in crop production in SAT India and observed a shift away from coarse cereals towards wheat, paddy and oilseeds. The Indian SAT

currently produces 87 per cent of the coarse grains, 82 per cent of oilseeds and 79 per cent of the pulses. It produces about 54% of total value of the major crops. Share of oilseeds in the cropped area has almost doubled in SAT India during 1968-70 to 1990-91. ICRISAT and ICAR (1999) examined the Typology Construction and Economic Policy Analysis for sustainable rainfed agriculture integrating both socio-economic and agro-ecological factors. The study also examined the economic efficiency of India's rainfed agriculture in selected systems. Ryan, J.G. and D.C. Spencer (2001) observed that though fertilizer use has increased significantly in all SAT regions, yet application rates are still extremely low. BIRTHAL P.S., P. Rao and P.K. Joshi (2002) studied the Agricultural diversification and disparities in SAT India and observed the farmers in the region are diversifying their crop production by shifting area proportionately more to high value crops like oilseeds, fruits and vegetables along with development of Live stock sector.

SECTION-III

Production Pattern in SAT States

3.1 Rainfed Agriculture in SAT States

Although irrigated area in the Country during the last five decades of planned development has increased from just about 22 million hectare in 1950-51 to about 77 million in 1999-2000, yet about 60 per cent of the net sown area is still dependant on rainfall. As per land use statistics of 1998-99, the net irrigated area in the country was reported to be about 54.56 million hectare against the net sown area of 142 million hectare. Thus about 87.5 million hectare of net sown area was reported to be under rainfed agriculture.

The magnitude of rainfed agriculture varies significantly across the states as shown in Table 1. The percentage of rainfed area to the net area sown is very low in northern states of Punjab, Haryana and Uttar Pradesh being 5.7, 23.2 and 31.4 per cent respectively. However, the share of rainfed area in the net sown area was 60-84 per cent in quite a number of states in Southern, Western and Eastern States of India.

Table 1 : Extent of Rainfed Agriculture in SAT and Non-SAT States in India

(,000 Hectare)

Sr. No.	State	Net Sown Area	Net Irrigated Area	Net unirrigated (Rainfed Sown Area)	Rainfed as Percentage of Net
	SAT				
1.	Andhra Pradesh	9846	3945	5901	59.90
2.	Gujarat	9600	3042	6158	68.30
3.	Karnataka	10075	2363	7712	76.50
4.	Madhya Pradesh	19940	6304	13640	68.40
5.	Maharashtra	17761	2567	15194	85.50
6.	Rajasthan	17075	5250	11825	69.20
7.	Tamil Nadu	5581	977	4604	82.50
	Total SAT States	89878	24448	65430	72.80

**Table 1 : Extent of Rainfed Agriculture in SAT
and Non-SAT States in India (Contd.)**

(,000 Hectare)

Sr. No.	State	Net Sown Area	Net Irrigated Area	Net unirrigated (Rainfed Sown Area)	Rainfed as Percentage of Net
	Non SAT				
1.	Assam	2751	572	2179	79.20
2.	Bihar	7411	3624	3787	51.10
3.	Haryana	3635	2793	842	23.20
4.	Himachal Pradesh	538	105	453	81.20
5.	J & Kashmir	736	309	427	58.00
6.	Kerala	2271	350	1921	84.60
7.	Orissa	6122	2523	3599	58.80
8.	Punjab	4139	3903	236	5.70
9.	Uttar Pradesh	17513	12012	5501	31.40
10.	West Bangal	5465	1911	3554	65.00
11.	Others	1542	2013		
	Total Non SAT	52143	30115	22028	42.20
	Grand Total	142021	54563	87458	61.58

The problem of rainfed agriculture varies from region to region depending upon the quantum and pattern of rainfall. In the region/ areas of high and assured rainfall, the rainfed agriculture is supposed to be better endowed. Thus rainfed areas of Kerala, parts of Orissa and Bihar, Assam and Himachal Pradesh are generally considered as favourably placed. However the problems of rainfed agriculture is severe in areas/states falling under semi-arid tropics where rainfall in most of the months fall short of evapo-transpiration and is associated with great degree of uncertainty. The state which are falling under semi-arid tropics include Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu. The share of rainfed agriculture in the net sown area in these states is relatively much higher being about 73 per cent against only about 42 per cent in non-SAT States. Share of rainfed area was as high as 85.5 in Maharashtra followed by Tamil Nadu and

Karnataka with percentage as 82.5 and 76.5 respectively. In other SAT States, share of rainfed area in the net sown area ranged 60-70 per cent. Thus states in the semi-arid tropics are basically characterised as rainfed agriculture.

Since states falling under SAT have generally rainfed agriculture, problems of the state/region are further compounded if the total rainfall is low. For example SAT districts falling in Orissa or Jharkhand or even East Madhya Pradesh (Chhattisgarh) have annual rainfall in the range of 1000-1200 mm where as annual rainfall in the SAT regions of Gujarat and Telangana ranged 800-900 mm. It was as low as in the range of 400-600 mm. In Rayalaseema, Karnataka, Tamil Nadu and Rajasthan. The level of productivity of crops is generally low and more prone to risk and uncertainty in these low rainfall areas under SAT rainfed conditions.

3.2 Cropping Pattern under Rainfed Agriculture of SAT States

The cropping pattern is largely influenced by the magnitude and pattern of rainfall along with the availability of irrigation water. The shifts in cropping pattern with the extension of irrigation towards high value crops are well recognised. Under rainfed agriculture when rainfall is higher and rainfall season is relatively longer as in the East and North-Eastern Indian States like Assam, Bihar, Orissa, West Bengal, East Madhya Pradesh (including Chhattisgarh) heavy water duty crop like paddy could also be cultivated under rainfed conditions. However in case of low rainfall areas where rainy season is relatively of short duration and evapo-transpiration in most of the months exceeds rainfall called semi-arid tropics, the choice of crops under rainfed conditions has to be restricted to those which are not only low water duty but also are of short duration. An idea about the cropping pattern under rainfed agriculture in SAT and non-SAT states can be had from Table 2.

Table 2 : Cropping Pattern under Rainfed Agriculture in SAT States vis-a-vis others 1998-99

(Area 000 Hect.)

Sr. No.	Crops	Andhra Pradesh	Gujarat	Karnataka	Madhya Pradesh	Maharashtra	Rajas- than	Tamil Nadu	SAT States	Non-SAT States	All States
1.	Rice	125 (1.79)	261 (3.76)	413 (5.0)	4147 (21.23)	1062 (5.71)	96 (0.61)	174 (5.72)	6278 (7.89)	15381 (40.00)	21665 (18.41)
2.	Jowar	771 (11.05)	268 (3.86)	1768 (20.12)	843 (4.32)	5019 (26.99)	560 (3.58)	335 (11.02)	9564 (12.02)	463 (1.20)	1002 (8.49)
3.	Bajra	80 (1.15)	879 (12.66)	265 (3.01)	132 (0.67)	1605 (8.63)	4647 (29.69)	152 (5.00)	7752 (9.75)	1343 (3.49)	9098 (7.73)
4.	Maize	262 (3.75)	360 (5.18)	287 (3.27)	849 (4.35)	207 (1.11)	938 (5.99)	30 (0.99)	2933 (3.69)	2132 (5.51)	5065 (4.29)
5.	Ragi	73 (1.05)	19 (0.27)	856 (9.74)	12 (0.06)	157 (0.84)	—	33 (1.08)	1150 (1.44)	478 (1.24)	1628 (1.38)
6.	Wheat	3 (0.04)	169 (2.43)	155 (1.76)	1414 (7.24)	227 (1.22)	142 (0.91)	—	2110 (2.65)	1893 (4.95)	4003 (3.39)
7.	Barley	— (011)	8	— (0.31)	60 (0.01)	2 (0.44)	69	— (0.75)	139 (0.50)	233 (0.31)	372
8.	Coarse Cereals	1255 (17.99)	1555 (22.39)	3249 (36.98)	3283 (16.80)	7108 (38.23)	6221 (39.75)	656 (21.59)	23327 (29.34)	4391 (11.39)	27118 (23.50)
9.	Total Cereals	1383 (19.82)	1985 (28.58)	3817 (43.44)	8844 (45.19)	8397 (45.17)	6459 (41.27)	830 (27.31)	31715 (39.88)	21665 (56.34)	53384 (45.37)
10.	Gram	145 (2.08)	347 (5.00)	305 (3.47)	1758 (9.00)	494 (2.66)	1831 (11.70)	5 (0.16)	4885 (6.14)	1207 (3.13)	6092 (5.16)
11.	Tur	318 (4.06)	348 (5.01)	410 (4.66)	358 (1.84)	995 (5.35)	39 (0.25)	68 (2.24)	2536 (3.19)	642 (1.67)	3178 (2.69)
12.	Total Pulses	1546 (22.15)	800 (11.52)	1595 (18.15)	4095 (20.96)	3028 (16.29)	4044 (25.84)	553 (18.19)	15661 (19.69)	5283 (13.74)	20944 (17.74)
13.	Ground Nut	1479 (21.19)	1764 (25.40)	794 (9.03)	238 (1.22)	146 (0.78)	211 (1.35)	597 (19.64)	5229 (6.57)	597 (1.55)	5826 (4.94)
14.	Rape & Mustered	— (0.36)	25	— (2.81)	548 (0.06)	11 (6.82)	1068 (0.03)	1 (2.08)	1653 (3.08)	1186 (2.40)	2839
15.	Oil Seeds	2349 (33.66)	2171 (31.26)	2096 (23.85)	5782 (29.58)	2323 (12.49)	2480 (15.87)	758 (24.94)	17959 (22.12)	3799 (9.88)	21758 (18.44)
16.	Cotton	735 (10.53)	946 (13.62)	397 (4.52)	312 (1.60)	3050 (16.40)	13 (0.08)	149 (4.90)	5602 (7.04)	57 (0.14)	5659 (4.79)
17.	Others	964 (13.81)	1042 (15.00)	879 (10.00)	510 (2.61)	1793 (9.64)	2653 (16.95)	749 (24.64)	8590 (10.80)	7683 (19.98)	16233 (13.75)
	All Crops	6977 (100.00)	6944 (100.00)	8784 (100.00)	19543 (100.00)	18591 (100.00)	15649 (100.00)	3039 (100.00)	79527 (100.00)	38451 (100.00)	117978 (100.00)

It is seen from Table 2 that under rainfed agriculture in SAT states, on the whole Jowar is the most important crop followed by Bajra amongst cereals. Coarse cereals in general accounts for about 29 per cent of the total cropped area under rainfed sector in SAT states under review. Though relative importance of different coarse cereals varies from state to state. Jowar is very dominant crop in Maharashtra accounting for about 27 per cent of cropped area in rainfed sector followed by Karnataka with about one-fifth of area under this crop. Share of Jowar in the total rainfed cropped area in Andhra Pradesh and Tamil Nadu is about 11 per cent, whereas it was around 4 per cent in other SAT states. Bajra is dominant in Rajasthan with about 30 per cent of the cropped area in rainfed sector under this crop followed by Gujarat and Maharashtra with percentage as 12.7 and 8.6 respectively. Maize is only moderately important in SAT states under rainfed conditions except in Maharashtra and Tamil Nadu where it is very minor crop. Ragi is important coarse cereal in Karnataka accounting for 9 per cent of cropped area.

The other important crops of rainfed agriculture in semi-arid tropics of India are pulses and oil seeds accounting for about 20 and 22 per cent of the cropped area in the sector. The important pulse crops included Gram and Tur and those of oilseeds as Groundnut, Rape & mustard and Soyabean. The relative importance of most of pulse and oilseed crops varies from state to state. Gram is most important crop in Madhya Pradesh and Rajasthan with share in the cropped area in the range of 9-12 per cent, in other SAT states its share is moderate in the range of 2-5 per cent except in Tamil Nadu where it is very minor crop. Tur is grown in almost all the SAT states in moderate proportion except in Rajasthan where it is a minor crop. The other pulse crops of Urad, Moong and Lentil etc. clubbed together are quite important in most of SAT states under rainfed sector.

Amongst oilseeds, Groundnut is more important in the states of Gujarat, Andhra Pradesh and Karnataka followed by Tamil Nadu, Madhya Pradesh and others. Rapeseed & mustard is a major crop in Rajasthan and Madhya Pradesh only. Soyabean, which is not shown in the table, is major crop in Madhya Pradesh, Maharashtra and Rajasthan. While share of area under oilseed crops in the total cropped area of rainfed sector was as high as 31-33 per cent in Andhra Pradesh and Gujarat followed by Madhya Pradesh with 29.6 per cent, share of oilseeds in the cropped area was about one-fourth in Karnataka and Tamil Nadu and moderately to fairly high in other SAT states.

Cotton is another important Commercial crop of rainfed agriculture in semi-arid tropics accounting for about 7 per cent of the total cropped area. This share was as high as 16.4 per cent in Maharashtra followed by Gujarat and Andhra Pradesh with share as 13.6 and 10.5 per cent respectively. In other SAT States Cotton accounts about 4-5 per cent of rainfed cropped area except in Rajasthan where Cotton is by and large, cultivated in irrigated sector.

Rainfed agriculture in non-SAT States is basically dominated by Paddy Crop which account for about 40 per cent of total cropped area in this sector. It is because that quite a significant part of this area falls in the high rainfall states of Assam, West Bengal, Bihar, Orissa, East Madhya Pradesh including Chhattisgarh, East Uttar Pradesh and Kerala. Maize is another cereal crop which is relatively important in the rainfed agriculture of non-SAT States followed by wheat. Other coarse cereals like Jowar, Bajra etc. are relatively less important in this Sector. The share of major pulses Gram and Tur is less in Non-SAT States although other pulses are as important as in SAT States. Groundnut and Cotton is not important in the cropping pattern of rainfed Sector of non-SAT States. However, some of the other oilseeds are quite important in the sector.

In the overall rainfed agriculture as shown in Table-3 in the country, Paddy is the most important crop accounting about 21.7 million hectare or 18.36 per cent of the total cropped area of about 118 million hectare. Other important crops include Jowar, Bajra, Maize and Wheat amongst cereals, Gram, Tur, Groundnut, Soyabean, Cotton etc. some other pulses and oilseeds are cultivated in a significant level in certain states.

Table 3 : Cropping Pattern under Rainfed and Irrigated Agriculture in SAT and other States

(Area 000 Hect.)

Sr. No.	Crop	Rainfed Area			Irrigated Area		
		SAT States	Non SAT States	Total	SAT States	Non SAT States	Total
1.	Rice (Paddy)	6278 (7.89)	15387 (40.00)	216665 (18.41)	8585 (27.18)	13226 (32.18)	21811 (29.94)
2.	Jowar	9564 (12.02)	463 (1.20)	10027 (8.50)	—	—	—
3.	Bajra	7752 (9.73)	1343 (3.49)	9098 (7.73)	—	—	—
4.	Maize	2933 (3.69)	2132 (5.54)	50.65 (4.30)	—	—	—

**Table 3 : Cropping Pattern under Rainfed and Irrigated
Agriculture in SAT and other States (Contd.)**

(Area 000 Hect.)

Sr. No.	Crop	Rainfed Area			Irrigated Area		
		SAT States	Non SAT States	Total	SAT States	Non SAT States	Total
5.	Ragi	1150 (1.45)	478 (1.24)	1628 (1.38)	—	—	—
6.	Wheat	2110 (2.65)	1893 (4.92)	4003 (3.40)	6814 (21.58)	15887 (38.55)	22701 (31.15)
7.	Barley	139 (0.17)	233 (0.60)	372 (0.32)	—	—	—
8.	Total Coarse Cereals	—	—	— (6.26)	1974 (3.27)	1349 (4.56)	3323
9.	Total Cereals	31715 (39.84)	21665 (56.33)	53380 (45.47)	173773 (55.00)	30462 (70.94)	—
10.	Gram	4885 (6.11)	1207 (3.14)	6092 (5.17)	—	—	—
11.	Tur	2536 (3.17)	642 (1.67)	3178 (2.70)	—	—	—
12.	Total Pulses	15661 (19.58)	5283 (13.73)	20944 (17.80)	1723 (5.46)	1075 (2.60)	2798 (3.84)
13.	Groundnut	5229 (6.54)	597 (1.55)	5826 (4.95)	1347 (4.27)	72 (0.17)	1419 (1.95)
14.	Rapeseed & Mastered	1653 (2.07)	1186 (3.08)	2839 (2.41)	2311 (7.31)	1550 (3.76)	3861 (5.30)
15.	Total Oilseeds	17959 (22.45)	3789 (9.85)	21758 (18.49)	5069 (16.03)	1927 (4.67)	6996 (9.60)
16.	Cotton	5602 (7.00)	57 (0.14)	5659 (4.81)	1842 (5.83)	1376 (3.33)	3218 (4.42)
17.	Sugarcane	—	—	— (5.46)	1728 (5.35)	2209 (5.40)	3937
18.	Fruits & Vegetable	—	—	— (4.01)	1267 (4.45)	1839 (4.27)	3106
19.	Condiments and Spices	—	—	— (4.20)	1329 (0.40)	164 (2.05)	1493
20.	Fodder	—	—	— (1.61)	510 (3.85)	1589 (2.89)	2099
21.	Others	8590 (10.74)	7643 (19.87)	16233 (13.79)	835 (2.64)	467 (1.13)	1302 (1.78)
	Total Cropped area	79527	38451	117978	31584	41200	72784

Figure in brackets show per cent of Total cropped area.

It may not be out of relevance to mention in brief about irrigated agriculture in India. Agriculture in irrigated sector is dominated by heavy water duty crops of Paddy and Wheat. Coarse cereals are relatively of less significance of irrigated sector in both SAT and

non-SAT States. The share of pulses and oilseeds in irrigated sector is higher in SAT States than in non-SAT States. Cotton and Sugarcane are cultivated in both the categories of States. However, while condiments and spices are more prominent in irrigated sector of SAT States, fodder crops are relatively have larger share in non-SAT States. The share of fruits and vegetable in the total cropped area is, by and large, quite comparable in irrigated agriculture of both SAT and non-SAT States.

3.3 Cropwise/Statewise Coverage of Rainfed Agriculture

In semi-arid states, rainfed agriculture dominates the sector both in terms of coverage of area and its share in production in majority of the crops. The share of rainfed area under principal crops in semi-arid states during 1997-98 is shown in Table-4. It would be seen that the major rainfed cereals included Jowar, Bajra, Maize and Ragi whose rainfed area was as high as 93.6, 94.6, 81.7 and 92.1 per cent respectively for major semi-arid seven states. The share of rainfed sector in Paddy area of SAT states was relatively less being about 42.2 per cent only, which may be attributed to relatively high share of irrigated area under this crop in the Southern States of Andhra Pradesh, Karnataka and Tamil Nadu. The share of rainfed area under Gram and Tur was of the order 77 and 97 per cent respectively in the semi-arid States under review. Wheat is not a major rainfed crop of SAT States except in a limited area of Maharashtra, Madhya Pradesh and Rajasthan. The share of rainfed sector interms of area is as high as of 83 per cent in Groundnut and 75 per cent in Cotton.

As far state-wise, crop-wise position is concerned, in Jowar rainfed sector accounts for about 98-99 per cent of acreage in Andhra Pradesh, Gujarat, Madhya Pradesh and Rajasthan, while in other SAT states it ranged 91-94 per cent. In case of Bajra rainfed sector covered 97-100 per cent in Madhya Pradesh, Maharashtra and Rajasthan. In other SAT states, it was 82-94 per cent except in Karnataka where the share of rainfed sector in area was about two-third. The share of rainfed sector in Maize area was as high as 97 per cent in Rajasthan followed by Gujarat and Maharashtra with share as 90 and 86 per cent. In other SAT states, this share for Maize ranged 51-67 per cent. In case of Gram rainfed sector area share was highest as 98.7 per cent in Andhra Pradesh followed by Karnataka at 91 per cent. This share was relatively low in Gujarat, Madhya Pradesh, Maharashtra in the range of 66-70 per cent.

Table - 4 : Share of Rainfed Area under Principal Crops in SAT States

(,000 Hect.)

Sr. No.	State	Paddy		Jowar		Bajra		Maize		Gram		Tur		Groundnut		Wheat		Cotton		Ragi	
		Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total
1.	Andhra Pradesh	127 (3.6)	3500	774 (98.0)	790	82 (82.0)	100	266 (66.5)	400	148 (98.7)	150	289 (74.17)	390	1514 (82.7)	1830	—	—	739 (81.2)	910	75 (76.5)	98
2.	Gujarat	267 (39.6)	673	278 (99.3)	280	919 (83.5)	1100	360 (90.0)	400	80 (66.7)	120	320 (88.9)	360	1756 (91.0)	1930	175 (25.0)	700	947 (62.3)	1520	—	—
3.	Karnataka	420 (31.1)	1350	1777 (93.5)	1900	201 (67.01)	300	300 (53.6)	560	308 (90.6)	340	358 (76.2)	470	845 (81.3)	1040	—	—	405 (81.0)	500	856 (93.9)	911
4.	Madhya Pradesh	41.50 (76.4)	5430	838 (99.8)	840	160 (100.0)	160	748 (86.0)	860	1755 (68.0)	2580	397 (99.2)	400	232 (92.8)	250	1475 (31.7)	4650	315 (605)	520	12 (100.0)	12
5.	Maharashtra	1065 (71.9)	1480	5032 (91.5)	5500	1613 (96.6)	1670	206 (85.8)	240	499 (69.3)	720	1000 (99.0)	1010	359 (66.0)	530	500 (49.0)	1020	3051 (97.1)	3140	157 (100.0)	157
6.	Rajasthan	98 (59.7)	164	578 (99.7)	580	4648 (98.9)	4700	939 (96.8)	970	1919 (86.8)	2210	—	—	290 (87.9)	330	232 (8.4)	2770	8 (1.2)	640	—	—
7.	Tamil Nadu	153 (6.7)	2260	345 (90.8)	380	160 (94.1)	170	30 (51.8)	58	— (95.4)	—	105 (58.8)	110	512 (87.0)	870	— (65.6)	—	151 (77.6)	230	83	107
	Total SAT States	6274 (42.23)	14857	9615 (93.62)	10270	7763 (94.90)	8180	2849 (81.68)	3488	4709 (76.90)	6120	2669 (97.41)	2740	5608 (82.71)	6780	2382 (26.1)	9140	5616 (75.28)	7460	1183 (92.06)	1285

Figures in bracket show percent to total area of the crop in the State.

Tur is, by and large, cultivated in rainfed sector in Madhya Pradesh and Maharashtra and fairly in large proportion in other SAT states with lowest share as 74 per cent in Andhra Pradesh. Groundnut is another dominant crop of rainfed sector in SAT states with share for total area ranging from 81-93 per cent except in Maharashtra and Tamil Nadu where this share was 66 and 60 per cent respectively. Ragi is by and large, rainfed crop in major growing states of Karnataka and Maharashtra, where as this share is somewhat lower in minor growing states of Madhya Pradesh and Tamil Nadu. In Cotton rainfed sector account for about 97 per cent of area in major growing state of Maharashtra followed by Andhra Pradesh and Karnataka with share as about 81 per cent. Cotton in Rajasthan is, by and large, grown in irrigated sector. Wheat is relatively minor crop of rainfed sector in SAT states.

3.4 Share of Rainfed Sector in Total Production

One of the important features of rainfed agriculture is that its share in the total production of crops is much lower than that of its area particularly in SAT states due mainly to low productivity of the sector. The share of rainfed sector in total production of different crops in major SAT states during 1997-98 is shown in Table 5. An examination of this Table show that about 85 per cent of Jowar, 91.4 per cent of Bajra, 69.1 per cent of Maize was produced by rainfed sector in SAT states. Further share of rainfed sector in the production of Tur was about 97 per cent and that of Gram and Groundnut as 72 and 75 per cent respectively. About 64 per cent of Cotton was being produced in the rainfed sector in SAT states. In case of relatively heavy water duty crops of Paddy and Wheat, rainfed sector produced only 22 and 13 per cent of total production of these crops in SAT states, which is almost half or even less than their share in area.

As far as state-wise position is concerned, in case of Jowar, the share of rainfed sector in the total production was 96-99 per cent in the states of Andhra Pradesh, Madhya Pradesh and Rajasthan, whereas it was in the range of 80-90 per cent in other SAT states. The share of rainfed sector in the total production was fairly high in the range of 94-99 per cent of Bajra in the states of Madhya Pradesh, Maharashtra and Rajasthan, Maize in Rajasthan, Tur in Andhra Pradesh, Gujarat, Maharashtra, Rajasthan and Tamil Nadu. The share of rainfed sector in the total production was also large in the range of 80-90 per cent in other states / crops like Bajra in Gujarat and Tamil Nadu, Gram in Karnataka and Rajasthan and

Table 5 : Share of Rainfed Production in Principal Crops in SAT States

(,000 Tonnes)

Sr. No.	State	Paddy		Jowar		Bajra		Maize		Wheat		Gram		Tur		Groundnut		Cotton		Rape & Mustard	
		Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total
1.	Andhra Pradesh	115 (1.35)	8510	500 (96.1)	520	46 (65.7)	70	673 (62.3)	1080	—	—	59 (98.3)	60	59 (98.3)	60	772 (66.6)	1160	1074 (81.4)	1320	—	—
2.	Gujarat	222 (21.3)	1040	200 (86.9)	230	1243 (82.9)	1500	526 (79.7)	660	259 (15.7)	1650	65 (65.0)	100	285 (79.16)	360	2344 (89.5)	2620	1838 (57.8)	3180	20 (5.7)	350
3.	Karnataka	735 (22.9)	3210	1050 (84.0)	1250	76 (58.5)	130	643 (42.6)	1510	—	—	105 (87.5)	120	92 (92.0)	100	486 (68.4)	710	547 (76.0)	720	—	—
4.	Madhya Pradesh	2996 (66.1)	4530	717 (98.2)	720	150 (100.0)	150	933 (81.8)	1140	1385 (19.2)	7220	1467 (60.1)	2440	257 (98.8)	260	228 (91.2)	250	278 (54.5)	510	218 (51.9)	420
5.	Maharashtra	1577 (66.0)	2390	3037 (80.3)	3780	1056 (94.3)	1120	247 (82.3)	300	204 (30.4)	670	190 (65.5)	290	351 (97.5)	360	354 (61.4)	570	1615 (92.3)	1750	—	—
6.	Rajasthan	96 (52.7)	182	269 (99.6)	270	2449 (97.6)	2510	1177 (95.7)	1230	280 (4.2)	6700	1645 (85.7)	1920	—	—	307 (83.0)	370	15 (1.7)	870	1040 (47.48)	2190
7.	Tamil Nadu	202 (2.9)	6890	307 (80.8)	380	182 (86.7)	210	34 (33.33)	102	—	—	—	—	36 (90.0)	40	813 (57.6)	1410	187 (51.9)	360	—	—
	Total SAT States	5963 (22.3)	26750	6080 (85.0)	7150	5202 (91.4)	5690	4161 (69.1)	6022	2128 (13.1)	16240	3541 (71.7)	4940	1149 (96.6)	1180	5304 (74.8)	7090	5554 (63.8)	8710	1278 (43.2)	2960

Figures in bracket show percent to total area of the crop in the State.

Groundnut in Gujarat and Rajasthan. The share of rainfed sector in total production of Cotton was about 92.3 per cent in Maharashtra, 81 per cent in Gujarat and 76-81 per cent in Andhra Pradesh and Karnataka. In other SAT states, share of rainfed sector in the production of this crop was 55-60 per cent except that in Rajasthan where it is by and large, grown in irrigated sector. Wheat is not a major crop of SAT states except that in Rajasthan and Madhya Pradesh where also bulk of its production is accounted for by the irrigated sector.

3.5 Yield Levels of Rainfed Agriculture in SAT

One of the basic problem in rainfed agriculture in semi-arid tropics is severe shortage of water in root zone of crops. Since evapo-transpiration is higher than the rainfall in most periods of the year, the rainfed crops suffer in terms of growth due to poor nutritional intake. In a good cases, the farmers are reluctant to take new high yielding varieties whose performance under rainfed conditions is even more risky. Due to variety of reasons like adoption of traditional varieties, low application of fertilizers and other nutrients and uncertainty of rainfall, the yield levels of rainfed agriculture in semi-arid states are significantly lower than that of irrigated agriculture in the same region/state. The average yield rates of irrigated and un-irrigated (rainfed) agriculture of principal crops in selected semi-arid states for the year 1997-98 are shown in Table 6. The ratios of yield rates of rainfed to irrigated and vice-versa for the same crops/states are shown in Table 7.

An examination of Table 6 and 7 reveals that in major cereal crops of Rice, Jowar and Wheat, the yield per hectare of rainfed (un-irrigated) sector on the whole in SAT states during 1997-98 was about 40 per cent of irrigated areas/sector. Thus yield per hectare of irrigated cereal crops in the semi-arid tropic is about 2.5 times to that of rainfed farms. The average yield per hectare of Rice in irrigated areas was about 2424 Kgs. against 947 Kgs. in rainfed area of SAT States. The average yield per hectare of Jowar and Wheat in SAT states was 1609 Kgs. and 2088 Kgs. in irrigated sector and 632 Kgs. and 893 Kgs. in rainfed sector respectively. This difference in yield per hectare of two sectors i.e., irrigated and rainfed sector is relatively less for low water duty cereals crops of Bajra, Ragi and Maize in which case on the whole yield of irrigated sector is almost two time to that of rainfed sector. The yield per hectare in irrigated sector was higher than rainfed sector in SAT states by about 80 per cent in Cotton, 61 per cent in Groundnut

Table 6 : Level of Yield of Un-irrigated and Irrigated Crop During 1997-98 in Semi Arid States

(Kg. per hect.)

Sr. No.	State	Paddy		Jowar		Bajra		Maize		Wheat		Gram		Tur		Groundnut		Rape & Mustard		Cotton	
		Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total	Un Irrigated	Total
1.	Andhra Pradesh	909	2489	645	2183	559	1889	2530	3040	—	—	398	500	179	800	510	1230	—	—	247	250
2.	Gujarat	850	1985	719	1500	1352	1419	1460	3350	370	2650	437	869	890	1875	1348	1590	689	1030	330	898
3.	Karnataka	1750	2661	593	1538	378	647	2143	3365	—	—	341	469	257	667	575	1150	—	—	230	309
4.	Madhya Pradesh	722	1198	855	1500	937	—	1247	1850	939	1838	836	1179	646	1000	982	1200	480	821	150	196
5.	Maharashtra	1481	1959	604	1587	643	948	1029	1560	409	896	380	452	348	900	986	1261	—	—	90	258
6.	Rajasthan	977	1303	476	915	527	1173	1254	1709	1208	2530	857	944	—	—	1057	1575	595	750	210	230
7.	Tamil Nadu	1320	3174	890	2057	1140	2800	1149	2417	—	—	—	—	327	800	1587	2320	—	—	210	372
	Average SAT	947	2424	632	1609	670	1170	1460	2912	893	2088	752	991	441	563	946	1524	573	801	160	291

Source - NSSO Crop Estimation Survey Reports Based on Crop Cutting Experiments.

Table - 7 : Yield Ratio of Rainfed to Irrigated Agriculture in Semi Arid States And Vice-Versa

(Kg. per hect.)

Sr. No.	State	Rice		Jowar		Bajra		Maize		Wheat		Gram		Tuu		Groundnut		Cotton	
		UI	I	UI	I	UI	I	UI	I	UI	I	UI	I	UI	I	UI	I	UI	I
1.	Andhra Pradesh	0.36	2.74	0.295	3.38	0.296	3.39	0.832	1.20	—	—	0.796	1.256	0.223	4.469	0.414	2.41	0.983	1.01
2.	Gujarat	0.43	2.33	0.479	2.08	0.953	1.05	0.411	2.43	0.139	7.16	0.503	1.988	0.474	2.106	0.847	1.180	0.367	2.72
3.	Karnataka	0.66	1.52	0.385	2.59	0.584	1.71	0.637	1.57	—	—	0.727	1.37	0.385	2.58	0.500	2.00	0.744	1.34
4.	Madhya Pradesh	0.60	1.66	0.570	0.75	—	—	0.674	1.48	0.511	1.96	0.709	1.41	0.646	1.548	0.818	1.22	0.765	1.31
5.	Maharashtra	0.76	1.32	0.380	1.63	0.678	1.47	0.660	1.516	0.456	2.20	0.840	1.19	0.387	2.586	0.782	1.27	0.348	2.86
6.	Rajasthan	0.75	1.33	0.520	1.93	0.449	2.22	0.733	1.36	0.279	3.57	0.907	1.102	—	—	0.671	1.49	0.875	1.09
7.	Tamil Nadu	0.41	2.40	0.433	2.31	0.407	2.45	0.475	2.10	—	—	—	—	0.408	2.46	0.684	1.46	0.564	1.77
	Average SAT	0.39	2.56	0.393	2.54	0.57	1.75	0.50	1.99	0.395	2.52	0.758	1.32	0.786	1.276	0.620	1.61	0.549	1.82

UI - Un Irrigated I - Irrigated

and about 40 per cent in Rape & Mustard. However, the yield per hectare of pulses which are, by and large, rainfed and low water duty crops, was only 20-30 per cent higher in irrigated conditions over rainfed areas.

However, the difference between rainfed and irrigated sector yield of crops in a state was also governed by the magnitude of rainfall. In a low rainfall state like Gujarat, Rajasthan and Karnataka, the yield rates of rainfed agriculture are significantly further lower than irrigated sector.

In non-SAT states, both rainfall and humidity are relatively high and water balance position in the root zone of the crops is not that bad. The difference in yield levels of rainfed and irrigated sector of principal crops is not that large as in the SAT states. For example the average yield of Paddy in rainfed sector of non-SAT states is lower only by about 41 per cent than that of irrigated sector of the region. Thus yield per hectare of Paddy in irrigated sector is higher by only 69 per cent than rainfed sector in non-SAT states against 156 per cent in SAT states. In case of Wheat, the yield per hectare of irrigated sector in the non-SAT states was higher by 103 per cent than that of rainfed sector whereas in SAT states, the irrigated yield rates were higher by 153 per cent than that in rainfed yield per hectare. Such difference in yield of low water duty crops like Jowar, Bajra, Gram etc. in two sectors in the two zones is relatively less and not that significant. Cotton is not a significant crop of rainfed sector in the non-SAT states.

3.6 Growth Performance of Principal Crops

Before examining the performance of SAT states in terms of growth, it would be of interest to study the all India growth rates of principal crops relevant for SAT region. The All-India growth rates of relevant principal crops for SAT region during the period 1980-81 to 1989-90 and 1990-91 to 1999-2000 are shown in Table 8.

An examination of Table 8 shows that the performance of the major coarse cereal crop of Jowar has not been satisfactory at the all India level. The decline in area under this crop has accelerated in nineties over eighties. Against the marginal growth rate of 0.28 per cent per annum during 1980-81 to 1989-90, its production showed a declining trend at the all India level during 1990-91 to 1999-2000. The rate of growth of yield also decelerated to 0.12 per cent per annum during nineties against a reasonable growth rate of

1.29 per cent per annum during earlier decade. The performance of Bajra interms of production and productivity growth has improved in the latest period of 1990-91 to 1999-2000 against the earlier decade of 1980-81 to 1989-90 whereas decline in area continued in both the periods. The performance of Maize has improved in recent period interms of increase in both area and yield and also the production. Despite a reasonably high rate of growth of yield of Ragi in recent period its production showed even a higher rate of decline at 1.21 per cent per annum against the 0.10 per cent per annum in earlier decade of 1980-81 to 1989-90 only because of much sharper decline in area under the crop in recent period. The rates of growth of production and productivity of Rice also decelerated in recent period over earlier decade. Amongst pulses, Gram has shown some improvement interms of growth of area, production and yield in recent period of 1990-91 to 1999-2000 as against the earlier decade whereas performance of Tur and other pulses as well as total pulses have deteriorated in recent decade as compared to earlier decade of 1980-81 to 1989-90.

Table 8 : All India Compound Growth Rates of Principal Crops of SAT States

(Per cent Per Annum)

Sr. No.	Crop	1980-81 to 1989-90			1990-91 to 1999-2000		
		A	P	Y	A	P	Y
1.							
2.	Jowar	-0.99	0.28	1.29	-0.71	-3.59	0.12
3.	Bajra	-1.05	0.00	1.09	-1.58	0.80	2.21
4.	Maize	-0.20	1.89	2.09	0.84	2.55	1.69
5.	Ragi	-1.23	-0.10	1.14	-3.22	-1.21	2.07
6.	Rice	0.41	3.62	3.19	0.62	1.90	1.27
7.	Wheat	0.46	3.57	3.10	1.67	3.81	2.11
8.	Gram	-1.41	-0.81	0.61	1.22	3.31	2.06
9.	Tur	2.30	2.87	0.58	0.65	0.04	0.69
10.	Groundnut	1.67	3.76	2.06	-2.25	-1.22	1.06
11.	Rapeseed & Mustard	1.95	7.26	5.22	1.66	1.95	0.29
12.	Soyabean	17.10	17.96	0.73	11.08	14.30	2.92
13.	Cotton	-1.25	2.80	4.10	2.30	1.73	-0.61
14.	Total Food grains	-0.23	2.85	2.74	-0.17	1.94	1.52
15.	Total Non Food grains	1.12	3.77	2.31	1.37	2.78	1.04
	All Principal Crops	0.10	3.19	2.56	0.25	2.26	1.31

A : Area, P : Production, Y : Yield.

The Groundnut which is a major oilseed crop in SAT states performed well in terms of growth during the period 1980-81 to 1989-90 at the all-India level with growth rate of production as 3.76 per cent per annum, but showed a decline in production at the rate as - 1.22 per cent per annum during the recent period of 1990-91 to 1999-2000. The rate of growth of productivity of this crop decelerated whereas area showed a large decline in recent period. The rates of growth of production and productivity of Rapeseed & Mustard decelerated in the recent period whereas Soyabean continued to show a very higher growth in production because of high increase in area. Despite increase in area in recent period of 1990-91 to 1999-2000, the rate of growth of production of Cotton decelerated in recent period as against the earlier decade of 1980-81 to 1989-90 because of negative growth of yield of this crop in recent period.

3.7 Crop-wise Recent Performance

The compound growth rates of principal crops in major SAT states during the recent period of triennia ending 1989-90 to 1999 - 2000 are shown in Table-9. It would be seen that Jowar which is one of the most important crop in the SAT states, its performance in terms of growth has not been generally satisfactory. Against the all-India low rate of growth in yield of 0.28 per cent per annum, the yield per hectare showed a decline with negative rate of growth in states of Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu. Andhra Pradesh and Karnataka are the only major states which have observed moderately high rate of growth of yield of Jowar in recent decade. The state of Gujarat which has shown highest rate of growth of yield is only a minor Jowar producing state. As far performance interms of production is concerned, it has been, by and large, dismal. All the SAT states under study have shown a decline in production during the period 1989-90 to 1999-2000. The major reason for decline in production of Jowar was reduction in area under this crop which has shown negative growth rates in all the states.

The performance of the other two coarse cereal crops of Bajra and Maize has been generally satisfactory. In case of Bajra, though the area has shown a declining trend in all the SAT states under study with all-India growth rate as -1.25 per cent per annum, its production has shown a moderate growth rate of 1.40 per cent per annum during the period 1989-90 to 1999-2000. The major Bajra producing states of Rajasthan, Maharashtra and Gujarat observed the rate of growth of production as 1.80, 2.50 and 1.29 per cent per annum respectively. Despite a significant increase in yield of

Bajra, the production showed a negative growth in the states of Andhra Pradesh, Karnataka and Tamil Nadu. However, the performance of Bajra in terms of increase in yield has generally been good during the period under review with all-India rate of growth as 2.70 per cent per annum. The rate of growth of yield was higher than the all-India average in five SAT states of Andhra Pradesh, Gujarat, Madhya Pradesh, Maharashtra and Rajasthan.

Table 9 : Compound Growth Rates of Principal Crops in SAT States During Triennia Ending 1989-90 and 1999-2000

(Per cent Per Annum)

Crop		Andhra Pradesh	Gujarat	Karnataka	Madhya Pradesh	Maharashtra	Rajasthan	Tamil Nadu	All India
Rice	A	0.17	2.70	2.00	0.88	0.01	4.41	1.34	0.84
	P	1.15	4.48	4.45	1.75	1.00	5.37	2.72	2.54
	Y	0.98	1.73	2.40	0.86	0.95	0.96	1.36	1.69
Jowar	A	-6.20	-10.30	-1.80	-8.80	-2.10	-5.20	-5.52	-3.80
	P	-4.40	-2.60	-0.03	-9.55	-2.60	-6.20	-5.30	-3.64
	Y	1.23	7.73	1.71	-0.75	-0.48	-0.90	0.24	0.28
Bajra	A	-9.60	-1.60	-2.40	2.20	-0.98	-1.20	-5.64	-1.25
	P	-6.40	1.29	-1.10	0.96	2.50	1.80	-3.20	1.40
	Y	2.94	3.06	1.34	3.25	3.18	3.90	2.35	2.70
Maize	A	3.32	2.51	8.90	0.10	10.20	0.81	9.18	0.87
	P	8.81	6.08	9.77	0.73	12.90	1.31	10.20	3.55
	Y	5.29	3.47	0.76	0.63	2.58	0.50	0.66	2.66
Pulses	A	0.49	1.37	0.72	0.75	0.31	4.13	-1.82	-0.02
	P	0.53	3.23	2.20	3.11	1.48	6.26	-2.10	0.93
	Y	0.04	1.86	1.46	2.35	0.76	2.04	-0.08	0.96
Groundnut	A	-1.50	1.42	-0.40	-2.70	-3.80	2.40	-2.36	-1.20
	P	-3.30	2.30	-0.72	-1.60	-3.32	4.98	1.49	-0.91
	Y	-1.82	0.87	-0.31	1.03	0.36	2.52	3.86	0.31
Cotton	A	5.70	4.63	-1.10	0.68	2.11	5.80	-1.90	2.29
	P	8.11	10.03	0.40	3.15	3.98	2.98	-3.00	2.74
	Y	2.27	5.27	1.61	3.80	1.84	-1.80	-1.20	0.42

A : Area, P : Production, Y : Yield.

Maize is the only coarse cereal crop which has shown positive growth in terms of both area and yield in all the SAT states during the period under review. The rate of growth of area was much higher than the all-India average of 0.87 per cent per annum, in the states of Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu. The rates of growth of production of Maize ranged between 6.08-12.90 per cent per annum in all the SAT states except in Madhya Pradesh and Rajasthan. The performance in terms of yield at the all-India level has been fairly high with rate of growth as 2.66 per cent per annum whereas the achievement in SAT states has been mixed. While three states of Andhra Pradesh, Gujarat & Maharashtra have shown a fairly high rate of growth of yield of maize, the other states of Karnataka, Madhya Pradesh, Rajasthan and Tamil Nadu have shown low rates of growth during the period under review.

The other major group of crops in the SAT region is the pulses which accounts slightly over one-fifth of the total cropped area. The performance of the pulses in the semi-arid states is somewhat better than the national average. Against the insignificant change in area at the all-India level as -0.02 per cent per annum, all SAT states except Tamil Nadu have shown positive growth of area during the period under review. Similarly rates of growth of yield and production of total pulses was positive in all the SAT states except Tamil Nadu during the period 1989-90 to 1999-2000. In fact the rate of growth of production of pulses was significantly high in Gujarat, Karnataka, Madhya Pradesh and Rajasthan, whereas it was fairly good in Maharashtra. The rate of growth of production of pulses was low in Andhra Pradesh. The only SAT state which showed decline in production and yield of pulses during the period under review is Tamil Nadu.

The only oilseed crops which is widely cultivated in all the SAT states, is Groundnut. The performance of Groundnut, however, in terms of growth in area, production and yield has not been satisfactory during the period under review. As regard area under this crop, it has shown a significant declining trend in five SAT states of Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra and Tamil Nadu with all-India average as -1.20 per cent per annum. The states of Gujarat and Rajasthan, however, showed a positive rate of growth of area under this crop as 1.42 and 2.40 per cent per annum respectively. As far as yield of Groundnut is concerned, against the all-India average growth rate of 0.31 per cent per annum during the period 1989-90 to 1999-2000 Rajasthan and

Tamil Nadu had a high rate of growth as over 2.5 per cent per annum whereas Gujarat and Maharashtra observed a marginally higher rate than the all-India average rate of growth. On the other hand, the states of Andhra Pradesh, Karnataka and Madhya Pradesh observed a declining trend in yield of Groundnut during the period under review. The production of Groundnut at the all-India level showed a declining trend with rate of growth as -0.91 per cent per annum. The states of Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra also observed declining trend in production during this period. However, the states of Gujarat, Rajasthan and Tamil Nadu have observed a significantly positive role of growth in production of Groundnut during the period under review.

About 80 per cent of the Cotton is produced in SAT states. The only other Cotton producing states are Punjab and Haryana where crop is, by and large, irrigated. The performance of the Cotton in terms of growth in production has been quite impressive with all-India average rate of growth as 2.74 per cent per annum during the period triennia ending 1989-90 to 1999-2000. All the SAT states have shown a very high rate of growth of production above 3 per cent per annum except Karnataka which had a low growth rate as 0.47 per cent per annum and Tamil Nadu showing a declining trend at the rate of 3.00 per cent per annum. Much of increase in production of Cotton is attributed to rise in area which has shown an increase in all the SAT states except Karnataka and Tamil Nadu where it showed a declining trend. The five major SAT Cotton producing states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh and Maharashtra showed a significantly high rate of growth of yield during the period under review. Rajasthan and Tamil Nadu, however, showed a declining trend in yield of Cotton during the same period against the all-India average growth rate as 0.42 per cent per annum.

3.8 State-wise performance

As far as state-wise performance is concerned Andhra Pradesh has shown a high rate of growth of production of over 8.0 per cent per annum of Maize and Cotton and a moderate rate of growth of Rice as 1.15 per cent per annum. Pulses showed a low rate of growth as 0.53 per cent per annum whereas production of Jowar, Bajra and Groundnut showed a decline in production during the period triennia ending 1989-90 and 1999-2000. The yield per hectare showed an increase in case of Rice, Jowar, Bajra, Maize and

Cotton whereas it declined in Groundnut. Pulses also showed a marginal increase in yield in the state. The area under Rice, Maize and Cotton showed an increasing trend whereas it declined in Jowar, Bajra and Groundnut.

Gujarat state performed quite well as production and productivity of all the crops under study showed a fairly high rate of growth except production of Jowar which showed a decline. The decline in production of this crop is attributed to a sharp decline in area at the rate of 10.30 per cent per annum. However, yield of Jowar in the state, during the period under review had shown a very rate of growth as 7.73 per cent per annum.

Karnataka showed a mixed performance. Production and productivity of Rice has shown a fairly high rates of growth as 4.45 and 2.40 per cent per annum respectively. However, Rice is, by and large, an irrigated crop in the state. The performance of major rainfed crops of Jowar, Bajra and Groundnut has not been satisfactory as production of these crops has shown a declining trend during the period under review. The production of Maize has shown an impressive increase at the rate of 9.77 per cent per annum. The production of pulses also showed a reasonably high rate of growth as 2.2 per cent per annum against the all-India average growth rate of 0.93 per cent per annum. The yield per hectare in the state showed an increasing trend for all the major crops except that of Groundnut which showed a decline.

Madhya Pradesh has performed fairly good in terms of increase in yield and production of pulses and Cotton and moderate in Rice. The production of Jowar declined because of reduction in both area and yield whereas production of Groundnut showed declining trend despite increase in yield, due to sharp decline in area. Bajra crop observed an impressive growth rate in yield as 3.25 per cent per annum but only a moderate of growth in production of about one per cent per annum due to decline in area. Maize observed a low rate of growth both in production and productivity.

Maharashtra has performed fairly good in terms of growth in production and productivity of Bajra, Maize, Cotton and Pulses. However, production of Jowar and Groundnut in the state have shown negative growth during the period under review. Jowar is the only crop in the state whose yield has shown declining trend. Rice has also shown a relatively low growth rate of production and productivity in the state.

In Rajasthan the rates of growth of production of Rice, Bajra, Pulses, Groundnut and Cotton were fairly high and above the all-India average. The rates of growth of production and productivity of Maize were much lower than the all-India average. The production and productivity of Jowar, which is a minor crop in the state showed a declining trend during the period under review.

Tamil Nadu performed fairly high positive growth rate in production of Rice, Maize and Groundnut during the period triennia ending 1989-90 and 1999-2000. However, production of Jowar, Bajra, Pulses and Cotton showed decline in the state during the same period. The rate of growth of yield of Groundnut was fairly high and reasonably good in rice and bajra but it was low in case of Jowar and Maize. The yield of pulses and cotton, however, in the state showed declining trend during the period under review.

3.9 Over all Agriculture Growth in SAT states

In the preceding section it has been observed that most of the SAT states have shown fairly good growth rate of production of principal crops grown in these states. However, over all performance could be seen only when production of all major and minor crops are combined in terms of value of output. Based on value of output of all the crops viz cereals pulses, oilseeds, fibers, sugarcane, fruits & vegetables drugs and Narcotics, conditions and spices others and by products at constant, prices of 1993-94, the growth-rates of agricultural production during triennia ending 1990-91 and 1999-2000 is shown in Table 10.

It is seen that the rate of growth of crop production in all SAT states except Andhra Pradesh is higher than the all-India average of 2.35 per cent per annum. Amongst SAT states, Tamil Nadu observed the higher rate of growth of crop production as 4.20 per cent per annum during nineties followed by Gujarat, Madhya Pradesh, Rajasthan and Karnataka with growth rates in the range of 3 to 3.73 per cent per annum. Maharashtra observed growth rate of crop production as 2.88 per cent per annum during the period under review. Against this most of the non-SAT states except Bihar, Himachal Pradesh and West-Bengal have growth rates of agriculture production lower than that of all-India average. In fact states of Punjab, Orissa, Jammu & Kashmir, Haryana, Kerala and Assam have observed much lower growth rate of agricultural production during nineties.

**Table 10 : Compound Growth Rate of Agricultural (Crop)
Production During Triennium Ending
1990-91 and 1999-2000**

Sr. No.	State	Average Annual Production During Triennium Ending		Compound Annual Growth Rate (Per Cent)
		1990-91	1999-2000	
	SAT			
1.	Andhra Pradesh	15017	16730	1.25
2.	Gujarat	9747	13594	3.74
3.	Karnataka	12516	16562	3.10
4.	Madhya Pradesh	14481	20118	3.70
5.	Maharashtra	17205	22172	2.88
6.	Rajasthan	10468	14356	3.55
7.	Tamil Nadu	9893	14292	4.20
	All India	193048	236701	2.35

3.10 Variability in Production in SAT states

It has been observed in the preceding section that the yield of rainfed crops was generally 40-50 per cent of irrigated sector in the SAT states. Further, most of the SAT states have crops, which are by and large, rainfed. These crops show large fluctuations in the production and productivity over years. The variations in production could be attributed to changes in both area and yield as influenced by the rainfed. The coefficient of variations (C.V.) of area, production and yield of principal crops in SAT states along with all-India average for the period 1991-2000 is shown in Table 11.

It is seen from Table 11 that variability in both area and yield for the most of the crops in SAT states is much higher than the all-India average. In case of Rice whose coefficient of variations for area and yield at the all-India level were observed as 2.59 and 5.37 per cent respectively, variability in area under Rice ranged from 4.71 in Tamil Nadu to 11.91 in Rajasthan in SAT states except in Madhya Pradesh. Maharashtra is not important for Rice production. However, variability in yield of Rice in SAT states is much higher

Table - 11 : Coefficients of Variations in Principal Crops in SAT States During 1991-2000

(Percent)

Sr. No.	State	Barley			Rice			Jowar			Bajra		
		A	P	Y	A	P	Y	A	P	Y	A	P	Y
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1.	Andhra Pradesh	5.19	12.89	11.06	7.42	13.28	7.92	18.01	19.12	16.17	24.64	24.54	12.37
2.	Gujarat	9.09	22.52	18.83	6.04	18.21	15.24	34.86	28.61	28.01	12.37	26.23	24.63
3.	Karnataka	3.03	10.21	8.21	5.40	9.70	5.32	8.10	12.34	9.48	20.55	33.12	17.20
4.	Madhya Pradesh	3.87	12.80	11.35	2.37	17.85	17.99	29.98	39.01	14.80	7.25	22.13	18.08
5.	Maharashtra	4.01	11.88	13.68	2.04	9.13	9.90	7.26	22.57	18.07	7.62	22.24	17.70
6.	Rajasthan	4.97	20.00	16.80	11.91	22.39	14.47	11.47	39.67	34.17	8.10	40.10	30.20
7.	Tamil Nadu	5.87	10.76	10.36	4.71	11.73	9.98	15.36	19.69	7.68	10.70	25.60	19.50
	All India	0.93	7.39	6.86	2.59	7.86	5.37	12.46	18.97	12.25	8.53	26.16	22.05

Sr. No.	State	Maize			Pulses			Ground Nut			Oil Seeds		
		A	P	Y	A	P	Y	A	P	Y	A	P	Y
		(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1.	Andhra Pradesh	18.56	29.64	15.51	7.59	21.44	14.08	12.71	28.21	22.73	10.57	24.92	19.49
2.	Gujarat	6.75	36.53	30.44	12.41	29.44	21.88	4.40	52.79	52.22	2.91	36.40	35.65
3.	Karnataka	29.63	29.04	7.78	9.41	18.43	12.55	11.84	21.24	14.31	16.28	18.24	10.45
4.	Madhya Pradesh	4.15	22.88	19.45	11.55	13.97	9.29	8.01	10.74	11.92	10.62	20.12	11.09
5.	Maharashtra	28.23	34.25	19.27	5.13	23.80	21.48	15.71	17.09	13.83	6.45	22.15	19.41
6.	Rajasthan	3.20	22.19	19.23	20.50	41.31	23.08	16.33	27.62	18.26	14.03	17.85	12.17
7.	Tamil Nadu	46.44	48.01	12.97	13.02	15.86	7.47	17.20	11.92	9.17	16.64	11.76	8.84
	All India	4.13	14.23	10.83	4.01	8.21	8.40	8.60	14.58	12.83	5.53	9.42	7.64

A - Area, P - Production, Y- Yield

being 17.98 per cent in Madhya Pradesh and about 15 per cent in Gujarat and Rajasthan 8-10 per cent in Andhra Pradesh, Maharashtra and Tamil Nadu. Variability in yield of Rice in Karnataka where it is, by and large, irrigated, is around the all-India level. The variability in production of Rice was much higher in the range of 10-22 per cent in all the SAT states against 7.96 per cent at the all-India level.

In case of Jowar and Bajra which are predominant rainfed crops of SAT states, variability in both area and yield is very high resulting much higher fluctuation in production. The variability in area under Jowar during 1991-2000 was as high as 34.86 per cent in Gujarat followed by 29.98 per cent in Madhya Pradesh. It was lower than all-India variability in area of 12.46 per cent in Maharashtra and Karnataka whereas it was in the range of 11-20 per cent in other SAT states. The variability in yield of Jowar was much higher than all-India level of 12.25 per cent in the states of Andhra Pradesh, Gujarat, Madhya Pradesh, Maharashtra and Rajasthan whereas it was lower in Karnataka and Tamil Nadu. The variability in area of Bajra was some what lower than that of Jowar but it was quite high at 24.64 per cent in Andhra Pradesh followed by Karnataka with 20.55 per cent. It was marginally lower than the all-India level of 8.53 per cent in the states of Rajasthan, Maharashtra and Madhya Pradesh. Bajra has shown highest variability in yield at the all-India level with coefficient of variation as 22.05 per cent during the period 1991-2000. However the Rajasthan which is one of the principal Bajra producing states has observed the variability in yield as 30.5 per cent followed by Gujarat with 24.63 per cent. Other states have also shown the variability in yield of Bajra in the range of 12-20 per cent.

The higher variability in area and yield of Jowar and Bajra resulted large fluctuation in production of these crops. The C.V. of production of these crops in Rajasthan was as high as 40 per cent. In other SAT states also the variability in production of these crops was above 19 per cent except for Jowar in Karnataka where it was 12.34 per cent. The variability in area production and yield in Maize was much lower than Jowar and Bajra at the all-India level but was higher in SAT states. The variability in production of Maize was as high as 48.0 per cent in Tamil Nadu and was above 22 per cent in all the SAT states. In case of total cereals, variability in area in the SAT states was 3-9 per cent against only 0.93 per cent at the all-India. Similarly the C.V. of yield and production in SAT states was much higher than the all-India average.

Further examination of variability of other rainfed crops revealed that fluctuation in area and yield of Pulses, Groundnut and Oilseeds is generally higher in SAT states than that of at the all-India level. However for crops which is mainly cultivated in semi-arid tropics, some of the state show lower variability than that at the all-India level. For example in case of Groundnut, variability in yield and production in Madhya Pradesh and Tamil Nadu was much lower than that at the all-India level. The implication of higher variability in area and yield is larger fluctuation in production of crops in SAT States. The higher variability/fluctuations in yield and production shows large risk involved in production of crops in SAT states which restricts the farmers to adopt new technology and larger use of modern inputs, which is one of the reasons for low productivity of crops in SAT states. The higher fluctuation / variability in production of principal rainfed crops in SAT states is mainly associated with variations in rainfall as examined in the subsequent sections.

3.11 Influence of Variability in Rainfall on Crop Production in SAT States

It has been observed that rainfed crops in SAT states have shown large variability in production and productivity over years. The variability in production is influenced by both changes in area and yield which inturn are influenced by various economic, technological and weather factors. It is generally felt that under normal development system, the production of crop would show a normal trend / growth path. If developmental efforts and inputs continue to follow same path as in the past the production would follow the same growth trend. The deviation from this trend would generally under such situation, be attributed to variation in weather. Of the various weather parameters, rainfall is the most important factor which varies from year to year, as other variables like temperature and humidity generally do not show large variation in the same month/period over years. The deviation in production from trend, therefore, show the influence of rainfall or weather. In an excellent rainfall years, production would be expected to be above the trend whereas in a poor rainfall year, production may be much below the expected trend level. Some times, even slightly low rainfall with well distribution over time make better positive impact on production rather than more rainfall.

Studies on crop-weather relations have suggested an index of weather influence on crop production which is based on ratio of actual and trend production, where as trend production is

obtained by fitting a linear trend as $P_t = a + bt$. The index of weather influence on production is constructed as $IWI = A_p/P_t \times 100$, where A_p and P_t are actual and trend production respectively.

The rainfed crops are more influenced by variability in weather/rainfall. The Rice is partially rainfed in Madhya Pradesh and Rajasthan. Jowar and Bajra are mainly rainfed in almost all the SAT states, same is true about Maize, Pulses and Groundnut. The study examined the association of variability in production with rainfall for the principal rainfed crops in SAT states. While index of weather influence on production for various selected crops/states were constructed as explained above, crop-wise production weighted rainfall indices as constructed by the DES in the Ministry of Agriculture, were used. While constructing the rainfall indices, Ministry considers the district-wise actual and normal rainfall which is then aggregated at state level by giving weight to each district in proportion to its contribution to the total production of that crop in the state as under:

$$R_{ij} = \frac{\sum \text{Ari} \cdot \text{Wij}}{\sum \text{Nri} \cdot \text{Wij}} \times 100$$

where Ari = Actual rainfall in the i^{th} district
 Nri = Normal rainfall in i^{th} district
 Wij = Production weight of i^{th} district for j^{th} crop
 Rij = Rainfall index of j^{th} crop

Though these rainfall indices are constructed for weekly and cumulative rainfall for South West monsoon season every year to monitor crop situation in different states, Cumulative S.W. monsoon season end production weighted rainfall indices have been used to establish relationship between variability in production and rainfall in this study. As per methodology explained production weighted rainfall index numbers for the years 1987-88 to 1999-2000 for principal Kharif crops in selected SAT states are shown in Table 12. It is seen from the Table 12 that the same rainfall for different crops on the state is giving different index because of different weight for various crops to each district. For example in 1990-91, rainfall index for Bajra was 101 in Karnataka, but it was only 89.1 for Jowar and 82.2 for Maize, which shows that while rainfall was normal in Bajra growing districts, it was some what less than normal in Maize and Jowar growing areas. Similar variations could be inferred from the production weighted rainfall indices for other crops in different SAT states.

Table 12 : Production Weighted Rainfall Index Numbers for Major Crops For Selected SAT States

Sr. No.	Year	Jowar				Bajra				Maize			
		A.P.	Karnataka	Maharashtra	Madhya Pradesh	Gujarat	Maharashtra	Karnataka	Rajasthan	Andhra Pradesh	Karnataka	Madhya Pradesh	Rajasthan
1.	1987	82.2	87.9	76.1	82.2	30.7	74.6	105.1	38.5	82.3	97.2	83.6	54.5
2.	1988	159.2	131.1	140.7	98.9	134.7	120.0	145.4	82.5	152.3	146.7	96.2	79.0
3.	1989	133.6	109.0	113.1	76.5	106.7	110.7	115.3	61.2	142.7	157.7	86.0	71.4
4.	1990	112.3	89.1	100.9	119.2	124.8	108.3	101.0	113.7	128.7	82.2	124.5	107.4
5.	1991	105.7	114.1	86.3	87.7	72.1	104.7	103.8	64.7	97.3	105.6	92.5	81.9
6.	1992	84.9	100.3	97.3	78.2	119.5	95.3	79.6	137.5	94.8	113.0	84.8	91.0
7.	1993	80.6	83.1	91.7	113.1	95.5	93.7	89.6	115.9	90.1	98.8	107.9	107.6
8.	1994	71.2	103.3	107.8	137.7	172.2	105.9	59.6	133.7	93.2	111.3	143.4	138.5
9.	1995	102.8	91.2	86.2	91.9	75.6	80.9	91.5	164.9	97.9	94.3	90.4	88.3
10.	1996	101.5	100.4	105.2	99.9	110.5	108.2	104.2	118.2	108.2	109.2	98.5	105.2
11.	1997	82.0	100.1	84.0	98.9	154.7	95.1	74.4	121.0	77.7	114.8	102.8	96.4
12.	1998	121.2	120.4	120.8	98.6	111.4	129.2	152.1	119.1	123.5	130.9	91.7	82.9
13.	1999	85.8	97.2	96.8	100.6	47.3	85.4	79.1	80.4	97.3	107.0	86.2	91.3
14.	2000	124.8	112.1	96.7	63.4	55.2	80.5	103.2	73.6	131.3	116.7	67.9	66.8

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Cotton			Groundnut			
Andhra Pradesh	Maharashtra	Gujarat	Gujarat	Andhra Pradesh	Karnataka	Tamil Nadu
74.9	75.5	38.5	38.5	85.5	98.4	93.3
144.5	141.5	136.8	136.8	174.9	147.7	129.8
145.9	112.2	105.2	105.2	153.3	111.6	115.3
109.4	132.2	117.5	117.5	96.2	92.4	83.3
120.3	80.3	69.7	69.7	121.1	85.2	108.9
90.0	101.4	100.5	100.5	90.2	101.7	97.3
85.1	89.6	95.4	95.4	96.8	90.6	109.1
75.4	106.5	156.5	156.5	74.8	93.9	74.2
106.4	86.6	75.2	75.2	140.3	86.6	119.7
110.5	101.5	110.2	110.2	120.1	101.1	93.5
104.4	77.9	146.6	146.6	105.1	98.3	89.7
123.5	130.5	156.7	156.7	138.7	137.2	103.8
99.9	97.7	48.0	48.0	90.8	94.4	57.7
164.8	100.5	53.6	53.6	136.2	114.5	97.4

1987 - Refers to S.W. Monsoon Period June - September 1987 and so on

3.12 Relationship Between Rainfall and Production of Crops in selected SAT states

Since crops in SAT states are highly dependant on rainfall, their production fluctuates around the trend depending upon the magnitude of rainfall particularly in Kharif season. Major Kharif crops of SAT states are Jowar, Bajra, Maize, Cotton and Groundnut. Taking into consideration the limitation of the time and space for presentation, it is proposed to present the relationship between production and rainfall for the selected crops for some selected states as illustrative.

If similar development efforts and programmes including investment are followed over along a medium term perspective then production pattern would follow a certain path of growth say increasing or decreasing production under normal rainfall situation. However, if actual rainfall situation deviates from normal, then coverage of area under the crop as well as its yield would also deviate. The deviation of production from the normal path which may be more or less than the normal trend production depending upon the magnitude of rainfall. The ratio of actual and trend line production would provide an index value greater, equal or less than one, depending upon the actual rainfall in that year and to its influence on production. This index has already been explained as Index of Weather Influence (IWI). For some selected crops and states relationship between production and rainfall as indicated by these indices is shown in Table 13 to Table 16. The examination of Table 13, which show relationship between rainfall and production of Jowar for Andhra Pradesh and Gujarat, show that the index of weather influence was less than 1.00 both in Andhra Pradesh and Gujarat in many years particularly when rainfall index was below normal i.e., 90 per cent of normal. Similarly when rainfall index showed excess rain i.e. 110 per cent or more, the index of weather influence or ratio of actual production to trend production was greater than one. Much strong relationship is observed in other crops like cotton and groundnut. Though there are exceptions in certain years when even less rainfall but well distributed has resulted better production. A strong relationship between production weighted rainfall indices and indices of weather influence on production could be observed as shown in figures 1-8. Once relationship between IWI and rainfall indices is established by taking IWI dependant on rainfall index, then forecasts of production of crops could be made taking into consideration the trend production, index of weather influence as predicted and actual rainfall. (This aspect is not covered in the study).

Table 13 : Relationship Between Rainfall and Production of Jowar

(Production 000 Tonnes)

Sr. No.	Year	Andhra Pradesh				Maharashtra			
		Actual Production	Trend Production	Rainfall Index	IWI	Actual Production	Trend Production	Rainfall Index	IWI
1.	1987-88	945	937	82.2	1.008	4278	5588	76.1	0.765
2.	1988-89	613	894	159.2	0.685	5962	5503	140.7	1.083
3.	1989-90	902	854	133.6	1.056	6635	5418	113.1	1.224
4.	1990-91	851	815	112.3	1.044	5948	5336	100.9	1.114
5.	1991-92	666	778	105.7	0.856	3390	5254	86.3	0.645
6.	1992-93	909	742	84.9	1.225	6688	5174	97.3	1.293
7.	1993-94	873	709	80.6	1.231	5976	5094	91.0	1.173
8.	1994-95	642	678	79.2	0.946	4581	5017	107.8	0.917
9.	1995-96	649	646	102.8	1.004	4940	4940	86.2	1.000
10.	1996-97	627	618	98.2	1.014	6241	4865	105.1	1.283
11.	1997-98	515	588	82.0	0.875	3780	4790	84.0	0.789
12.	1998-99	527	561	121.2	0.939	4484	4717	120.8	0.951
13.	1999-00	538	536	85.8	1.003	4660	4645	96.8	1.003
14.	2000	540	511	124.8	1.056	4690	4574	96.7	1.025

I.W.I. = Index of Weather influence obtained as ratio of actual to trend production.

Table 14 : Relationship Between Rainfall and Production of Bajra

(Production 000 Tonnes)

Sr. No.	Year	Gujarat				Rajasthan			
		Actual Production	Trend Production	Rainfall Index	IWI	Actual Production	Trend Production	Rainfall Index	IWI
1.	1987-88	346	909	30.7	0.381	463	1472	38.5	0.314
2.	1988-89	1488	928	134.7	1.601	2694	1496	82.5	1.800
3.	1989-90	1325	947	106.7	1.399	1830	1520	61.2	1.204
4.	1990-91	1025	967	124.8	1.060	2492	1545	113.7	1.613
5.	1991-92	819	987	72.1	0.829	1072	1570	64.7	0.683
6.	1992-93	1652	1008	119.5	1.638	2894	1595	137.5	1.814
7.	1993-94	748	1029	95.5	0.726	1048	1621	115.9	0.646
8.	1994-95	1272	1050	172.2	1.209	2568	1647	133.7	1.559
9.	1995-96	1059	1072	75.6	0.987	1156	1672	164.9	0.691
10.	1996-97	1309	1095	110.5	1.195	2315	1708	118.2	1.355
11.	1997-98	1495	1117	154.7	1.338	2511	1728	121.0	1.453
12.	1998-99	1281	1141	117.4	1.122	1797	1756	119.1	1.023
13.	1999-00	851	1165	47.3	0.730	1299	1784	80.4	0.728
14.	2000-01	850	1189	55.2	0.715	1300	1813	73.6	0.717

I.W.I. = Index of Weather influence obtained as ratio of actual to trend production.

Table 15 : Relationship Between Rainfall and Production of Groundnut

(Production 000 Tonnes)

Sr. No.	Year	Andhra Pradesh				Gujarat			
		Actual Production	Trend Production	Rainfall Index	IWI	Actual Production	Trend Production	Rainfall Index	IWI
1.	1987-88	1906	2282	85.5	0.8352	140	894	28.9	0.1565
2.	1988-89	2170	2226	174.9	0.9747	2875	9.36	146.0	3.0700
3.	1989-90	2086	2171	153.3	0.9605	1694	980	101.5	1.7270
4.	1990-91	2367	2118	101.2	1.1173	1063	1027	85.0	1.0249
5.	1991-92	2152	2066	121.1	1.0413	700	1076	61.9	0.6505
6.	1992-93	1965	2016	90.2	0.9746	2068	1127	115.2	1.8347
7.	1993-94	2546	1966	96.8	1.2945	677	1180	64.9	0.5734
8.	1994-95	1671	1918	74.8	0.8709	2380	1236	137.9	1.9247
9.	1995-96	2626	1871	140.3	1.4031	1028	1295	75.5	0.7937
10.	1996-97	2046	1825	120.1	1.1206	2449	1356	118.1	1.8053
11.	1997-98	1156	1781	95.1	0.6490	2616	1420	121.1	1.8411
12.	1998-99	2156	1737	138.7	1.2409	2578	1488	122.8	1.7322
13.	1999-00	1090	1694	90.8	0.6431	720	1558	44.7	0.4619
14.	2000-01	2030	1653	136.2	1.2277	690	1632	57.3	0.4226

I.W.I. = Index of Weather influence obtained as ratio of actual to trend production.

Table 16 : Relationship Between Rainfall and Production of Cotton

(Production 000 Tonnes)

Sr. No.	Year	Maharashtra				Amdhra Pradesh			
		Actual Production	Trend Production	Rainfall Index	IWI	Actual Production	Trend Production	Rainfall Index	IWI
1.	1987-88	1468	1577	75.5	0.9308	537	736	74.9	0.7288
2.	1988-89	1373	1643	85.2	0.8352	566	795	86.5	0.7117
3.	1989-90	2211	1713	112.2	1.290	913	858	145.9	1.0847
4.	1990-91	1880	1786	132.2	1.0623	1101	926	109.4	1.1885
5.	1991-92	1155	1862	80.3	0.6202	1298	999	120.3	1.2983
6.	1992-93	1807	1941	101.4	0.9308	1147	1079	90.0	1.0630
7.	1993-94	2625	2023	89.6	1.2972	1349	1164	85.1	1.1583
8.	1994-95	2500	2109	106.5	1.1851	1426	1258	95.0	1.1334
9.	1995-96	2796	2199	86.6	1.2715	1610	1356	100.4	1.1868
10.	1996-97	3143	2292	101.5	1.3711	1878	1464	110.5	1.2827
11.	1997-98	1753	2389	77.9	0.7335	1320	1580	104.4	0.8352
12.	1998-99	2619	2491	130.5	1.0513	1522	1705	123.5	0.8924
13.	1999-00	3100	2596	100.5	1.1938	1600	1840	99.9	0.8692
14.	2000-01	1800	2706	97.7	0.6649	1660	1966	114.8	0.8355

I.W.I. = Index of Weather influence obtained as ratio of actual to trend production.

Figure - 1 : Relationship between Rainfall and Production of Jowar ('000 tonnes) Maharashtra

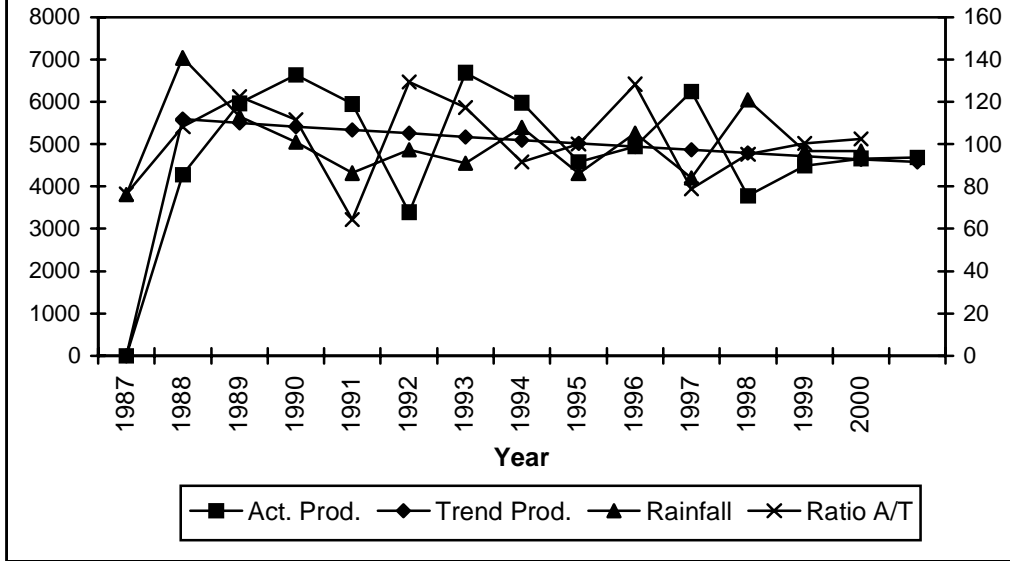
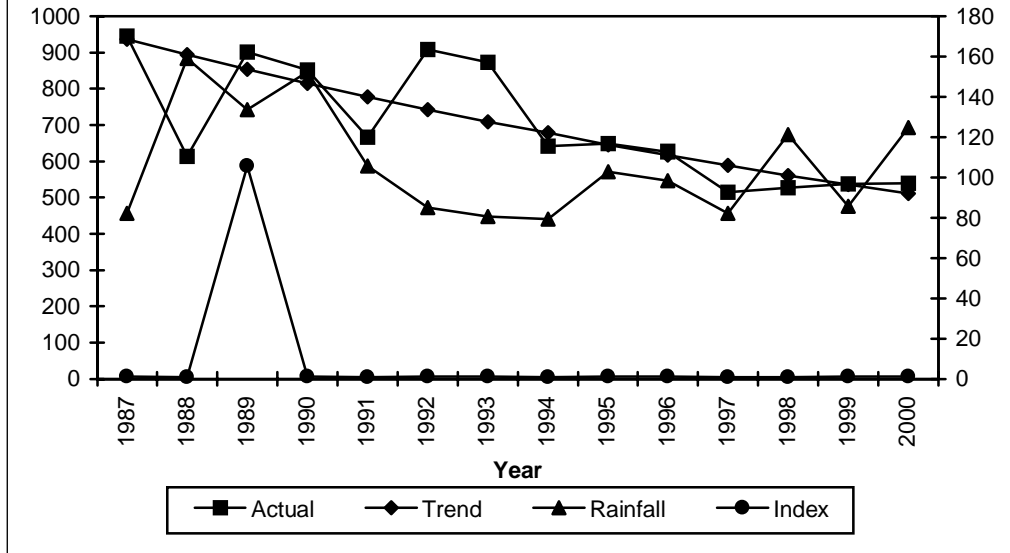
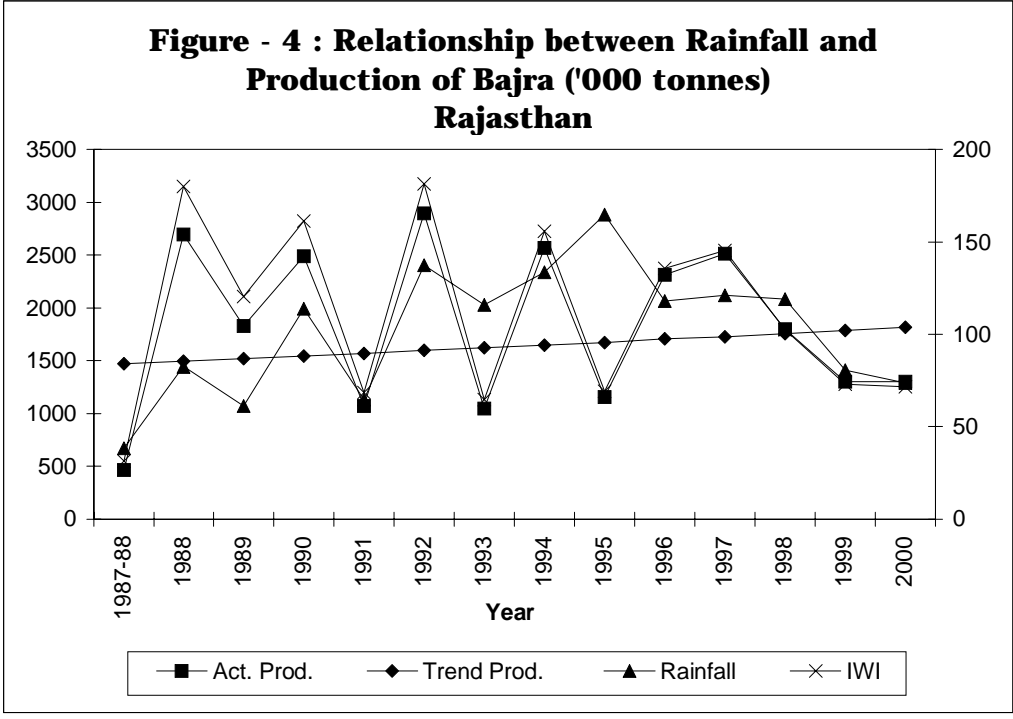
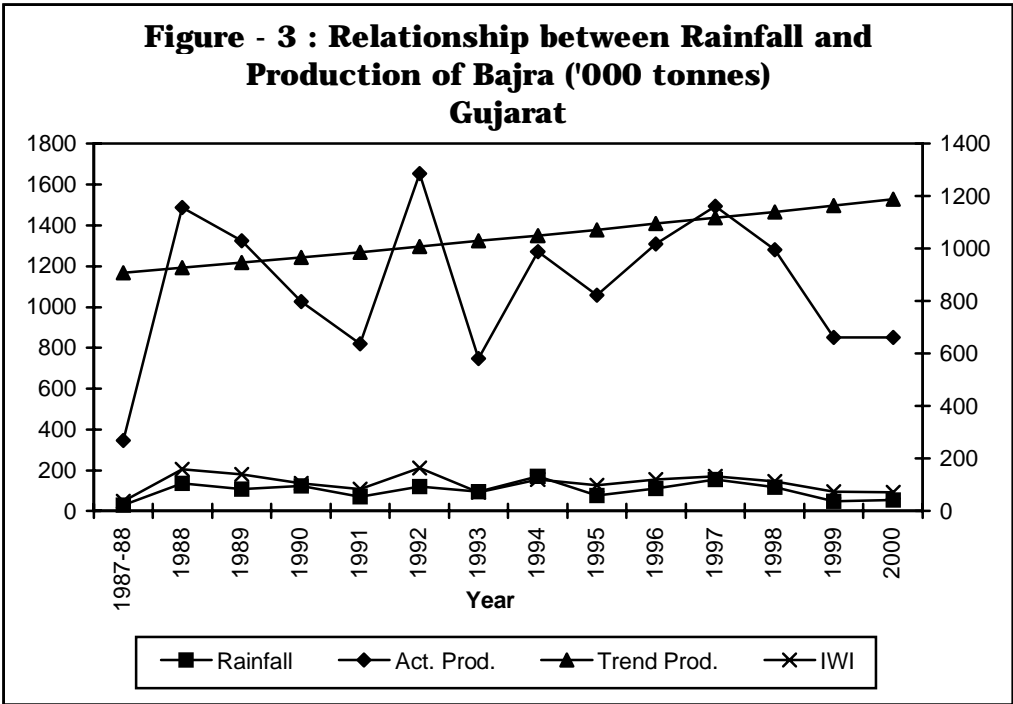


Figure - 2 : Relationship between Rainfall and Production of Jowar ('000 tonnes) Andhra Pradesh





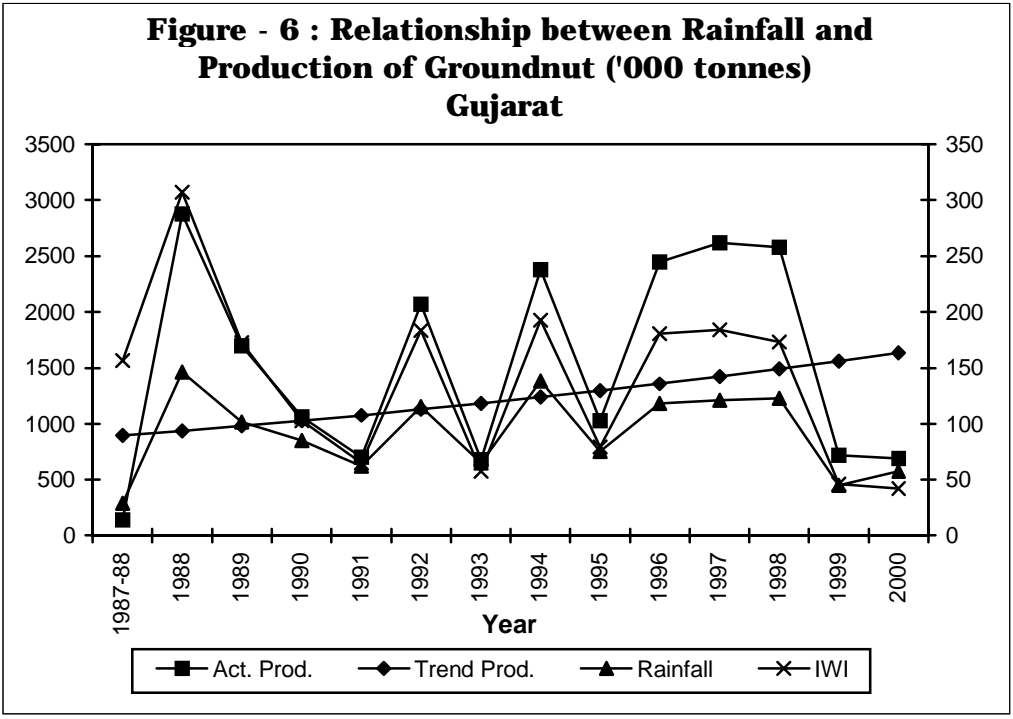
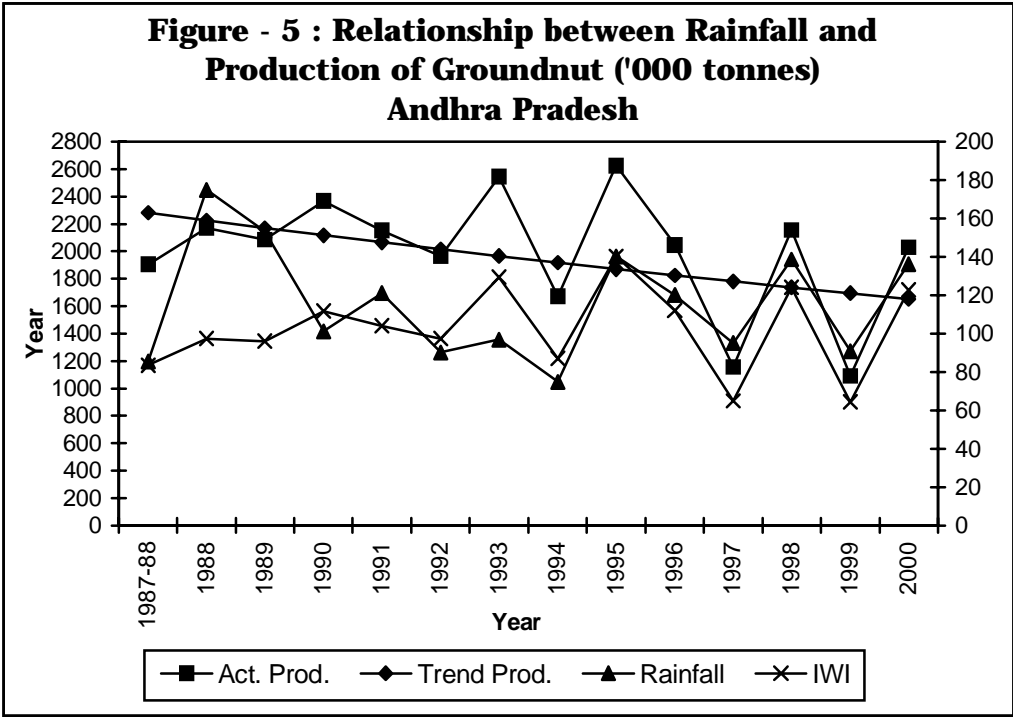


Figure - 7 : Relationship between Rainfall and Production of Cotton ('000 tonnes) Maharashtra

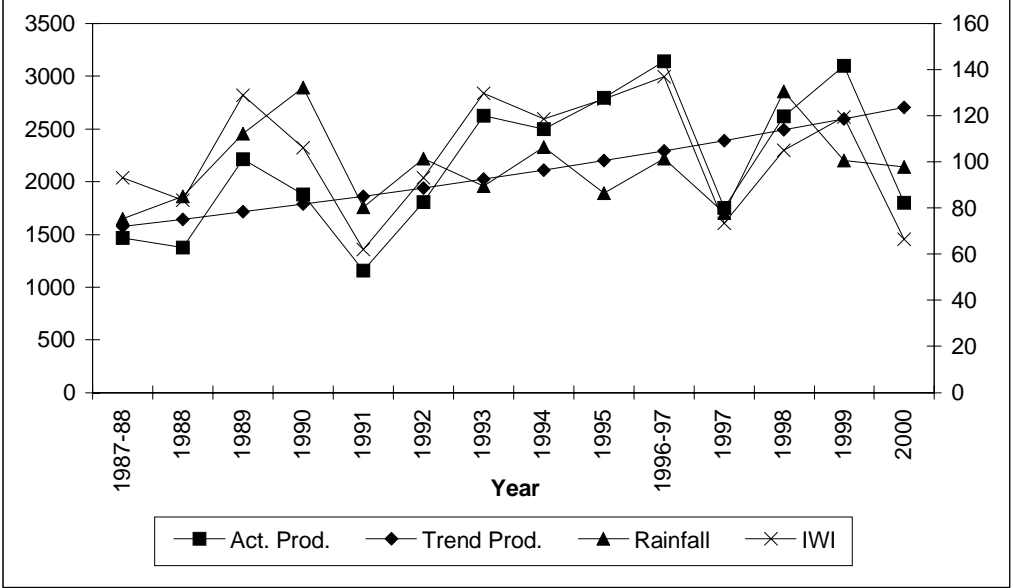
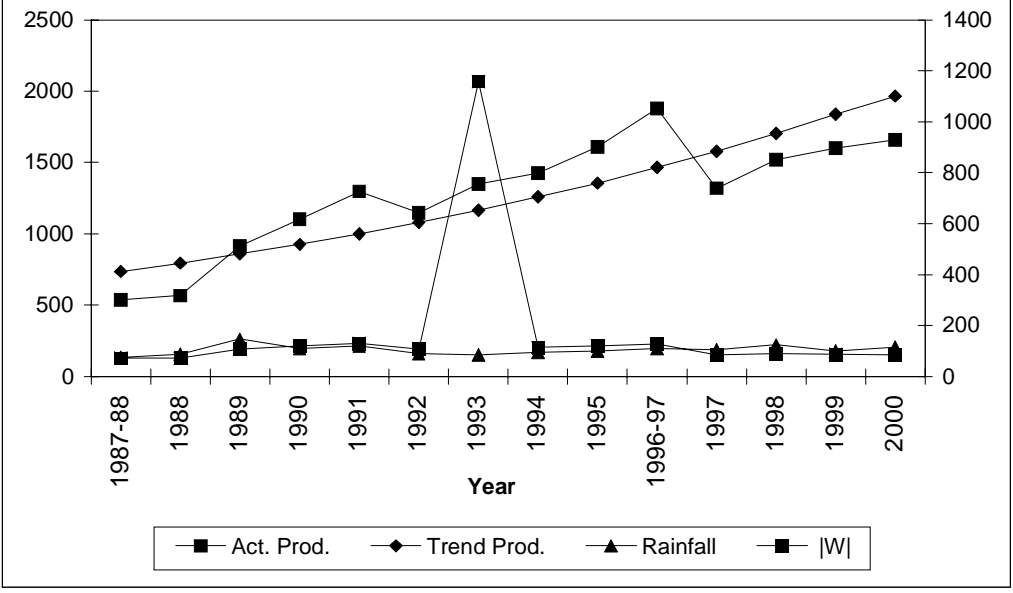


Figure - 8 : Relationship between Rainfall and Production of Cotton ('000 tonnes) Andhra Pradesh



3.13 Influence of Rainfall and Technological Trend on Production

Under growing technology and shifting cropping pattern, it is difficult to observe any significant impact of rainfall on production of crops, as yield and area of crop behave differently. Yet, the functional relationship if established over time where production of the crop is regressed against the rainfall and technological trend, may provide a useful explanation of variations in production over period. The functional relationship between production as dependant variable and rainfall and technological trend as explanatory factors for Jowar, Bajra, Cotton and Groundnut for some major SAT growing states are shown in Table 17.

Table 17 : Impact of Rainfall and Technology (Time) Trend on Production of some Principal Crops in Selected SAT Sates

Sr. No.	Crop	State	Coefficients of			Coefficient Multiple Determination (R ²)
			Intercept	Rainfall	Time	
1.	Jowar	Andhra Pradesh	1263.2308	-2.5834 (-2.0788)	-38.3619 (-4.9035)	0.6931
		Maharashtra	6504.2493	-8.0244 (-0.7909)	-80.4522 (-1.1394)	0.1625
2.	Bajra	Gujarat	319.0126	6.9511 (4.3289)	11.8718 (0.7577)	0.6333
		Rajasthan	934.9174	11.5844 (-1.9085)	-39.5850 (-0.7726)	0.3492
3.	Cotton	Andhra Pradesh	814.6465	-1.4035 (-0.6325)	83.0710 (5.8401)	0.7564
		Maharashtra	1151.2038	3.4237 (0.4380)	87.6561 (2.2661)	0.3191
		Gujarat	-497.0421	13.5841 (5.8873)	146.8337 (6.69446)	0.8802
4.	Groundnut	Andhra Pradesh	1632.6974	5.4733 (1.8932)	-35.9950 (-1.3044)	0.2617
		Gujarat	-881.3768	24.4842 (14.7053)	25.2402 (1.7259)	0.9520
5.	Maize	Karnataka	62.8067	2.6843 (2.2341)	96.6125 (16.6263)	0.9618

Figures in brackets are 't' value.

It would be seen from Table 17 that rainfall and technological trend explained almost about 69 per cent of variability in production of Jowar in Andhra Pradesh but much lower in Maharashtra. A very high rainfall has generally negative impact on production which may be attributed to shift of Jowar area to other better yielding crops in a good rainfall year and reduction in yield also as large marginal land remains under the crop in such good year. In case of Bajra, rainfall has positive and significant effect on production in both major growing states of Gujarat and Rajasthan. Similarly in case of Cotton rainfall has significantly positive impact on production in Gujarat, positive impact in Maharashtra and insignificant in Andhra Pradesh. Technological development has significantly positive impact on production of Cotton in all the three states of Andhra Pradesh, Maharashtra and Gujarat. The rainfall and technology has explained bulk of the variability in production of Cotton in the States under study.

In case of Groundnut also, rainfall has shown significantly positive impact on its production in both Andhra Pradesh and Gujarat. Technological trend has positive impact on yield of Groundnut in Gujarat but insignificant impact in Andhra Pradesh. The rainfall and technological trend has explained about 95 per cent of the variability in production of Groundnut in Gujarat but only about one-fourth in Andhra Pradesh.

As for Maize is concerned both rainfall and technological trend have shown positive and significant impact on its production in Karnataka. The two explanatory factors have explained about 96 per cent of the variability in production in the State during the period under review.

SECTION-IV

Economics of Crop Production

4.1 Cost of Cultivation and Profitability of Crops

Before examining the over all viability of rainfed agriculture in SAT states, it would be important to study the economics of production of principal crops in these states. Data on cost of cultivation / production of crops are available from the Comprehensive Scheme for Studying the Cost of Cultivation / Production of Principal crops in India of the Directorate of Economics and Statistics, Ministry of Agriculture being implemented in all the major states and the results of the which are generally published in the reports of the Commission for Agricultural Costs and Prices. However, this data is available only for a few principal crops for the state as a whole, and no separate estimates of cost of production for irrigated and rainfed crops are analyzed by the Ministry of Agriculture. Hence the present study used only the state level average data to examine the economics of crop production in SAT states.

In order to avoid the problem of presentation and space, the study examined the cost of cultivation on selected items, quantity of use of major inputs, yield, gross value of output along with total cost (Economic Cost i.e., Cost C2) and paid out Cost (Cost A2). Further profitability of crop of production was examined by taking the return over total cost as well as that over paidout cost. While total cost of cultivation is considered as full economic cost as it included all costs both paidout for purchased inputs and well as imputed value cost of owned resources / inputs. Since value of imputed cost of owned inputs / resources remains with the farmers, it is considered as part of farm business income which is estimated as difference between gross value of output and paidout cost (Cost A2) of cultivation.

The data regarding cost and return of principal crops in SAT states for the year 1998-99 are given in Table 18 to Table 24. While detailed information regarding item-wise cost, yield, return as well as physical quantities of inputs are presented in the tables, comments however, are restricted to economics of production / cultivation of crops.

**Table 18 : Estimates of Cost of Cultivation of
Principal Rainfed Crops in Andhra Pradesh (1998-99)**

(Rs. Per Hectare)

Sr. No.	Items of Cost	Paddy	Jowar	Bajra	Maize	Ragi	Moong nut	Groundnut
1.	Human Labour	7456.73	2656.88	1424.76	4382.15	5511.63	2174.26	5027.22
2.	Bullock Labour	645.72	2211.69	1390.16	1087.66	1256.04	652.47	876.07
3.	Machine Labour	1178.46	266.72	250.47	200.89	210.20	313.62	411.59
4.	Seed	634.52	169.70	224.51	734.20	161.08	333.39	2541.04
5.	Fertilizer & Manure	2693.98	1041.09	752.76	1491.58	1671.20	316.92	1311.04
6.	Irrigation	757.02	10.31	3.16	116.78	1042.18	0.09	329.62
7.	Other Variable Cost	787.70	148.90	1513.54	224.91	193.13	286.28	491.77
8.	Total Operational Cost	14154.13	5514.29	5559.36	8238.17	10045.46	4077.03	10988.45
9.	Fixed Cost	8642.99	3784.72	2164.70	4824.86	3416.51	1870.41	5938.73
10.	Total Cost (C ₂)	22797.43	9299.02	7724.06	13063.03	13461.97	5947.44	16927.18
11.	Paid-out Cost (A ₂)	12121.28	4897.44	4227.45	6352.24	6515.04	2975.47	9053.33
12.	Yield per hectare (Qtl.)	48.55	10.26	13.31	31.17	16.23	3.37	11.88
13.	Gross value of out-put	25938.87	7002.38	5505.22	12949.97	8244.96	4958.68	17604.65
14.	Net Income	3141.44	-2296.64	-2218.84	-113.06	-5217.01	-988.76	677.47
15.	Farm Business Income	13817.59	4401.76	1277.77	6597.73	1729.92	1983.21	8551.32
16.	Seed (kg.)	77.94	18.84	6.96	18.26	10.86	17.48	101.44
17.	Fertilizers (Kg.)	185.32	77.46	43.25	100.18	67.45	6.34	61.64
18.	Human Labour (Hrs.)	1023.36	431.99	479.20	697.34	1108.84	376.66	793.67
19.	Bullock Labour (Hrs.)	56.82	100.58	123.75	95.92	124.83	59.67	69.98

In Andhra Pradesh principal crops studied were Paddy, Bajra, Maize, Ragi, Moong and Groundnut. Considering the total cost of cultivation (Cost C₂) and gross value of output, the net income or return over cost was observed as negative for Bajra, Maize, Ragi and Moong. In fact value of output of these crops do not cover the full economic cost of cultivation per hectare. In case of Groundnut the net income was positive but low being Rs. 677.5 per hectare. These are all, by and large, rainfed crops in Andhra Pradesh. Paddy in the state is, by and large, an irrigated crop which however, showed a reasonable net income of Rs. 3141.44 per hectare.

From farmers point of view, it is the farm business income which is more relevant as it considers return over paidout cost of cultivation. However, even farm business income per hectare was less than Rs. 2000 for rainfed crops of Bajra, Ragi and Moong. It was moderately good in Maize and Groundnut being Rs. 6597.73 and Rs. 8551.30 per hectare respectively. These two crops have about 20-25 per cent of the area as irrigated also. However, the

return over paidout cost of cultivation for Paddy in Andhra Pradesh was observed to be fairly high being Rs.13817.59 per hectare.

In Gujarat the major rainfed crops for which cost studies data was available included Bajra, Tur, Groundnut, Cotton, and Rapeseed. The irrigated crops studied in the state included Sugarcane and Wheat. The economics of rainfed crops in Gujarat state is shown in Table 19. An examination of Table 19 shows that the economics of rainfed crops in the state is fairly good as net income from all the crops is reasonably high being Rs. 6160.77 per hectare in case of Tur and Rs. 7300 and 7500 for Groundnut and Cotton respectively. However it was low as Rs. 2114.67 per hectare for Bajra. Farm business income per hectare in the state for major rainfed crops was fairly high in the range of Rs. 10,000-14,000 except for the Bajra which was around Rs. 6,000. On the whole the cultivation of rainfed crops in the state is reasonably profitable proposition even considering the full economic cost.

Table 19 : Estimates of Cost of Cultivation of Rainfed Crops in Gujarat (1998-99)

(Rs. Per Hectare)

Sr. No.	Items of Cost	Bajra	Tur	Groundnut	Cotton	Rapeseed & Mustard	Wheat
1.	Human Labour	3309.79	2652.87	3933.32	4918.11	2257.87	3351.75
2.	Bullock Labour	613.50	1443.14	1833.55	783.35	289.18	355.34
3.	Machine Labour	1181.05	314.73	634.63	939.47	1202.88	1358.47
4.	Seed	232.80	285.70	2598.69	621.47	111.25	1202.48
5.	Fertilizer & Manure	1149.94	494.51	1353.33	1630.06	1293.04	1507.12
6.	Irrigation	604.04	140.93	309.56	558.97	2006.72	1894.59
7.	Other Variable Cost	61.53	735.32	425.15	1376.19	195.76	345.11
8.	Total Operational Cost	7152.65	6067.20	10094.00	10827.62	7356.70	10014.87
9.	Fixed Cost	2158.38	3094.52	4114.61	4713.21	3547.35	3707.11
10.	Total Cost (C ₂)	9311.03	9161.72	14208.84	15540.83	10904.05	13721.98
11.	Paid-out Cost (A ₂)	5440.04	5386.55	8113.54	8657.17	6365.40	8301.83
12.	Yield per hectare (Qtl.)	16.69	8.31	12.42	10.93	14.43	30.69
13.	Gross value of out-put	11925.70	15322.49	21505.75	23006.18	18612.13	19413.65
14.	Net Income	2114.67	6160.77	7296.91	7465.35	7708.08	5691.67
15.	Farm Business Income	5985.66	9935.94	13392.21	14349.01	12246.72	11111.82
16.	Seed (kg.)	5.56	11.97	101.33	6.98	4.96	142.84
17.	Fertilizers (Kg.)	75.91	39.75	66.86	90.62	103.36	137.11
18.	Human Labour (Hrs.)	577.65	578.36	551.45	863.79	442.61	547.23
19.	Bullock Labour (Hrs.)	39.06	100.34	67.18	47.75	20.07	23.74

In Karnataka, comprehensive scheme data regarding costs and return for rainfed crops was available for Jowar, Maize, Ragi, Groundnut and Sunflower. An examination of Table 20 shows that economics of rainfed crops in the state is not very encouraging. The return over full economic cost i.e., Cost C₂ during the 1998-99 was negative for Ragi and Sunflower and nominally positive at Rs. 42.54 per hectare in Groundnut. It was moderate of Rs. 620.62 per hectare for Jowar. As far as farm business income is concerned, it was in the range of Rs. 1700-4200 only for all the crops which from any economic standard cannot be considered as reasonable.

Table 20 : Estimates of Cost of Cultivation of Principal Rainfed Crops in Karnataka (1998-99)

(Rs. Per Hectare)

Sr. No.	Items of Cost	Jowar	Maize	Ragi	Groundnut	Sunflower
1.	Human Labour	1603.10	2374.52	5077.39	3114.28	1783.22
2.	Bullock Labour	917.69	982.86	1814.43	1055.82	986.04
3.	Machine Labour	133.61	414.52	505.74	138.45	219.17
4.	Seed	112.23	584.20	109.19	2233.13	758.02
5.	Fertilizer & Manure	840.68	1583.47	1739.95	1224.35	1062.70
6.	Irrigation	8.61	85.15	25.34	20.02	19.07
7.	Other Variable Cost	—	163.10	—	—	—
8.	Total Operational Cost	3738.10	6187.78	9465.55	8042.02	4948.06
9.	Fixed Cost	1816.59	3085.32	2905.60	3079.05	1972.12
10.	Total Cost (C ₂)	5555.29	9273.10	12371.15	11121.07	6920.18
11.	Paid-out Cost (A ₂)	3034.54	5549.07	6571.57	6969.59	4093.31
12.	Yield per hectare (Qtl.)	7.52	23.58	14.56	8.28	4.94
13.	Gross value of out-put	6175.91	11719.48	8313.49	11163.61	6458.72
14.	Net Income	620.62	2446.38	-4057.66	42.54	-461.46
15.	Farm Business Income	3141.37	6170.41	1741.92	4194.02	2365.41
16.	Seed (kg.)	8.07	16.39	17.85	87.40	5.80
17.	Fertilizers (Kg.)	43.72	99.17	52.10	64.49	55.18
18.	Human Labour (Hrs.)	377.25	533.59	857.30	651.53	388.15
19.	Bullock Labour (Hrs.)	75.83	73.67	173.32	100.55	77.83

Estimates of cost of production in Madhya Pradesh were available for a good number of rainfed crops including Jowar, Maize, Tur, Urad, Soyabean and Gram as also partially irrigated crops of Paddy and Wheat. An examination of Table 21 would reveal that gross value of output of Paddy and Maize in the state do not cover the total cost of cultivation as net income of these crops was

negative. Gross Value of output hardly covered the full cost of cultivation in case of Urad. In other crops, the net income ranged from Rs. 1200-1800 except that for Tur whose net income was Rs. 3263.84 per hectare. What is really worth noting is that the farm business income (return over payout expenses) in the state is also not very satisfactory being only in the range of Rs. 3000-7300 for different crops. Taking into consideration the level of farm business income of different crops, Tur, Wheat, Gram, Soyabean and Jowar may be considered reasonably profitable whereas Maize, Urad and Paddy in the state are low profit crops.

Table 21 : Estimate of Cost of Cultivation of Principal Rainfed Crops in Madhya Pradesh (1998-99)

(Rs. Per Hectare)

Sr. No.	Item of Cost	Paddy	Jowar	Maize (Tur)	Arhar	Urad Bean	Soya	Wheat	Gram
1.	Human Labour	3333.10	2714.96	3011.69	2132.96	1918.24	2374.00	2064.10	1689.84
2.	Bullock Labour	1570.97	887.39	1002.55	678.54	774.95	618.44	630.00	544.92
3.	Machine Labour	238.34	185.56	316.61	305.08	244.73	826.67	881.06	789.79
4.	Seed	631.38	224.04	157.94	362.90	337.35	1281.18	855.30	1208.63
5.	Fertilizer & Manure	1175.27	394.91	785.75	271.12	206.64	814.48	893.87	405.39
6.	Irrigation	203.53	—	19.74	—	19.83	1.98	684.23	231.42
7.	Other Variable Cost	—	—	—	—	—	—	—	—
8.	Total Operational Cost	7354.90	4547.82	5386.66	3855.64	3570.38	6224.38	6158.99	5186.85
9.	Fixed Cost	3764.21	2934.42	2450.53	3371.52	1747.49	3123.05	4101.23	3425.69
10.	Total Cost (C ₂)	11119.11	7482.24	7837.19	7229.16	5317.87	9347.43	10260.22	8612.54
11.	Paid-out Cost (A ₂)	6076.30	3398.31	3349.67	3159.00	2455.14	5173.04	5146.69	4558.39
12.	Yield per hectare (Qtl.)	19.19	11.33	11.36	7.19	3.35	11.39	18.26	9.85
13.	Gross value of out-put	10286.21	8972.49	6519.79	10493.76	5330.34	10581.48	12077.12	10287.33
14.	Net Income	-832.90	1490.25	-1317.40	3263.84	12.47	1234.05	1816.90	1674.79
15.	Farm Business Income	4209.91	5574.18	3170.12	7334.76	2875.20	5408.44	6930.43	5728.94
16.	Seed (kg.)	103.52	15.71	23.48	18.51	21.41	99.60	117.33	85.48
17.	Fertilizers (Kg.)	67.90	32.66	50.40	18.63	10.17	49.44	79.87	30.90
18.	Human Labour (Hrs.)	717.91	443.36	559.33	406.75	403.43	391.13	372.75	280.29
19.	Bullock Labour (Hrs.)	135.74	95.43	88.00	70.09	94.32	52.06	53.31	48.49

For Maharashtra cost of production estimates were available for Jowar, Tur, Moong, Groundnut, Soyabean and Cotton as shown in

Table 22. It was observed that the level of net income per hectare for Tur, Groundnut and Soyabean was reasonably high and relatively low in Jowar and Moong. The same hold good for farm business income which was highest for Tur as Rs. 11479.93 per hectare followed by Groundnut and Soyabean. The farm business income was low in the cultivation of Moong and Jowar in the range of Rs. 4500-6000 per hectare. Separate estimates of cost and return for Kharif and rabi Jowar are not available. It is reported that economics of rabi Jowar is much better than Kharif Jowar because of quality of grain and its prices.

Table 22 : Estimates of Cost of Cultivation of Principal Rainfed Crops in Maharashtra (1998-99)

(Rs. Per Hectare)

Sr. No.	Items of Cost	Jowar	Tur (Arhar)	Moong	Ground-nut	Soyabean	Cotton
1.	Human Labour	2695.96	2406.10	2320.75	4785.17	2390.18	3802.12
2.	Bullock Labour	1076.36	627.17	1064.00	1654.36	1431.57	1656.60
3.	Machine Labour	378.82	131.93	213.94	228.94	465.15	155.50
4.	Seed	235.55	389.93	405.48	2575.73	1391.08	689.33
5.	Fertilizer & Manure	644.21	247.61	529.73	1332.56	835.47	1580.52
6.	Irrigation	100.72	5.33	0.11	564.29	—	49.01
7.	Other Variable Cost	—	—	—	—	—	681.17
8.	Total Operational Cost	5258.64	3933.94	4673.64	11419.39	6789.77	8614.24
9.	Fixed Cost	2582.57	3692.06	197492	4285.04	2767.97	3445.95
10.	Total Cost (C ₂)	7841.21	7626.00	6648.56	15704.43	9557.74	12060.19
11.	Paid-out Cost (A ₂)	4428.92	3270.65	4070.16	9351.41	6194.72	7693.24
12.	Yield per hectare (Qtl.)	11.06	8.54	5.62	12.18	13.62	7.62
13.	Gross value of out-put	9452.28	14751.58	8611.51	18884.22	12344.55	13567.60
14.	Net Income	1611.07	7125.58	1962.95	3179.79	2786.81	1507.40
15.	Farm Business Income	5023.36	11479.93	4541.35	9532.81	6149.83	5874.36
16.	Seed (kg.)	10.48	16.18	16.65	90.05	77.54	3.25
17.	Fertilizers (Kg.)	40.61	16.34	27.89	62.02	56.88	95.24
18.	Human Labour (Hrs.)	503.49	486.17	454.09	979.38	479.45	866.13
19.	Bullock Labour (Hrs.)	79.49	43.26	76.12	108.61	104.30	150.80

In Rajasthan, estimates of cost of cultivation were available for rainfed crops of Bajra, Maize, Soyabean, Barley and Gram and also

for Cotton which is irrigated crop in the state. These estimates of cost of production are shown in Table 23. An examination of Table reveal that the net income per hectare was highest in Cotton followed by Soyabean, it was moderate in case of Barley and Gram, but low in Bajra. The value of output of maize did not cover the cost of cultivation showing a significant loss in its production. However, farm business income was highest in Cotton being Rs. 10801.32 per hectare followed by Barley and Soyabean with return over paidout cost as around Rs. 7500. The level of farm business income was low being less than Rs. 5000 per hectare in Bajra, Maize and Gram.

Table 23 : Estimates of Cost of Cultivation of Principal Rainfed Crops of Rajasthan (1998-99)

(Rs. Per Hectare)

Sr. No.	Items of Cost	Bajra*	Maize	Soyabean	Cotton*	Barley	Gram
1.	Human Labour	2404.82	4293.64	2700.60	4408.84	3879.83	1550.51
2.	Bullock Labour	106.26	1453.08	566.59	226.22	564.25	186.09
3.	Machine Labour	568.01	237.82	912.02	689.26	1189.56	622.18
4.	Seed	70.71	150.35	1055.87	324.07	756.23	822.06
5.	Fertilizer & Manure	151.69	1327.94	370.51	952.12	426.55	25.00
6.	Irrigation	93.51	163.50	—	330.60	1205.62	52.26
7.	Other Variable Cost						
8.	Total Operational Cost	3440.80	7738.52	5755.44	8343.17	8171.04	3330.61
9.	Fixed Cost	1368.46	2531.18	2475.49	3563.58	3391.20	1764.93
10.	Total Cost (C2)	4809.26	10269.70	8230.89	11908.75	11562.24	5095.54
11.	Paid-out Cost (A2)	1522.11	4240.42	4150.85	5238.00	5441.54	2529.71
12.	Yield per hectare (Qtl.)	8.61	10.74	11.71	8.61	20.93	5.83
13.	Gross value of out-put	5201.33	8224.71	11625.34	16039.32	13098.43	6960.71
14.	Net Income	692.07	-2044.29	3394.45	4130.57	1536.19	1865.23
15.	Farm Business Income	3679.22	3984.29	7474.49	10801.32	7656.89	4431.06
16.	Seed (kg.)	5.11	31.24	89.31	13.62	136.30	53.96
17.	Fertilizers (Kg.)	7.31	32.90	24.45	60.42	26.22	1.70
18.	Human Labour (Hrs.)	317.79	650.76	394.64	539.73	459.59	185.19
19.	Bullock Labour (Hrs.)	6.27	85.90	33.12	16.07	35.56	13.01

* Relate to 1997-98 the latest available.

Cost estimates of rainfed crops of Tamil Nadu of as shown in Table 24 included Jowar, Bajra, Tur, Groundnut and Cotton. The cost estimates reveal that the economics of cultivation was generally

not favourable for rainfed crops in the state. The total cost of cultivation was observed more than gross value of output with net income as negative in case of Jowar, Bajra and Cotton. The net income in cultivation of Tur was low being Rs. 1175.64 and reasonably high in Groundnut at Rs. 3087.37 per hectare. However, return over paidout cost show Cotton was most profitable crops for the farmers of Tamil Nadu with farm business income as Rs. 10806.20 per hectare followed by Groundnut and Tur. Jowar and Bajra are the least profitable crops of the state with farm business income less than Rs. 3000 per hectare.

Table 24 : Estimates of Cost of Cultivation of Principal Rainfed Crops of Tamil Nadu (1998-99)

(Rs. Per Hectare)

Sr. No.	Items of Cost	Jowar	Bajra	Tur	Groundnut	Cotton
1.	Human Labour	2691.94	2606.28	4894.14	6385.93	9967.28
2.	Bullock Labour	203.43	554.65	461.39	643.11	202.38
3.	Machine Labour	727.47	249.59	417.60	843.79	1498.55
4.	Seed	222.20	199.80	301.16	2254.63	552.81
5.	Fertilizer & Manure	284.75	445.76	586.09	1391.15	2184.43
6.	Irrigation	49.04	13.65	30.58	406.36	418.13
7.	Other Variable Cost	—	—	—	—	—
8.	Total Operational Cost	4288.45	4179.67	6977.67	11915.97	16800.92
9.	Fixed Cost	1897.46	2181.85	4767.63	4979.00	6556.98
10.	Total Cost (C2)	6185.91	6361.52	11745.30	16894.97	23357.91
11.	Paid-out Cost (A2)	3749.40	3735.03	4862.31	9964.44	11796.79
12.	Yield per hectare (Qtl.)	8.34	10.79	6.50	17.43	10.04
13.	Gross value of out-put	6112.44	5828.13	12920.94	19892.34	22602.99
14.	Net Income	-73.47	-533.38	1175.64	3087.37	-754.92
15.	Farm Business Income	2363.04	2893.10	8058.63	9927.90	10806.20
16.	Seed (kg.)	21.87	6.59	15.80	108.39	10.19
17.	Fertilizers (Kg.)	7.98	22.60	18.28	78.82	125.46
18.	Human Labour (Hrs.)	340.25	393.15	721.61	946.73	1371.87
19.	Bullock Labour (Hrs.)	13.65	41.42	59.05	64.35	9.69

4.2 Overall Crop Economy

So far economics of only selected rainfed crops have been examined as constrained by the availability of information from the comprehensive scheme. Many of the crops which were either not covered under price support operation or are of relatively less economic importance for the national or state economy, are not studied in the scheme. Those uncovered crops, though minor in terms of area, are

often very important in regard to the contribution to the farm income as they are mostly crops like vegetables, spices, fodder and other crops which are of high value. It is, therefore, imperative to consider the income from all the crops to know over all economy of crop production.

Under given technology output-input ratio is considered to be stable in crop production. Since availability and adoption of technology varies from crop to crop in different states, the output-input ratios varied accordingly for different crops/states. It was observed that in the preceding section that gross value of output hardly covered the total cost of cultivation (Cost C2) in some of the crops whereas it provided some net income in others. Since total cost included the imputed value of some of the farmers owned resources/inputs, the appropriate measure of economy was considered farm business income which shows value of output over all paidout cost (Cost A2) in the cultivation of crops. The gross value of output-Cost A2 ratio as observed from the crops covered under the comprehensive scheme during the period 1995-2000 (average) are shown in Table 25.

Table 25 : Ratio of GVO to Paid out Cost for Principal Crops in SAT States (1995-2000)

Sr. No.	Crop	Andhra Pradesh	Gujarat	Karnataka	Madhya Pradesh	Maharashtra	Rajasthan	Tamil Nadu
1.	Paddy	1.94	—	2.63	2.01	—	—	1.83
2.	Wheat	—	2.40	—	2.45	—	2.94	—
3.	Jowar	1.47	—	1.82	2.36	2.06	—	1.67
4.	Bajra	—	2.10	1.04	—	1.55	3.55	1.75
5.	Maize	1.77	—	—	2.14	—	2.43	—
6.	Ragi	—	—	1.18	—	—	—	1.25
7.	Gram	—	—	—	2.44	—	3.07	—
8.	Tur	—	3.01	—	3.51	3.87	—	—
9.	Urad	2.68	—	—	2.50	2.11	—	—
10.	Moong	1.73	—	—	—	1.94	—	—
11.	Groundnut	1.70	2.33	1.43	—	1.85	—	1.77
12.	Soyabean	—	—	—	2.33	1.80	2.65	—
13.	Sunflower	—	—	1.73	—	1.48	—	—
14.	Rape & Mustered	—	2.48	—	3.15	—	3.42	—
15.	Cotton	1.76	2.66	2.02	2.13	1.82	4.23	1.87
16.	Sugarcane	2.56	—	3.80	—	1.96	—	2.51
17.	All-Crops Average	1.91	2.45	1.85	2.29	1.97	3.17	1.98
18.	Cost A ₂ - out put Ratio	0.5235	0.4081	0.5319	0.4367	0.5075	0.315	0.505
19.	Farmer Business Income-output ratio	0.4765	0.5919	0.4681	0.5633	0.4925	0.6850	0.4950

— Crop not studied under the Cost Studies in the State.

Source - Abhijit Sen and M.S. Bhatia "Cost of Cultivation and Farm Income", State of the Indian Farmer - A Millennium Study, DAC, Ministry of Agriculture Government of India, Academic Foundation, New Delhi, 2004.

An examination of the Table 25 shows large variations in GVO-Cost A2 ratios across crops and states. At the all-India level this ratio was highest for Tur as 3.84 followed by Rapeseed & Mustard and Sugarcane as 3.18 and 3.03 respectively. It was reasonably above 2.0 for most of the other crops except for Jowar and Ragi in coarse cereals, Moong in Pulses, Groundnut and Sunflower in Oilseeds where it was slightly less than 2.0.

State-wise examination revealed that in Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu over all GVO-Cost A2 ratios were low being less than 2.0, whereas it was as high as 3.17 in Rajasthan followed by Gujarat and Madhya Pradesh as 2.45 and 2.29 respectively. These ratios suggests that use of purchased inputs in relation to value of output was high in Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu as compared to that in Gujarat, Madhya Pradesh and Rajasthan.

4.3 Farm Business Income and Poverty Level Economic Holding.

One of the limitation of the comprehensive scheme data regarding cost production estimates is its inadequate coverage of crops in almost all the states. Though rapid adoption of new technology has helped in raising the crop productivity, it has also resulted in large increase in use of purchased inputs thereby increasing paidout cost and affecting the farm business income. Since average size of holding in the country is declining continuously from 2.2 hectares in 1970-71 to 1.60 hectares in 1990-91 and to almost 1.40 hect. are in 1997-98 and so in states, the question of farming to remain a viable occupation is being raised often. There could be various concepts of economic holding like those based on 'full family employment' or 'level of income'. In this study an economic size of farm is defined that is just sufficient to provide a level of income to keep an average family above the poverty line without having to resort to non-farm activity.

The Planning Commission has issued a state specific poverty line using NSSO consumer expenditure data for 1999-2000 in terms of Rs. per capita per month of 30 days. This amount was multiplied by 60.8 to convert the annual income requirement for an average family of 5 members for each state to meet the poverty line.

The total value of agriculture (Crop production) state-wise was available from CSO at current prices for 1999-2000. Taking into consideration the total cropped area, the gross value of output per hectare and weighted average GVO-Cost A2 ratio for each state, farm business income from crop production per hectare was obtained. Since income from crop production is substantially supplemented by the income from Livestock in all the state and more so in SAT states, the farm business income from crop production was raised by the ratio of total agricultural out put (Crop Production Plus Livestock) to crop production as available from the CSO's State Domestic Product. Taking into consideration the total farm business income per hectare of cropped area and required annual income as per poverty line, estimates of required cropped area were made for different states, which was further adjusted with the cropping intensity of each state to obtain the required poverty line economic size of holding. The estimates of required income, farm business income from crop production and total agriculture income per hectare along with required economic size and existing size of holding are shown in Table 26. It would be seen from Table 26 that required size of holding which could yield an income just enough to meet the poverty line varies from 0.96 in Andhra Pradesh and 0.97 hectare in Tamil Nadu to 1.68 hectares in Madhya Pradesh and 1.48 hectares in Gujarat and Rajasthan. The size of holding required for the same income in Karnataka and Maharashtra is about 1.30 hectares. It may also be observed that this size of holding is required when it has considered (a) income from Livestock as the part of holding and agriculture is practiced as mixed farming and (b) holding contains part of parcels as irrigated as an average percentage of irrigated area in the state.

4.4 Poverty Level Income of Purely Rainfed Farms:

Considering the difference in the productivity of irrigated and rainfed crops per hectare, an average value of output per hectare of rainfed crops for different states were obtained. Since the ratio of payout cost to total value of output is slightly higher for irrigated crops, the share of Farm Business Income in total value of output in rainfed conditions was observed slightly higher. The level of farm business income of per hectare of cropped area and required size of holding that would provide the poverty level income under purely rainfed conditions in SAT States is shown in Table-27. It would be seen that the required size of rainfed holding which could provide the level of farm business income to meet the poverty line varied from 1.40 to 1.60 hectare in Andhra Pradesh, Karnataka,

Table 26 : Farm Business Income and Poverty Level Economic Size of Holding in SAT States

Sr. No.	State	Rural Poverty Line (Rs.)		Value of Crop output (Rs. in Lakh) 1999-00	Gross Cropped Area ('000 Hect.)	Gross Value of Output Per Hect. (Rs.)	Farm Business Income per Hect.	Ratio of Total Agricultural Production to crop output	Total Farm Income Per Hect.	Cropped Area. Required Hect.	Required size of Holding Hect.	Average size of Holding Hect.
		Per Capita Per month	Per Family Per Annum									
1.	Andhra Pradesh	263	15986	2850364	12786	22293	10623	1.27	13491	1.18 (1.50)	0.96 (1.23)	1.41
2.	Gujarat	319	19392	1490784	9589	15547	9202	1.29	11870	1.63 (2.15)	1.48 (1.92)	2.64
3.	Karnataka	310	18823	2779829	12815	21692	10154	1.26	12794	1.47 (1.85)	1.27 (1.59)	1.92
4.	Madhya Pradesh	311	18929	3150725	25762	12230	6889	1.25	8611	2.20 (2.75)	1.68 (2.11)	2.37
5.	Maharashtra	319	19373	3947576	21881	18411	9067	1.32	11968	1.62 (2.13)	1.32 (1.74)	2.00
6.	Rajasthan	344	20917	1944846	17739	10964	7510	1.45	10889	1.92 (2.78)	1.47 (2.12)	3.71
7.	Tamil Nadu	3006	18705	1942324	7412	26205	12971	1.26	16343	1.14 (1.44)	0.97 (1.22)	0.84

Figures in Brackets show the size of Holding if only Crop production is practiced.

Maharashtra and Tamil Nadu, where as it ranged between 1.80 - 2.00 hectare in Madhya Pradesh, Rajasthan and Gujarat. It would thus be clear that the purely rainfed holding required to meet the same income are generally 30-50 percent higher than that normal holding having partly irrigated areas in different SAT States.

Table 27 : Level of Farm Business Income and Poverty Line Economic Size of Rainfed Farms in SAT State

(Rupees)

Sr. No.	Crop	Rural Poverty Line Annual Income	Gross Value per Hectare		Farm Business Income per Hect.		Rainfed Cropped Area required (hect.) (hect.)	Required Poverty level Economic size of holding
			Rain-fed	Irri-gation	Crop Produc-tion stock	Total Including Live		
1.	Andhra Pradesh	15986	15191	31901	7519	9549	1.67	1.41
2.	Gujarat	19392	11576	23152	6853	8840	2.19	2.06
3.	Karnataka	18823	17026	35176	7968	10039	1.87	1.64
4.	Madhya Pradesh	18929	9984	18969	5620	7025	2.69	1.86
5.	Maharashtra	19373	15885	333303	8133	10736	180	1.47
6.	Rajasthan	20917	8675	16488	5934	8604	2.43	1.81
7.	Tamil Nadu	18705	17060	34120	8445	10640	1.76	1.53

4.5 Economically viable Holding in SAT States

There is no standard definition of economically viable holding. Economic Holding however, have been defined on the basis of either income or employment for the farm family.

An economic holding is defined as “holding that provide an income which is sufficient to maintain a minimum level of living or provide the full employment for the farm family”. Since data regarding employment in agriculture are inadequate to measure the full employment, the economic size of holding was considered based on level of income, where the minimum requirement was pegged at the Poverty Line Income.

Economically viable holding is rather more than economic unit in the sense that viable holding is supposed to produce an income

enough to meet the requirements both for family and farm and be in a position to take up the farm development. The requirement of income for family is much more than the poverty line minimum. However, there was not sufficient data about distribution of farm income for states that could provide the base line to determine the income that meets the requirement of farm family. In the absence of detailed information about the distribution of gross farm income as also about consumption needs as well as production requirements, an alternative approach based on per Capita Income of the State was assumed. It was felt that a farm which could provide per Capita Income as about half of the state average may be considered as economically viable. Even, this assumption considering the proportion of population engaged in agriculture, the per capita income of agricultural population would be about 28-30 per cent of that of non-agricultural population. This also holds true at the all India level where per capita income of non-agricultural population is about 3.75 times to that of agricultural population.

Based on the State Domestic Product per Capita, the required income for an average family of five members in agriculture was estimated for different states. This level of farm business income was considered enough to meet the family expenditure needs as well as farm requirements both for current inputs and some developmental needs, and the farm that could provide this level of farm business income was considered as economically viable farm. The level of State Domestic Product per capita, the required income for an average family of five members in agriculture, farm business income per hectare and required viable economic size of holding for different SAT states is shown in Table 28. It would be seen that the viable economic size of farm in rainfed SAT states varied from 2.74 hectares in Madhya Pradesh and Rajasthan to 3.70 hectare in Andhra Pradesh, Karnataka and about 4.50 hectares in Tamil Nadu and Maharashtra. The required viable size of holding for rainfed sector of Gujarat is 5.6 hectare. Size of viable economic holding has largely been influenced by the cropping pattern, level of productivity and farm business income of crops as well as cropping intensity. In Gujarat not only the farm business income per hectare was low but it also had lowest cropping intensity in rainfed sector being 106.2. In Madhya Pradesh and Rajasthan, though the farm business income per hectare is low, the required viable size of holding was small because of low per capita state income and relatively higher cropping intensity in rainfed sector which was as 143.7 and 134.2 per cent respectively during 1998-99.

Table 28 : Economically Viable size of Holding in SAT States

Sr. No.	State	Per Capita NSDP (Rs.) 1999-00	Per Capita Income (Rs.)		Annual Family viable/ Income in Agriculture	Value of Output per Hect. (Rs.)	Farm Business Income per hect. (Rs.)	Required Cropped Area (Hect.)	Required Viable Farm size. (Hect.)
			Agri.	Non Agri.					
1.	Andhra Pradesh	14715	7357	25002	36785	22293	10623	3.46	2.93
2.	Gujarat	18625	9312	27976	46560	15547	9202	5.06	4.75
3.	Karnataka	16343	8171	25539	40855	21692	10154	4.02	3.54
4.	Madhya Pradesh	10907	5453	18628	27265	12230	6889	3.95	2.74
5.	Maharashtra	23398	11699	32796	58495	18411	9067	6.45	5.26
6.	Rajasthan	12533	6266	22439	31330	10964	7510	4.17	3.11
7.	Tamil Nadu	19141	9570	26973	47850	26205	12971	3.69	3.20

It would also be seen that in practically all the rainfed SAT States, the marginal and small holding are not economically viable units. Amongst semi-medium holdings (2.0 to 4.0 hectare size class) also only about one-fourth of the holdings which are in the range of 3.5 - 4.0 hectares are viable holdings in the states of Andhra Pradesh, Karnataka, Madhya Pradesh, Rajasthan and Tamil Nadu. In Gujarat and Tamil Nadu holdings upto the size of semi-medium class i.e. upto 4 hectares are not economically viable unit as per criteria discussed above.

SECTION-V

Methods and Programme to Improve Viability

5.1 Major Constraints of SAT States

Based on the analysis in the preceding sections, it would be worthwhile to briefly discuss the major constraints of rainfed agriculture in SAT states. As already explained that agriculture in SAT is highly dependent on rainfall, the percentage of irrigated area under principal crops in some of the states is very low as inferred from Table-4. For some principal rainfed Crops, the share of irrigated area to total area under the crop is 1-5 percent only as shown in Table-29. Because of high dependence on rainfall water, adoption of high yielding varieties in the SAT state is relatively much lower as would be seen from Table-30. For example in Paddy against the all India average of 77 per cent of area under high yielding varieties, the area of these varieties was much low in Madhya Pradesh and Rajasthan where crop is partly rainfed. Similarly share of high yielding varieties in the total area of the crop is much lower for Bajra in Andhra Pradesh, Rajasthan and Maharashtra where crop is by and large, rainfed. Since Jowar is by and large, rainfed in all the states, there is not much of the difference in the use of high yielding varieties across the states except in Gujarat and Rajasthan where again proportion of area under HYV is very low.

Table 29 : Percentage coverage of irrigated area under Principal Crops in SAT States (1998-99)

Sr. No.	Crop	Andhra Pradesh	Gujarat	Karnataka	Madhya Pradesh	Maharashtra	Rajasthan	Tamil Nadu	All India
1.	Rice	95.9	70.6	70.90	23.3	29.7	53.7	93.5	52.3
2.	Jowar	2.1	6.7	7.1	0.1	10.6	0.2	9.8	8.1
3.	Bajra	14.1	21.0	9.6	—	4.4	3.0	9.4	7.0
4.	Maize	33.8	10.8	54.0	1.7	14.2	5.7	56.5	21.7
5.	Wheat	81.8	81.2	40.3	71.8	55.4	96.2	—	85.8
6.	Total Cereals	75.1	42.6	29.1	36.5	16.8	35.2	73.7	49.6
7.	Gram	1.4	29.0	10.6	33.4	26.6	12.7	5.3	21.0
8.	Tur	0.5	11.5	0.9	1.0	1.6	—	2.3	4.2
9.	Total Puses	0.8	10.6	3.9	20.6	7.6	8.8	7.1	12.1
10.	Foodgrains	59.1	35.6	22.9	32.0	14.3	25.1	62.2	42.4
11.	Groundnut	19.4	8.5	21.6	8.0	27.7	36.6	34.5	19.4
12.	Rapeseed & Mustard	—	88.9	—	36.5	12.8	69.1	0.0	58.3
13.	Soyabean	—	—	33.7	1.6	0.5	8.1	89.8	2.5
14.	Total Oilseeds	19.1	25.7	20.9	5.4	9.4	42.3	43.9	23.2
15.	Cotton	16.8	38.0	21.0	41.1	3.7	96.0	36.7	54.9
16.	Sugarcane	94.1	100.0	100.0	97.9	100.0	96.3	100.0	91.7
17.	All Crops	44.7	36.3	25.3	26.2	15.4	31.8	54.8	39.2

Table 30 : State-wise Area under High Yielding Varieties (1996-97)

(000 Hect.)

Sr. No.	State	Paddy		Jowar		Bajra		Maize		Wheat	
		Total	HYV	Total	HYV	Total	HYV	Total	HYV	Total	HYV
1.	Andhra Pradesh	3970	3699 (93.0)	852	599 (70.3)	124	72 (58.1)	377	322 (85.4)	—	
2.	Gujarat	642	533 (83.0)	348	180 (51.7)	1072	795 (74.2)	399	211 (52.9)	581	410 (70.5)
3.	Madhya Pradesh	5292	3471 (65.6)	978	788 (80.6)	134	93 (69.4)	844	508 (60.2)	4206	3000 (71.32)
4.	Maharashtra	1478	1293 (87.5)	5692	4791 (84.2)	1947	34 (1.7)	324	262 (80.6)	799	740 (92.6)
5.	Karnataka	1347	1016 (75.3)	1994	1401 (70.3)	416	270 (64.9)	437	353 (80.8)	248	7 (2.8)
6.	Rajasthan	147	43 (29.3)	623	13 (2.1)	4702	1870 (39.8)	921	24 (2.60)	2433	1742 (71.6)
7.	Tamil Nadu	2269	2120 (93.4)	496	496 (100)	207	186 (89.4)	67	67 (100.0)	—	—
8.	All India	43283	33399 (77.16)	11572	8270 (71.5)	10000	6098 (60.98)	6248	3764 (60.24)	25943	23726 (91.4)

Note : Figures in Bracket showed percent to total area of the crop in the state.
HYV : High Yielding Varieties.

The associated constraint of the rainfed crops with traditional/ local varieties is limited or less use of yielding increasing inputs like fertilizers as shown in Table-31. The use of fertilizers in many of the SAT states / rainfed crops is less than half or even one-third of the recommended level of application. A mention may be particularly made of Karnataka and Madhya Pradesh in Jowar, Rajasthan and Madhya Pradesh in Maize, Karnataka, Rajasthan and Tamil Nadu in case of Bajra, Groundnut and Cotton in a number of major growing SAT States.

Table 31 : Crop-wise Use of Fertilizers in SAT States (1998-99)

Kgs. per hect.

Sr. No.	Crop	Recommended Level		Andhra Pradesh	Gujarat	Karnataka	Madhya Pradesh	Maharashtra	Rajasthan	Tamil Nadu
		H.Y.V.	Local							
1.	Jowar	140-160	60-80	77.00		43.75	46.60	40.60		7.90
2.	Bajra	120-140	60-70	43.25	75.91	56.00			27.60	22.60
3.	Maize	140-180	60-80	100.18	—	99.17	50.40	—	23.0	
4.	Gram		40-60	—	—	—	30.90	—	1.70	
5.	Moong/ Urad		30-40	12.34	—	—	10.17	27.89	—	—
6.	Tur		40-60	—	39.75		18.63	16.34	—	18.28
7.	Ground Nut		80-100	61.64	66.86	60.49	—	62.02	—	78.28
8.	Cotton	180-220	80-100	205.00	90.62	60.19	70.15	—	60.42	125.46
9.	Ragi		60-80		60.45	—				80.00
10.	Soya-bean		60-80	—	—	—	52.10	50.00	19.07	—

Source : Comprehensive Scheme for Studying Cost of Cultivation of Principal Crops in India, DES, Ministry of Agriculture.

Low use of yield raising inputs like high yielding varieties seeds, fertilizers, irrigation and other purchased inputs suggests that farmers in the SAT region / state are generally using traditional practices of farming for various reasons like higher risk in crop production associated with large fluctuations in area, yield and production under rainfed conditions. Higher risk in crop production restricts the farmers to make higher investments in inputs to raise productivity. This has already been reflected in higher G.V.O. Cost A_2 ratio or higher farm business income to G.V.O. ratio.

Because of low productivity and farm income under rainfed farming in SAT states, farmers are hardly in a position to meet their essentials of life. There would hardly be any savings for an average farmer for investments and improvements on farms.

Further, SAT farmers have low bargaining capacity in terms of borrowing funds, price determination and marketing of products, are more prone to international shocks by most of the commodities produced by them like pulses, coarse cereals particularly Sorghum (Jowar) and Maize as well as oilseeds. Of late, cotton economy has also been influenced by the international price situation.

5.2 Ways to Improve Viability

There are various approaches and options that could be pursued to improve the economic viability of rainfed farming in semi-arid tropics. The profitability of crops could be raised either by reducing the cost of production or raising the productivity of crops. The total productivity could be raised either by more intensive use of land through multiple cropping or by use of modern technology. Integrated supply of production inputs along with adequate infrastructure, market and price support could help immensely in improving the viability of crop production. Some major ways of improving the viability of rainfed agriculture in SAT states are discussed hereunder.

5.2.1 Transfer of Available Technology

National Agricultural Research System has been seriously engaged to evolve appropriate production technology for different systems of farming in the country including rainfed in semi-arid zones. The foregoing analysis has revealed that the yield levels of the rainfed farms in SAT states is very low. However, the research system has evolved various new strains of different crop grown in rainfed conditions of semi-arid zones and have tested under farmer conditions to identify region specific viable and feasible cropping systems for increasing production. The system has developed various varieties of coarse cereals, pulses, oilseeds and other crops shown in rainfed SAT and successfully tested under the all India Coordinated Research Project on Dry land Agriculture (AICRPDA) and more recently of the Field Level Demonstrations show the potentials of raising the productivity of crops in rainfed system. The results of field level demonstrations on pulses and oilseeds (Rainfed) in SAT

states during 2000-2001 are shown in Table 32 and Table 33 respectively.

**Table 32 : Performance of FLD's on Pulses (Rainfed)
in SAT States (2001-2002)**

Sr. No.	Crop	State	No. of Farmers	Average Yield Quintals per hect.		Increase in yield (%)
				Local	Demonstration	
1.	Green Gram (Kharif)	Andhra Pradesh	11	7.9	11.5	50.6
		Karnataka	7	4.4	7.0	59.1
		Maharashtra	5	7.2	9.4	30.5
		Rajasthan	110	5.0	8.6	72.0
2.	Black Gram (Kharif)	Andhra Pradesh	12	5.4	7.7	40.6
		Karnataka	25	6.2	8.8	41.9
		Madhya Pradesh	12	3.9	7.0	79.5
		Maharashtra	26	5.0	7.4	47.0
		Rajasthan	49	5.4	8.5	57.4
3.	Pigeonpea (Tur) (Kharif)	Andhra Pradesh	30	8.5	11.0	29.4
		Gujarat	11	6.4	7.4	15.7
		Karnataka	169	9.4	12.5	33.0
		Madhya Pradesh	56	7.0	12.1	58.6
		Maharashtra	28	8.7	11.5	35.8
		Rajasthan	5	5.0	9.5	90.0
4.	Chick pea (Rabi)	Andhra Pradesh	28	10.4	11.1	6.7
		Karnataka	333	7.2	9.1	26.3
		Tamil Nadu	22	9.9	15.5	56.6

The results under AICRPDA showed that yield levels of Jowar, Bajra and Maize in almost all the SAT states under new technology is significantly higher by 100-250 per cent than that of farmers using traditional technology. The pulses, which is another major group of crops under rainfed conditions of SAT region, the performance of the field level demonstration on pulses as shown in Table 32 revealed that productivity of these crops could be raised under rainfed conditions significantly by following available modern technology. The average yield per hectare on demonstration fields was higher by 32-72 per cent in green gram (moong), 40-80 per cent in black gram (urad) 16-90 per cent in pigeonpea (Tur/Arhar) and 7-56 per cent in chickpea (Chana) in different SAT states.

Similarly in oilseeds crops, the other important group of crops in rainfed areas of SAT states, the Field Level Demonstrations show that yield per hectare could be increased significantly by adopting available technology as shown in Table-33. The yield per hectare of demonstration fields of soyabean was 70 per cent higher in Karnataka where as it was higher by about 52 per cent in Madhya Pradesh and Rajasthan than the local yields. Similarly the yield levels of demonstration fields were higher by 30-60 per cent in groundnut, 24-64 per cent in sunflower (Kharif), 30-35 percent in sunflower. Seasmum which is a rainfed crop of tribals in Madhya Pradesh, showed that yield could be almost tribled by adopting new technology. The above facts of FLD's under rainfed conditions in SAT states clearly show that there is great scope of raising the yield of crops and thus improving the economic viability of farms in this sector.

Table 33 : Performance of Field Level Demonstrations on Oilseeds (Rainfed) in SAT States

Sr. No.	Crop	State	No. of Farmers	Average Yield Quintals per hect.		Increase in yield (%)
				Local	Demonstration	
1.	Soyabean (Kharif)	Andhra Pradesh	15	16.7	20.5	22.5
		Karnataka	51	9.6	16.4	70.8
		Madhya Pradesh	173	9.5	14.4	51.5
		Maharashtra	429	11.5	15.5	34.7
		Rajasthan	34	7.4	11.3	52.7
2.	Groundnut (Kharif)	Andhra Pradesh	176	11.6	15.3	31.9
		Karnataka	314	7.2	9.1	27.3
		Madhya Pradesh	12	9.7	15.1	55.6
		Maharashtra	232	9.8	15.8	61.2
		Tamil Nadu	164	16.6	20.5	23.4
3.	Sunflower (Kharif)	Karnataka	86	7.4	9.2	24.3
		Maharashtra	24	7.8	12.8	64.1
4.	Seasamum (Kharif)	Andhra Pradesh	90	3.5	4.5	28.5
		Madhya Pradesh	31	2.1	5.8	176.0
		Maharashtra	37	3.9	5.3	35.8
		Rajasthan	27	3.1	4.4	41.9
		Tamil Nadu	88	5.4	6.6	22.0
5.	Mustard	Rajasthan	10	13.2	16.0	21.3
6.	Safflower (Rabi)	Karnataka	62	5.1	6.6	29.4
		Maharashtra	38	7.9	10.5	34.8

5.2.2 Water Shed Based Technology

Based on the experience of AICRPDA, an area development approach on water shed basis was adopted, encompassing systems for efficient land and rain water use in rainfed sector. Since major problem in rainfed sector is shortage of water, the basic approach in this programme required water harvesting and installing diversion drains to remove excess rainfall water from upper reaches away from fields, providing over all drainage, constructing broad based bunds in fields, putting maximum area under monsoon cropping and adopting improved crop production and cattle raising technology. These projects were initiated in many selected districts in SAT states, results of some of which are shown in Table-34. The yield of

Table 34 : Average Productivity of some of Cereal Crops under Farmers Technology and Improved Crop Production Technology in Various Water Sheds

Sr. No.	Name of Water Shed / State	Crop	Yield of Crops (Kg. Per Hect.)		Increase in Yield (percent)
			Farmer's Traditional Technology	Improved Technology	
1.	Jumarnela, Ranchi (Jharkhand)	Rice	500	1250	150
		Maize	750	2500	233
2.	Mittarmari, Kolar (Karnataka)	Ragi	600	2260	276
3.	Jaladrasi, Bellary (Karnataka)	Jowar	680	1445	112
4.	Barkheda Hat, Guna (Madhya Pradesh)	Sorghum	500	2500	400
		Maize	600	3700	516
5.	Hingonia, Indore (Madhya Pradesh)	Sorghum	960	2040	108
6.	Nibhua, Sidhi, (Madhya Pradesh)	Paddy	700	1010	44
		Sorghum	800	1250	56
		Maize	1000	1450	45
7.	Kolhawadi, Ahmed Nagar, (Maharashtra)	Sorghum	540	1390	157
		Bajra	435	630	45
8.	Padalsinghi (Parbani) (Maharashtra)	Sunflower	800-1000	2100-2500	150
9.	Taddenpalli (Andhra Pradesh)	Sorghum	1400	2180	55
		Maize -	920	2007	118
		Gram			
10.	Sultapur (Andhra Pradesh)	Sorghum	1268	1922	51
		Arhar	216	481	122

crops with improved technology under water shed in most of the cases is 2 to 3 time than that of traditional farmers in the same region. For example yield per hectare of Ragi crop in Karnataka under water shed improved technology was observed as 2260 Kgs. against 600 Kgs. of traditional farmers. Similarly yield of Jowar with improved technology under water shed in Madhya Pradesh (Indore & Guna), Karnataka (Bellary), Maharashtra (Ahmed Nagar & Parbani) etc. was significantly higher than traditional farmers of the respective areas. These projects had large coverage with about 100 districts spread over sixteen states having rainfall even upto 1150 mm but not having more than 30 percent of area irrigated. The experience of the projects also revealed that the given the efficient use of rainfall water combined with available crop production technology, the viability of rainfed sector could be improved significantly in SAT states.

5.2.3 Improvement in Agricultural Development

Since the rainfed agriculture in semi-arid is characterized by low productivity and poor income, the agriculture of the region is relatively less developed in terms of use inputs as well as mode of cultivation. The use of agricultural credit, electricity consumed in agriculture and fertilizer consumption per hectare in different states during 1999-2000 is given in Table-35. It would be seen that in major millet growing states of Madhya Pradesh, Maharashtra and Rajasthan, credit outstanding on 31st March, 1999 was only Rs.400-500 per cropped hectare. It was significantly high in three Southern states of Andhra Pradesh, Karnataka and Tamil Nadu which have significant part of cropped area under high value by and large irrigated crops like Paddy and Sugarcane. Use of electricity for agriculture per hectare of cropped area amongst states was lowest in Rajasthan followed by Madhya Pradesh, Maharashtra and Karnataka. The use of electricity in agriculture per hectare was highest in Gujarat followed by Tamil Nadu and Andhra Pradesh. Use of electricity in agriculture in SAT states is not low in general as compared to other non SAT states except that in Punjab and Haryana.

**Table 35 : Level of Agricultural Development
in various States**

Sr. No.	State	Agricultural Credit March 1999		Consumption of Electricity for Agri. Per cropped Hect. (KWH)	Fertilizer Consumption per hect. (Kgs.) 1999- 2000	Percentage of Irrigated Area
		Total Lakh (Rs.)	Per Hect. Cropped Area (Rs.)			
SAT STATES						
1.	Andhra Pradesh	2312.70	1776	921	174.59	44.7
2.	Gujarat	811.96	799	1407	91.02	35.3
3.	Karnataka	1629.36	1347	546	108.74	25.3
4.	Madhya Pradesh	1062.41	405	387	46.08	26.2
5.	Maharashtra	1105.52	495	485	88.80	15.4
6.	Rajasthan	1011.75	524	297	36.61	31.8
7.	Tamil Nadu	1687.10	2587	1288	160.41	54.8
NON SAT STATES						
1.	Assam	149.97	366	12	27.57	14.5
2.	Bihar	826.32	828	152	98.43	47.3
3.	Haryana	649.60	1077	748	146.80	79.8
4.	Himachal Pradesh	110.26	1152	18	38.42	18.8
5.	J & Kashmir	58.04	538	120	57.92	41.4
6.	Kerala	209.22	697	126	71.18	14.4
7.	Orissa	509.37	597	34	41.66	29.0
8.	Punjab	998.01	1211	1024	179.97	92.2
9.	Uttar Pradesh	2414.85	906	200	123.53	66.4
10.	West Bengal	470.48	493	142	133.77	26.8

However, the use of major yield increasing input viz fertilizer in SAT states of Madhya Pradesh, Rajasthan and Maharashtra is quite low. It was lowest at 37 Kgs. in Rajasthan and 46 Kgs. in Madhya Pradesh. In states of Gujarat and Maharashtra where average consumption of fertilizer appears to be moderate, it was because of principal crop of sugarcane for which fertilizer consumption per hectare was 250 and 350 Kgs. respectively. If one examine, the fertilizers consumption of rainfed crops in the SAT states, it would be observed that the fertilizer consumption per hectare ranges only 15-30 Kgs. which is far below the recommended levels for these crops in such rainfed conditions. Further means of cultivation/ Production in terms of use of machine power as tractors, pump sets

etc. are not well developed in some of the states as shown in Table-36. The number of pump sets and tractors per 100 hectares in some of the SAT states like Madhya Pradesh, Maharashtra and Karnataka is quite low. If crop production in the rainfed sector of semi-arid region is to be made economically viable proposition through raising productivity, then efforts have to be made to enable the farmers to apply the recommended level of yield raising inputs including fertilizers, improved varieties seeds besides use of improved means and technique of production. This may call for more liberal availability of credit to rainfed farmers in semi-arid zones as income and savings of the farmers are very low in this sector to meet the requirement for purchased inputs. Support in turn may also be required to refinancing to the banking system of the region for adequate credit flow for adoption of technology and investments.

Table 36 : Intensity of Pump Sets and Tractors in Different States in India

Sr. No.	State	Pumpsets (000)	Tractors (000)	Cropped Area (000 hect.)	Number per hundred hect.	
					Pump Sets	Tractors
SAT STATES						
1.	Andhra Pradesh	1650	1040	14337	11.51	7.20
2.	Gujarat	1150	445	10306	11.16	4.32
3.	Karnataka	909	57	12821	7.09	0.44
4.	Madhya Pradesh	1059	106	20391	5.19	0.52
5.	Maharashtra	845	45	17090	4.94	0.26
6.	Rajasthan	1779	856	16632	10.69	5.15
7.	Tamil Nadu	1343	241	5211	25.77	4.62
NON SAT STATES						
8.	Assam	1	—	3987	—	—
2.	Bihar	1225	34	10401	11.77	0.32
3.	Haryana	504	174	5547	9.08	3.13
4.	Himachal Pradesh	2	2	903	0.22	0.22
5.	Jammu & Kashmir	3	1	1106	0.27	0.09
6.	Kerala	379	160	2002	18.93	7.99
7.	Orissa	95	24	6018	1.57	0.39
8.	Punjab	718	217	7827	9.17	2.77
9.	Uttar Pradesh	4408	287	25996	16.95	1.10
10.	West Bengal	92	39	7862	1.17	0.49

5.2.4 Price and Market Support for Rainfed Crops of Semi-Arid Zone

The major group of rainfed crops of semi-arid states are coarse cereals, pulses and oilseeds besides cotton. Though 15 crops of these groups are covered under minimum price support policy, but there has hardly been occasion when actual price support has been made effective for these crops. During the last decade viz 1992-93 to 2000-01, except two years, when the procurement of coarse cereals of about 6-8 lakh tonnes i.e. 3-4% of the total production was made, the procurement, has never exceeded a few thousand tonnes or 0.05 percent of production; hardly having influence a market prices. In case of Pulses, probably market prices have in most of the year remained above MSP level, so were never procured under price support policy except Gram during 1999-2000. However, commercial purchases of Pulses by the NAFED to meet the requirement of PDS through co-operatives in urban areas have been in operation. Similarly price support operations made under MSP policy for oilseed crops has been practically absent except for Rapeseed seed and Mustard in one or two years limited to one or two state for a few thousand tonnes. In the absence of adequate market support, despite crops covered under MSP policy, the market prices of coarse cereals, pulses and oilseeds could not move in tune with prices of other major agricultural commodities. It is certain that despite the crops remained covered under MSP Policy, the rainfed crops have not received adequate market support adversely affecting their market prices. Index of Whole Sale Prices of some of Principal crops of Cereals, Pulses and Oilseeds with 1993-94 = 100 as base are shown in Table 37. It is seen from the indices of wholesale prices that increase over 1993-94 as base in cereals was much higher being 73 per cent as against increase 39.2 per cent of Gram, 50.3 per cent in Arhar, 39.4 per cent in Groundnut and 18.0 per cent in Rape & Mustard Seeds during the some period. The increase in wholesale price of total oilseeds and edible oils was 29.3 and 3.3 per cent respectively. Relative moments of wholesale prices as deflated by the indices of Agricultural Commodities show that the real whole sale prices of Gram and Arhar during 2000-01 were almost 10.6 and 4.5 per cent lower than that of 1993-94 whereas that of Groundnut and Rape & Mustard Seed were lower by 10.5 and 24.2 per cent respectively. This showed that farmers who are generally producers of pulses like Gram and Arhar and Oilseeds like Groundnut and Rape & Mustard Seeds have been at disadvantage in recent years as the real prices received by them in recent years were relatively lower with base as 1993-94. The paper do not

propose to analysis reasons for this relatively low prices, which are often quoted as large imports of edible oils under Liberalized trade policy but are also attributed to inadequate price and market support for these commodities.

Table 37 : Index Number of Whole Sale Prices And Relative Indexes

(Base 1993-94 = 100)

Sr. No.	Commodities	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01
1.	Rice	111.3	117.4	128.5	134.3	146.2	171.3	167.5
2.	Wheat	108.9	112.1	137.3	138.1	151.8	174.7	176.6
3.	Jowar	132.7	175.1	175.6	172.3	191.1	240.6	199.7
4.	Bajra	132.6	147.8	147.2	143.4	156.6	201.2	184.0
5.	Maize	142.3	147.6	161.1	148.5	154.4	193.6	176.9
6.	Cereals	113.6	120.8	135.7	138.4	150.9	177.8	173.0
7.	Gram	108.3	74.8	96.7	124.6	110.9	115.4	139.2
8.	Arhar	109.8	161.1	170.7	136.2	186.2	176.3	150.3
9.	Groundnut	122.6	135.1	135.0	133.9	150.8	139.6	139.4
10.	Rapeseed and Mustard Seed	116.1	123.6	119.4	116.9	163.6	138.7	118.0
11.	Oil Seeds	118.5	128.6	130.6	128.3	148.5	133.4	129.3
12.	Edible Oils	110.9	116.9	115.1	113.5	139.1	122.1	103.3
13.	Agricultural Commodities	112.6	121.6	127.2	132.8	140.7	145.3	155.7
Relative Price Indices to all Agricultural commodities								
1.	Rice	98.8	96.5	101.0	101.1	103.9	117.8	107.5
2.	Wheat	96.7	99.6	107.9	103.9	107.9	120.2	113.4
3.	Jowar	117.8	143.9	138.0	129.7	130.0	165.5	128.2
4.	Bajra	117.7	121.5	115.7	107.9	111.3	138.4	118.1
5.	Maize	126.4	121.4	126.6	111.8	109.7	133.2	113.6
6.	Gram	96.2	61.5	76.0	93.8	78.8	79.4	89.4
7.	Arhar	97.5	132.5	134.2	102.6	132.3	121.3	96.5
8.	Groundnut	108.9	111.1	106.1	100.8	107.2	96.1	89.5
9.	Rapeseed and Mustard Seed	103.1	101.6	93.8	88.0	116.4	95.4	75.8
10.	Edible Oils	98.5	96.1	90.5	85.5	98.8	84.0	66.3

5.2.5 Improvement in Credit Availability in Relation to Credit Needs

It has been seen that institutional Credit in the SAT States generally was quite low except in some of the Southern States which were also Sugarcane growers, despite reasonably developed banking

infrastructure as shown in Table-38. The agricultural credit per hectare of cropped area was only around Rs. 500 in the States of Madhya Pradesh, Maharashtra and Rajasthan and about Rs.800 in Gujarat. The Most of the farmers in rainfed sector of SAT States are having low productivity and farm business income. These farmers hardly have the saving or reserve to meet the expenses and purchase the required inputs from their own resources. In fact farmers normally be given the institutional loan to meet their all cash expenses which generally is considered equivalent to paid out cost (Cost A₂) of cultivation per hectare of crops. Since the amount would vary taking into consideration the cropping pattern and level of technology to be used, the existing level of cost A₂ would only an indicative of credit needs of the crops. Further some of the items of paid out cost are farm family supplied, like part of the seeds,

Table 38 : Level of Agricultural Credit in SAT and Non SAT States of India (1999)

Sr. No.	State	Agricultural Credit		Rural Population (Lakh)	Rural Banks per Lakh Rural Population (No.)	Agricultural Credit (Rs.)	
		Total loan outstanding March, 99 (Rs. Lakh)	Number of Rural Banks			Per Capita Rural Population	Per Hectare of Cropped Area
SAT							
1.	Andhra Pradesh	231270	2441	526	4.64	440	1776
2.	Gujarat	81196	1548	302	5.12	269	799
3.	Karnataka	162936	2221	345	6.46	472	1347
4.	Madhya Pradesh	106241	2696	586	4.60	181	405
5.	Maharashtra	110552	2324	528	4.40	276	495
6.	Rajasthan	101175	1915	401	4.77	258	524
7.	Tamil Nadu	168710	1839	392	4.69	430	2587
NON SAT							
8.	Assam	14997	836	230	3.63	65	366
9.	Bihar	82632	3525	850	4.41	97	828
10.	Haryana	64960	695	144	4.82	451	1077
11.	Himachal Pradesh	11026	658	61	10.78	181	1152
12.	Jammu & Kashmir	5804	580	75	7.73	77	538
13.	Kerala	20932	347	224	1.55	93	697
14.	Orissa	50937	1614	299	5.40	170	597
15.	Punjab	99801	1118	161	6.94	620	1211
16.	Uttar Pradesh	241485	5426	1320	4.11	183	906
17.	West Bengal	47048	2278	565	4.03	83	493

maintenance cost of bullocks on feed and fodders etc., thus the actual requirement of credit to meet the cash expenses may be lower than the total paid out cost. It was assumed that credit needs from the Institutional sources be pegged at half of the paid out cost. A summary statement of credit need based on paid out cost of cultivation of crops of different SAT States is shown in Table-39. It would be seen that for crops like coarse cereals of Jowar and Bajra, the credit need varies from Rs. 1700/- in Madhya Pradesh and Gujarat to Rs. 2400 in Andhra Pradesh and Maharashtra. Credit need of the groundnut crop to meet half of the cash expenses to varied from Rs. 3485 in Karnataka to Rs. 4982 in Tamil Nadu while in other state it was in the range of Rs.4000 to Rs. 4500. There was large variation in credit needs of cotton in SAT states because of large differences in cultural practices and level of technology. Credit needs for pulses to meet cash expenses were somewhat lower in the range of Rs.1200-2500 per hectare for different crops/State. Taking into consideration the cropping pattern and cash requirements of different crops, credit availability has to be raised to around three times to that of existing level.

Table 39 : Crop-wise Credit Requirement of Farmers to Meet Cash Expenses in SAT States

Rs. Per Hectare

Sr. No.	Crop	Andhra Pradesh	Gujarat	Karnataka	Madhya Pradesh	Maharashtra	Rajasthan	Tamil Nadu
1.	Paddy	6060	—	—	3018	—	—	—
2.	Jowar	2450	—	1517	1700	2215	—	1875
3.	Bajra	2114	2720	—	—	—	760	1868
4.	Maize	3175	—	2775	1675	—	2120	—
5.	Ragi	3290	—	3286	—	—	—	—
6.	Gram	—	—	—	2780	—	1265	—
7.	Arhar	—	2694	—	1580	1635	—	—
8.	Moong/Urad	1490	—	—	1230	2035	—	—
9.	Ground Nut	4526	4056	3485	—	4675	—	4982
10.	Soyabean	—	—	—	2586	3097	2075	—
11.	Cotton	6590	4328	2950	2700	3846	2620	5900
12.	Sunflower	—	—	2046	—	—	—	—
13.	Wheat	—	—	—	2575	—	—	—
14.	Average	5200	3100	3000	2550	3600	1700	4900

— Details were not available from Cost Studies Scheme.

5.2.6 Protection from Liberalized Trade Policy

Rainfed farming is characterized as the poor resource farmers with low productivity but high unit cost of production. As principal crops of the rainfed areas of the semi-arid regions are coarse cereals like sorghum, Pearl millet, etc. Pulses and oilseeds besides Cottons, the efficiency of production as examined in terms of Resource Cost Ratio (RCR) and Nominal Protection Coefficient (NPC) by some of the studies (Gulati, Chand Ramesh) suggest that except the Cotton, the coefficient of most of the crops of coarse cereals are either close to or higher than unity. The situation is particularly vulnerable for oilseeds and some pulses for which coefficients were in many cases greater than unity as imports of these commodities may be profitable for private trade under liberalized policy adversely affecting domestic prices and thus profitability of these crops in this sector. The impact is already visible in oilseeds crops whose real prices during 2000-01 were lower by 15 - 25 per cent than that of 1993-94. The similar impact on domestic prices of pulses is also seen though not to that magnitude. The protection coefficient of coarse cereals though marginally lower than unity do not provide sufficient incentive to trade for import but if efficiency of production of these crops is not improved or maintained, it may be difficult to protect the producers of coarse grains also particularly producers of Jowar and Maize in future. Further bound level of tariff for edible oils should be used to check the import to only desired level which do not depress domestic prices of these commodities.

The other important rainfed commercial crop of the SAT states is cotton which has large international market of which India is one of the major players. So far India has maintained a competitive edge in the international market and the interest of the cotton growers in the SAT states was well protected. However, to maintain this comparative advantage, efficiency of resource use in the cotton production has to be improved so that unit cost of production be reduced and the situation arising out of liberalized global trade be used for national advantage. The controversy about the use of BT cotton needs to be settled once for all because still controversial statements about its achievements are being issued from different sources like scientific institutions, trade organization, Governments (State and Centre) as also by the farmers.

5.2.7 Comprehensive Insurance of Rainfed Crops

As already discussed that rainfed crops in semi-arid tropics have large variability in production due to fluctuations in the area and yield. The large risks associated in production of these crops in the SAT states hampers the adoption of technology and use of yield raising inputs. To overcome this problem, the risk of losses in production and cost of technology, has to be transferred from the farmers to a third party like Insurance Companies by introducing Comprehensive Insurance Scheme for rainfed crops in SAT states. Though the Government introduced a Comprehensive Crop Insurance Scheme (CCIS) first as "Pilot Project" and then introduced a new scheme entitled. "National Agricultural Insurance Scheme" (NAIS) since rabi 1999-2000, the experience of the scheme noted various weaknesses by the state implementing agencies which related to parameters like estimation of yield at a unit level, threshold yield and estimates of area under the crop for the farmers. The other problem related with the scheme was the timely settlement of claims of the farmers about damage of crop which some times take 2 or 3 years. Farmers of SAT region, particularly rainfed, have hardly any capacity, to withstand the financial hardship for such a long time. The newly introduced Minimum Income Insurance Scheme based on guaranteed MSP and actual yield which covers only rice and wheat farmers again do not ensures rainfed farmers in SAT states as these crop are, by and large irrigated. Thus, therefore, there is urgent need to properly implement, the National Agricultural Insurance Scheme to protect the interest of rainfed farmers in SAT states. The other way out could be that the Government may also extend the Minimum Income Insurance Scheme to rainfed Crops of Jowar and Pearl millet (Bajra) in SAT states on pilot basis and equity consideration.

5.2.8 Developing Agro-Processing in Rainfed Areas

In order to improve the economic state of rainfed farmers, it would be desirable to raise the share/contribution that rainfed agriculture make to the overall economy. This could be possible by increasing the volume of marketable products for domestic consumers as well as exports by raising productivity. Further, it would also be required to develop and promote agri-business activities for promotion of value added processing for increasing the income of farmers/population of rainfed regions. Most of the commodities produced under rainfed farming system like pulses, oilseeds, cotton etc. undergo processing before they reaches to the

final consumer. However, processing activities of such commodities are generally undertaken away from producing areas because of lack of adequate infrastructure in the region.

5.2.9 Reorientation of Extension System / Institutions

The extension system / institutions working in the rainfed areas needs to be further strengthened for effective transfer of already developed packages of technology. Some modifications in the working and priorities of research and extension institutes may be needed to ensure that the requirements of rainfed agriculture can be met.

5.3 NABARD and Rainfed Agriculture

NABARD, which has been supporting goal of attaining required growth in agriculture in general and in developed irrigated areas in particular, should pay special emphasis in refinancing activities of support of developing rainfed agriculture. It should guide development financial institutes like Commercial Banks and RRB's for assuming greater role in supporting rainfed development projects. It may also provide greater financial support for on farm trials/demonstrations of new rainfed technology NABARD may also identify some of the areas / location specific projects that focus on programmes for increasing productivity or income of whole farm rather the productivity of one or two crops. It may also consider the involvement of NGO's in development projects for rainfed agriculture.

5.4 Summary Conclusions

The cropping pattern of rainfed sector is dominated by coarse cereals of Jowar, Bajra, Maize, Ragi, Gram and Arhar in Pulses, Oilseeds like Groundnut, Sunflower, Soyabean, Cotton, Paddy and Wheat in rainfed sector are minor crops as they are generally cultivated under irrigated sector. As semi-arid tropic states have generally problem of shortage of water, as in most months evapotranspiration ratio exceeds the rainfall, the farmers normally selects the varieties which are generally of short duration requiring less of water and nutrients. The productivity/yield of rainfed sector in SAT states is, therefore, very low which for some of major cereals is just about 40 per cent of the irrigated sector in the same state/region. The difference between the yield of irrigated and rainfed sector for pulses and oilseeds was relatively less being 30 and 60 per cent respectively. The yield of cotton in rainfed sector is almost half of that in irrigated sector.

Though operational/variable cost on some of major yield inputs like fertilizers, seed varieties, irrigation, plant protections chemicals etc. is quite low in rainfed sector but cultivation / production of crops in the rainfed sector requires some extra-cultural operations to conserve the soil moisture. However, there is not much of the difference for fixed items of cost.

Because of low productivity of crops in rainfed sector in SAT states, often the gross value of output do not cover the full economic cost (Cost C_2) of cultivation as Bajra, Maize, Ragi and Moong in Andhra Pradesh, Ragi and Sunflower in Karnataka, Paddy and Maize in Madhya Pradesh, Bajra in Rajasthan and Jower and Bajra in Tamil Nadu. In many of the cases the net income was positive but the margin of profit was relatively low. However, in rainfed sector as use of modern inputs was relatively low. Share of imputed items of cost was higher with relatively low paidout cost (Cost A_2) of cultivation, share of farm business income in the Gross value of output in the rainfed sector is higher than irrigated crops. The required size of holding which yield an income just enough to meet the poverty line varied from about 0.96 hectare in Andhra Pradesh and Tamil Nadu to 1.48 hectare in Gujarat and Rajasthan and 1.68 hectare in Madhya Pradesh. The similar economic holding for Karnataka and Maharashtra was estimated as 1.30 hectares. This estimate of requirement of holding size was when it considered, (a) Income from Live-stock as a part of holding and (b) holding contain part of parcels as irrigated as average percentage of irrigated area in the state. If holdings were wholly rainfed, the required size of holding to yield an income to meet the poverty line varied from 1.40 to 1.60 hectare in Andhra Pradesh, Karnatakam, Maharashtra and Tamil Nadu, whereas it ranged between 1.80 - 2.0 hectare in Madhya Pradesh, Rajasthan and Gujarat.

Economically viable size holdings defined as those that could provide an income enough to meet the requirement of both the family and farm and be in a position to take up some farm development. The viable economic size of farm in rainfed states varied from 2.74 hectare in Madhya Pradesh and Rajasthan to 3.7 hectare in Andhra Pradesh, Karnataka and about 4.50 hectare in Tamil Nadu and Maharashtra. The size of viable economic holding was influenced by the cropping pattern, level of productivity, farm business income and cropping intensity. In Gujarat because of low farm business income per hectare and lowest cropping intensity, but relatively high per capita income in the State, the viable economic size of holding in the rainfed sector was estimated as larger at 5.6

hectare. It was further observed that in practically all the rainfed SAT states, the marginal and small holding are not economically viable units and only one fourth of the semi-medium holdings are viable in the SAT states except in Gujarat and Tamil Nadu where viable units are still larger.

The major constraints of rainfed farming in SAT states is higher dependence on rainfall and shortage of water in root zone of crops. The share of irrigated area to total area under some of the principal crops is 1-5 per cent only. The use of fertilizers in many of SAT states is less than half or even one-third of the recommended level of application. Because of low level of application of yield raising modern inputs and traditional practices of farming, the yield and value productivity per hectare of the rainfed crops in SAT states is generally low. Besides farmers are constrained of poor bargaining powers in terms of acquiring funds, marketing of produce and price determination as market intervention by the government for rainfed crops is not on the scale as for major irrigated crops of rice, wheat and sugarcane.

It is observed that there is large scope of raising the productivity and economic viability of rainfed farming in SAT as demonstrated under coordinated Research Project on dry land agriculture and Front Line Field Level Demonstration of the ICAR on coarse cereals, pulses and oilseed under rainfed conditions in SAT states. Water shed based technology which encompasses system of efficient land and rain water also had shown that yield of crops with improved technology could be raised to about two times than the yield of traditional farmers of the same region.

The farmers of SAT states particularly rainfed, requires more credit and better market and price supports. The market intervention for most of rainfed crops in SAT states in terms of procurement and price support is inadequate. Further rainfed crops are more prone to risk from shocks of international prices as their competitiveness is at margin. There is need to improve the efficiency of resource use to reduce the cost of production of the rainfed crops like Oilseeds, Cotton and Coarse Cereals to protect the farmers in SAT states. Further in order to reduce the risk of yield and price fluctuations, besides new Agricultural Insurance Scheme, the newly introduced Minimum Income Insurance Scheme based on MSP and actual yield started for wheat and paddy be also extended to major coarse cereal crops of Jower and Bajra in SAT States on pilot basis.

Further to improve the economic state of rainfed farmers, it would be desirable to raise their marketable surplus by improving productivity and promoting the agri-business activities in rainfed areas to promote value added processing for increasing the income in the sector. The reorientation of extension system and other institutions working in the rainfed areas may also be needed including their strengthening so that the requirement of the sector can be met. NABARD may have to pay special attention in refinancing activities for support of developing rainfed agriculture and may provide guidance to development financial institute like Commercial Banks and RRB's for assuming greater role in supporting rainfed agriculture. NABARD may also help in identifying some of the areas / location specific projects for raising the income of the whole farm rather than productivity of individual crops.

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Annexure I : List of Districts Under Semi-ARID Regions

Sl. No.	State/ District	Net Sown Area 000 hect.	Gross Cropped Area 000 hect.	Cropping Intensity	Net Irrigated Area in per cent	Normal South West Monsoon Rainfall mm
ANDHRA PRADESH						
1.	Nizamabad	252.3	387.9	153.7	63.0	964
2.	Krishma	479.2	739.1	154.2	68.8	681
3.	Guntur	616.1	870.8	141.3	56.3	534
4.	Neelona	319.8	360.7	112.8	84.9	334
5.	Chifforn	477.2	540.5	113.2	38.0	387
6.	Cuddapah	401.3	457.4	113.9	39.5	382
7.	Anansapur	1012.4	1065.2	105.2	14.3	311
8.	Kurnool	899.9	1018.5	113.2	19.9	460
9.	Mahbub Nagar	796.3	864.5	108.5	22.3	588
10.	Hyderabad	0.2	0.2	100.0	100.0	609
11.	Medak	451.8	543.4	120.2	31.3	752
12.	Adilabad	457.1	578.2	105.7	14.3	944
13.	Karim Nagar	395.7	579.8	146.5	67.4	813
14.	Warangal	523.7	648.8	123.9	57.3	850
15.	Khammen	460.7	503.9	109.4	42.7	899
16.	Nalgonda	567.6	724.3	127.6	39.4	534
		8201.3	9883.2	120.5	38.5	
GUJARAT						
17.	Surat	422.0	469.4	111.2	49.9	137.2
18.	Sabarkantha	449.0	557.4	124.1	42.6	789
19.	Bhavnagar	635.2	686.2	108.0	25.9	570
20.	Bulsar	308.6	353.5	114.5	41.6	1946
21.	Banaskantha	819.2	1133.1	138.3	44.1	585

Sl. No.	State/ District	Net Sown Area 000 hect.	Gross Cropped Area 000 hect.	Cropping Intensity	Net Irrigated Area in per cent	Normal South West Monsoon Rainfall mm
22.	Baroda	526.7	561.8	106.6	35.7	928
23.	Ahmedabad	577.0	625.8	108.4	30.0	634
24.	Mehsana	709.0	903.9	127.5	54.7	645
25.	Kaira	506.9	635.1	125.3	60.8	834
26.	Rajkot	737.4	808.1	109.6	20.1	574
27.	Jamnagar	585.5	665.3	113.6	14.6	441
28.	Amreli	495.8	526.1	106.1	16.5	524
29.	Surender Nagar	690.0	721.4	104.5	18.4	499
30.	Junagarh	587.2	671.2	114.3	25.9	794
31.	Panch Mahals	473.1	615.7	130.1	25.5	957
32.	Broach	414.2	416.8	100.6	22.1	820
		8874.5	10350.9	116.6		
KARNATAKA						
33.	Raichur	531.9	642.3	120.7	23.6	469
34.	Shimoga	213.6	248.1	116.2	61.2	2669
35.	Bellary	499.2	583.6	116.9	30.4	374
36.	Mysore	395.4	486.2	122.9	30.4	346
37.	Mandya	248.8	297.5	119.6	40.9	297
38.	Chitradurga	426.3	485.1	113.8	12.7	270
39.	Belgaun	858.6	988.5	115.1	37.9	574
40.	Gulbarga	1183.0	1420.1	120.0	14.0	630
41.	Bidar	379.4	463.7	122.2	9.8	720
42.	Bijapur	794.6	873.1	109.8	15.3	419
43.	Tunkur	614.2	658.0	107.1	18.3	317
44.	Dharwad	326.7	463.4	141.8	12.1	458

Sl. No.	State/ District	Net Sown Area 000 hect.	Gross Cropped Area 000 hect.	Cropping Intensity	Net Irrigated Area in per cent	Normal South West Monsoon Rainfall mm
45.	Chickmanglur	292.6	321.7	109.9	8.9	1799
46.	Hassan	375.5	433.1	115.3	20.7	583
47.	Kolar	386.0	415.8	107.7	21.2	382
48.	Bangalore	380.2	418.6	110.0	37.9	427
		7906.0	9198.8	116.3	21.5	
MADHYA PRADESH (including CHHATISHGARH)						
49.	Ujjain	480.1	819.5	170.6	54.4	846
50.	Hoshangabad	293.6	418.3	142.5	79.1	1325
51.	Sehore	376.7	578.0	153.4	45.5	1127
52.	Dewas	373.5	590.5	158.1	42.4	983
53.	Dhar	505.3	731.6	144.8	46.0	802
54.	Shajapur	442.3	720.5	162.8	48.8	941
55.	Mandsaur	350.9	570.0	162.4	44.4	814
56.	Ratlam	325.0	518.6	159.5	44.8	922
57.	Tikamgarh	263.4	398.6	151.3	67.5	971
58.	Raipur	550.4	650.0	118.2	49.8	1098
59.	Rajgarh	414.7	603.3	145.5	40.8	922
60.	Shivpuri	413.5	532.2	128.7	40.3	814
61.	Bilaspur	371.9	482.5	129.7	34.4	1095
62.	Indore	257.1	448.5	174.4	62.2	876
63.	Khargone	411.0	484.0	117.7	42.7	753
64.	Chhatarpur	383.4	484.4	126.3	44.2	985
65.	Khandwa	438.3	543.6	124.0	34.4	858
66.	Raisen	426.2	551.4	129.4	34.6	1148
67.	Vidisha	530.6	637.7	120.2	27.1	1043

Sl. No.	State/ District	Net Sown Area 000 hect.	Gross Cropped Area 000 hect.	Cropping Intensity	Net Irrigated Area in per cent	Normal South West Monsoon Rainfall mm
68.	Betul	407.1	531.8	130.6	25.6	962
69.	Damoh	302.3	389.1	128.7	26.9	1089
70.	Guna	633.7	745.9	117.7	24.3	968
71.	Sagar	531.9	689.0	129.5	31.6	1087
72.	Jhabua	361.8	474.4	131.1	22.3	792
73.	Durg	548.2	730.8	133.3	31.0	1043
74.	Chhindwara	495.9	615.5	124.1	24.2	1020
75.	Mandla	198.0	262.3	132.5	6.8	1289
76.	Raigarh	283.3	302.4	106.7	12.9	1327
77.	Surguja	489.4	559.7	114.4	5.2	117.9
78.	Satna	362.2	488.1	134.7	29.4	951
79.	Panna	243.2	284.0	116.7	20.7	1100
80.	Shahdol	359.9	462.9	128.6	4.9	1061
81.	Jabalpur	278.6	368.6	132.3	33.3	1289
82.	Sidhi	377.0	368.5	134.9	13.3	1041
		13480.4	18236.7	135.3	35.3	
MAHARASHTRA						
83.	Satara	577.8	690.3	119.5	30.5	1014
84.	Akola	818.5	1069.9	130.7	2.6	710
85.	Yeotmal	849.9	980.2	115.3	5.2	888
86.	Buldhana	692.9	843.2	121.7	5.6	860
87.	Parbhani	825.7	1317.5	159.5	7.9	790
88.	Aurangabad	702.5	1018.7	145.0	23.5	605
89.	Chandrapur	459.6	558.1	121.4	21.5	1161
90.	Osmanabad	507.5	721.6	142.8	20.0	648

Sl. No.	State/ District	Net Sown Area 000 hect.	Gross Cropped Area 000 hect.	Cropping Intensity	Net Irrigated Area in per cent	Normal South West Monsoon Rainfall mm
91.	Wardha	366.5	387.0	105.6	5.5	905
92.	Nanded	710.6	819.2	115.3	8.2	836
93.	Sangli	591.7	680.0	114.9	20.5	486
94.	Solapur	1037.7	1123.5	108.2	20.8	477
95.	Dhulia	734.7	818.1	111.3	14.0	601
96.	Ahmednagar	1145.6	1450.7	126.6	25.1	436
97.	Beed	778.2	930.5	119.6	26.1	577
98.	Amravati	752.0	1024.2	136.7	7.8	828
99.	Nagpur	547.6	591.8	108.1	18.6	956
100.	Thane	244.6	260.6	106.5	5.9	
101.	Jalgaon	850.5	1309.0	153.9	16.7	662
102.	Pune	977.2	1171.7	119.9	23.6	859
103.	Nasik	886.6	974.2	109.9	20.5	900
		15057.9	18742.0	124.4	15.9	
RAJASTHAN						
104.	Bundi	259.4	387.2	149.3	68.8	730
105.	Kota	275.0	414.2	150.6	77.3	732
106.	Chittorgarh	397.4	623.4	156.8	36.7	774
107.	Sirohi	145.6	200.2	137.5	54.1	840
108.	Bhilwara	350.8	509.4	145.2	38.1	648
109.	Tonk	485.0	604.0	124.6	36.5	588
110.	Pali	598.9	756.1	126.2	30.1	467
111.	Banswara	231.1	352.1	152.1	52.3	893
112.	Jhalawar	312.5	506.2	161.9	49.8	911
113.	Jalore	542.9	706.6	130.1	28.7	408

Sl. No.	State/ District	Net Sown Area 000 hect.	Gross Cropped Area 000 hect.	Cropping Intensity	Net Irrigated Area in per cent	Normal South West Monsoon Rainfall mm
114.	Udaipur	243.4	357.9	147.0	32.1	575
115.	Ajmer	411.6	578.9	140.6	27.9	430
116.	Dungarpur	116.8	180.2	154.2	28.3	699
		4370.8	6207.1	142.0	42.5	
TAMIL NADU						
117.	Thanjavur	201.8	268.2	132.9	85.8	323
118.	North Arcot					
119.	Ram Nathaopuram	189.0	189.0	100.0	38.5	126
120.	Coimbatore	328.7	354.2	107.7	49.9	193
121.	Trichelveli Katta Baimman	164.1	194.7	118.6	68.9	113
122.	Trichurapalli	185.2	201.1	108.6	55/1	258
123.	Salem	253.6	365.2	144.0	43.9	487
124.	Madhurai	164.4	177.0	107.6	65.7	270
125.	Kanyakumari	82.6	100.6	121.8	35.1	460
126.	The Nilgiris	77.4	77.9	100.6	1.0	815
		1646.8	1927.9	117.1	53.1	

**Annexure II : List of Districts Classified as
Semi-ARID in Other States**

Sl. No.	State / District
	BIHAR/ JHARKHAND
1.	Shahabad
2.	Patna
3.	Gaua
4.	Monghyr
5.	Bhagalpur
6.	Palamau
7.	Sainthal Pargana
8.	Ranchi
9.	Hazaribag
10.	Dhanbad
	ORISSA
11.	Sambalpur
12.	Sundergarh
	UTTAR PRADESH
13.	Jhansi
14.	Mirzapur