Rural Livelihoods in Dry Lands of India: A Sustainable Livelihoods Framework

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RESEARCH UNIT FOR LIVELIHOODS AND NATURAL RESOURCES
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Foreword

The Centre for Economic and Social Studies (CESS) was established in 1980 to undertake research in the field of economic and social development in India. The Centre conducts interdisciplinary research in the areas such as rural development, poverty, agriculture and food security, irrigation and water management, public finance, demography, health, environment and other studies. The Centre's focus has been on policy relevant research through empirical investigation with sound methodology. Being a Hyderabad based think tank, it has focused on, among other things, several distinctive features of the development process of Andhra Pradesh, though its sphere of research activities has expanded beyond the state, covering other states apart from issues at the nation level.

Dissemination of research findings to fellow researchers and policy thinkers is an important dimension of policy of relevant research which directly or indirectly contributes to policy formulation and evaluation. CESS has published several books, journal articles, working papers and monographs over the years. They provide an opportunity for CESS faculty, visiting scholars and students to disseminate their research findings in an elaborate form.

The CESS has established the Research Unit for Livelihoods and Natural Resources (RULNR) in the year 2008 with financial support of Jamsetji Tata Trust. The core objective of the RULNR is to conduct theoretical and applied research on policy relevant issues on human livelihoods and natural resource management, especially in areas related to river basins, forest and dryland ecosystems and to provide an effective platform for debates on policy relevant aspects for academicians, policy makers, civil society organisations and development practitioners. RULNR intends to adopt a multi-disciplinary approach drawing on various disciplines such as ecology, economics, political science, and social anthropology.

The present CESS-RULNR monograph by P. Aparna on rural livelihoods in dry lands of India makes an attempt to assess the status of assets of households living in dry lands based on secondary data covering 211 dry land districts of the country. It shows that the asset position of households in these districts is not strong enough to support them in the event of risk and uncertainty. It finds that with regard to the status of various household assets, a majority of these districts fall in the category of middle level of development in India. While incidence of poverty is lower in dry land areas as compared

to other areas, areas cultivating rice and wheat, experience high incidence of poverty. The author argues for increasing the irrigation facilities and farm productivity for poverty reduction. The threat of resource degradation in these areas is increasing due to excessive use of groundwater, chemicals and fertilizers and calls for new policy initiatives.

I hope that this monograph will help in formulation of policies for strengthening the asset position of dry land areas.

Manoj Panda
Director, CESS

CONTENTS

Sl. No.		Page No.
	Foreword	*iii*
	List of Tables and Figures	*vii*
	Acknowledgements	*x*
	Executive Summary	*ix*
Chapter I	**Sustainable Livelihood Approach and Dry Lands**	**1-19**
1.0	*Introduction*	1
1.1	*Challenges of Livelihoods in Dry Lands of India*	*2*
1.2	*Objectives of the Study*	*7*
1.3	*Dry Land Areas in India*	*7*
1.4	*Dry Land Typologies*	*12*
1.5	*Basic Features of Dry Lands*	*15*
1.6	*Structure of the Report*	*19*
Chapter II	**Sustainable Rural Livelihoods: Status of Assets**	**20-36**
2.1	*A Framework for Livelihoods Analysis*	*20*
2.2	*Asset Framework*	*23*
2.3	*Methodology*	*25*
2.4	*Status of Assets*	*26*
2.5	*Different Stages of Development*	*33*
2.6	*Relationship between Livelihood Capitals*	*34*
2.7	*Summary*	*35*
Chapter III	**Poverty in Dry Land Areas**	**37-53**
3.1	*Introduction*	*37*
3.2	*The Link between Poverty and Environmental Degradation*	*37*
3.3	*Link between Agricultural Intensification and Environmental Degradation*	*38*
3.4	*Programmes for Poverty Alleviation*	*39*
3.5	*Methodology*	*39*
3.6	*Poverty in Dry Land Areas*	*41*

3.7	*Environmental Degradation in Dry Lands in India*	*50*
3.8	*Summary*	*52*
Chapter IV	**Agricultural Intensification in Dry Lands of India**	**54-67**
4.1	*Introduction*	*54*
4.2	*Objectives and Methodology*	*57*
4.3	*Agricultural Intensification in Dry Lands*	*57*
4.4	*Cropping Pattern*	*61*
4.5	*Land Productivity*	*64*
4.6	*Summary*	*66*
Chapter V	**Summary and Conclusions**	**68-73**
5.1	*Introduction*	*68*
5.2	*Dry Land Areas*	*68*
5.3	*Dry Land Typologies*	*69*
5.4	*Socio-Economic Profile of Dry Lands*	*69*
5.5	*Status of Assets*	*70*
5.6	*Poverty and Environmental Degradation*	*71*
5.7	*Livelihood Strategies: Agriculture*	*72*
5.8	*Measures for Sustainable Agricultural Development and to Alleviate Poverty*	*73*
	References	*74-78*

List of Tables and Figures

Sl. No.		Page No.
1.1	Area under Agro-Ecological Regions by Different Sources 2001	8
1.2	State-wise List of Districts having Dry Land Areas	10
1.3	Crop-based Distribution of Districts	13
1.4	Irrigation-based Distribution of Districts	14
1.5	Occupation-based Typology	15
1.6	Density of Population based on Crop Cultivation	15
1.7	Density of Population based on Irrigation	16
1.8	Density of Population by Occupation	16
1.9	Crop-based Sex Ratio	17
1.10	Irrigation-based Sex Ratio	17
1.11	Crop-based Female Literacy	17
1.12	Irrigation-based Female Literacy	18
1.13	Occupation-based Female Literacy	18
1.14	Scheduled Caste Population	18
1.15	Scheduled Tribe Population	19
2.1	Indicators of Livelihoods Capitals	24
2.2	Human Capital across the Regions	27
2.3	Human Capital Index	27
2.4	Natural Capital across the Regions	29
2.5	Physical Capital across the Regions	31
2.6	Financial Capital across the Regions	31
2.7	Social Capital across the Regions	32
2.8	Composite Indices of Capitals across the Regions	33
2.9	Number of Districts on the basis of Ranks for Human Capital	33
2.10	Number of Districts on the basis of Ranks for Natural Capital	34
2.11	Number of Districts on the basis of Ranks for Physical Capital	34
2.12	Number of Districts on the basis of Ranks for Financial Capital	34

2.13	Number of Districts on the basis of Ranks for Social Capital	34
2.14	Relationship between Natural Capital and other Capitals	35
3.1	Distribution of Rural Population and Poor across Dry Land Areas 2004-05	41
3.2	Incidence of Poverty across Dry Land Areas 2004-05	42
3.3	Severity of Poverty across Dry Land Areas 2004-05	43
3.4	Inequality in Consumption Expenditure and Average MPCE	44
3.5	Incidence of Head Count Poverty across Social Groups 2004-05	45
3.6	Incidence of Head Count Poverty across Occupational Groups 2004-05	46
3.7	Crop-based Incidence of Poverty in Dry Land Areas 2004-05	47
3.8	Crop-based Incidence of Poverty in Arid Areas 2004-0	47
3.9	Crop-based Incidence of Poverty in Semi-Arid Areas 2004-05	47
3.10	Crop-based Incidence of Poverty in Dry Sub-Humid Areas 2004-05	48
3.11	Poverty and Livelihood Development	49
3.12	Distribution of Estimated Area under Different Problems	50
3.13	Distribution of Estimated Area under Degradation in Dry Land States	51
4.1	Percentage of Area under Crops Cultivated using Technology	58
4.2	Percentage of Improved Seeds Area by Type of Seed	59
4.3	Percentage of Improved Seeds Area by Crop	59
4.4	Percentage of Area under Manure by Type of Manure	60
4.5	Estimates of Irrigation Ratio from Different Sources	61
4.6	Cropping Pattern in Dry Land Areas	62
4.7	Cropping Pattern in High Irrigated Areas	63
4.8	Cropping Pattern in Less Irrigated Areas	64
4.9	Important Crops across Zones	64
4.10	Productivity of Important Crops in Dry Lands TE 2006	65
4.11	Index of Yield Instability in Dry Land Areas 1999-2006	66

List of Figures

Sl. No.		Page No.
1	Distribution of Arid Area by States	11
2	Distribution of Semi-Arid Area by States	11
3	Distribution of Dry-sub-humid Area by States	11

List of Appendix Tables

1	List of Districts in Arid Area	79
2	List of Districts in Semi-Arid Area	80
3	List of Districts in Dry-sub-humid Area	84

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Executive Summary

Livelihood security and environmental sustainability are the two important challenges of the developing countries. Livelihood security comprises attributes related to the level of income, stability of income, and reduction in the overall risk profile of households. Environmental sustainability refers to the stability of resources such as soils, water, rangeland, forests and biodiversity. In the process of making a livelihood, people use resources extensively without paying attention to the consequence of their actions. Population pressure, construction of dams, establishment of plantation forests etc diminish their access to resources. As a result, they may cut down forests for agricultural land and fuel wood, which can lead to soil degradation, loss of soil nutrients, flooding, sinking of groundwater levels, siltation of rivers and lakes, and other ecological problems, thus initiating a vicious spiral of environmental degradation and poverty. Excessive use of water, overgrazing, and untimely applications of fertilizers can also lead to environmental degradation. Thus, meeting current and future food needs may be in conflict with the goal of protecting the productive capacity of the natural resource base.

Fragile environment on one hand and growth of population, inequality, poverty, and the rising consumer demand, etc., on the other pose severe threat to the livelihood strategies of rural people in the dry land areas of the country. The human well-being in dry lands is low because the natural rate of provision of ecosystem services is inherently low.

The main objectives of the study are to examine the asset status of rural people, poverty mapping and intensification of agriculture, changes in cropping pattern and agricultural productivity in the dry lands of India.

The study followed the National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) classification to identify the dry lands of the country. NBSS & LUP classified the country into 20 Agro-Eco Regions (AER) and 60 Agro-Eco Sub-Regions (AESR) on the basis of soil, bio-climatic type, and physiographic situations. The agro-ecological regions fall into six major bio-climatic regions. They are Arid, Semi-Arid, Dry-sub-humid, Moist-sub-humid, Humid, Per-humid. The first three regions i.e. Arid, Semi-Arid and Dry-sub-humid constitute the dry land areas. There are 211 dry land districts in India, of which, arid area comprises 25 districts, semi-arid area comprises 131, and dry-sub-humid area consists of 55 districts. Overall, there are 11 states in India which have dry land districts. On the basis of cropping pattern, ratio of irrigated area and percentage of workers in agriculture, the study classified the 211 dry land districts into

crop-based, irrigation based and occupation based typologies. The study used the Sustainable Livelihoods framework to analyse the status of assets in dry land areas. The unit record data available in CD-ROMs of the National Sample Survey Organisation (NSSO) was used for the data on the five capitals namely human, natural, physical, financial, and social. Based on the UNDP methodology for constructing Human Development Index, a dimension index is created for each of the indicators of the five capitals.

Using one time point data, the study seek to understand the status of assets across the dry zones. The performance of all the capitals across the zones reveals that the values of human and natural capital are higher in all the zones irrespective of their irrigation status. The relative development of the districts in all the three regions has been compared on the basis of the values of the mean and standard deviation of the composite indices. In all the regions across the high and less irrigated tracts and for all capitals, more number of districts fall in the middle level of development. Natural capital is positively and significantly related to human capital in all irrigated tracts of dry land zones. For physical capital, except for the arid zone there is a positive association. There is a negative relationship between natural capital and social capital but the relationship is not statistically significant. Overall the asset position of households in the dry zones is not very strong to support them in the event of risk and uncertainty. However, the positive relationship between natural, human and physical capital suggests that better use and enhancement of available natural resources will improve the asset position of these households.

Poverty has been examined in terms of extent, intensity, severity and consumption inequalities. The analysis is based on unit record data of the 61st Round (2004-05) of the National Sample Survey (NSS) on Consumer Expenditure. The incidence of poverty is lower in the dry land areas as compared to the all-India level. However, the less irrigated areas in the dry land zones have shown higher incidence of poverty. Apart from incidence, other measures such as severity, intensity, and inequality of consumption expenditure are also high in these areas. Further, it has been observed that where the agricultural productivity is higher, the incidence of poverty is lower. Incidence of poverty is lower in the areas with high livelihood development index. However, there are inter-regional differences in this regard. This is clearly seen in the irrigated and less irrigated districts of Madhya Pradesh. Thus, increase in the level of irrigation and productivity leads to reduction in poverty. However, high irrigation and application of fertilizers and other materials to increase productivity result in environmental degradation. Thus, the resources must be managed efficiently to avoid such degradation.

Technology, price policy, and irrigation have changed the cropping pattern from coarse cereals and pulses to rice and wheat. The study observed that higher productivities of all crops in areas with high irrigation level. The instability is also found to be low in these areas. Agricultural intensification is being rapidly practiced in the dry land zones. The area under improved seeds and modern inputs has been very high in the arid and semi-arid zones as compared to all-India. Intensification of agriculture increases productivity, but excessive use will create environmental as well as socio-economic problems. The approach to dry farming technology suffers from inadequate analysis of the physical environment and indifference to farmer circumstances. There is a need for devising region-specific policies apart from increasing public investment in irrigation, infrastructure, agricultural research, and extension.

CHAPTER - I
Sustainable Livelihood Approach and Dry Lands

1.0 Introduction

The concept of sustainable development was evolved as a compromise between the two contradictory aims of developed and developing countries. From the perspective of developed countries, sustainable development implies conserving the environment while from the perspective of developing countries it means continued pursuit of development with the aim of reducing poverty. The contradiction between the two interpretations of political ideal of sustainable development persisted at the World Commission on Environment and Development (WCED) in 1987, the UN Conference on Environment and Development (UNCED) in 1992, and at the World Summit on Sustainable Development (WSSD) in 2002. The lack of universal agreement over the definition of sustainable development resulted in different interpretations both as a political ideal and as a theoretical concept (Alan Grainger, 2005). Though the debate on 'sustainability' has created a great deal of concern, there has been very little progress in making the concept operational (Jodha, 1991). The trade-off between sustainable development and livelihoods raised many issues such as food security of the present generation versus that of the future generation, economic development policy versus environmental damage, etc. (Acharya, 2004).

The Millennium Ecosystem Assessment Report (MA, 2005) argues that provision of ecosystem services is crucial for attaining sustainable human livelihoods. It categorized ecosystem services into supporting, provisioning, regulating and cultural services. The natural process of nutrient cycling through macro decomposers that are less water-sensitive is disturbed by excessive use of land for livestock grazing and crop production. The moisture in soil which is an important factor for nutrient cycling is affected by the slow process of soil formation in dry land areas. The soils have low water holding capacity and are deficient in organic matter and several nutrients, and therefore cannot support high crop yields on sustained basis. The destruction of vegetation and the removal of crust by trampling in arid and semi-arid dry lands lead to increased surface reflection of radiation and reduced rainfall. Lower rainfall further reduces soil moisture and vegetation cover and induces further degradation in service provision. The report defines human well-being as a composite of the basic materials for a good life viz., freedom and choice,

health, good social relations, and security. These are directly linked to the availability of ecosystem services. It is pointed out that human well-being in dry lands is low because the natural rate of provision of ecosystem services is inherently low.

Fragile environment on one hand and growth of population, inequality, poverty, and the rising consumer demand, etc., on the other pose severe threat to the livelihood strategies of rural people in the dry land areas of the country. The present chapter examines the conditions and trends prevailing in the dry lands of India in Section I. The Sustainable Livelihoods Framework (SLF), which enables better understanding of the causes of poverty, is also presented in this section. The objectives of the study are discussed in Section II. Classification of dry land areas in the country is given in Section III. The study brings out dry land typologies based on the cropping pattern, irrigated area, and occupation. Classification of dry land districts on the basis of the above typologies is discussed in Section IV. The basic features of dry land areas in the country are presented in Section V. Finally, Section VI describes the structure of the report.

1.1 Challenges of Livelihoods in Dry Lands of India

1.1.1 Water Scarcity and Droughts

Water scarcity has been the most critical constraint in dry land agriculture. This is caused by the low and erratic rainfall, lack of proper harvesting, storage and conservation of rain water, increased over-exploitation of both surface and groundwater resources, lack of proper allocation and inefficient use of water, lack of well-defined property rights in water backed by law, and shortcomings in the design and implementation of drought relief programs (ICRISAT, 2005). The dry land areas in India are prone to drought once in every three years. The areas which are most vulnerable to droughts include western Rajasthan, eastern Rajasthan, Saurashtra, Kutch and north Gujarat, western Uttar Pradesh, Tamil Nadu, and Rayalseema and parts of Telangana in Andhra Pradesh.

1.1.2 Groundwater Exploitation

Recent trends in irrigation show the distortion in the development and utilization of water resources for agricultural purposes. Two-thirds of the net irrigated area in the country is under wells and tube wells. The reasons for growing dependence on ground water resources could be the decline in public investment in irrigation in 1990s, extension of Green Revolution technologies to rain-fed and dry regions, and neglect of small surface water harvesting systems such as tanks (Reddy D and Srijit Mishra, 2009). Another dimension of this problem is that the regions with high groundwater potential remain under utilized due to availability of cheap canal water, while in dry regions there has been over-exploitation of groundwater. The authors argue that watershed programmes

have not made much progress except in a few pockets and an added problem is that the traditional water harvesting structures have become defunct.

1.1.3 Land Degradation and Poor Quality of Soils

Land degradation is a serious problem in India. The extent of human-induced soil degradation in India has been estimated at 188 million hectares which accounts for 60 percent of the total geographical area. The magnitude of loss is high in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Rajasthan, Tamil Nadu, and West Bengal. Most of the states mentioned above have extensive semi-arid areas (Sudhakar Reddy, 2007). India has been giving priority to watershed development programmes which are crucial for reversing land degradation and raising land productivity in rain-fed agriculture. However, evaluation studies on this programme expressed doubts about the sustainability of the programme (Deshpande *et al.*, 1999).

Increasing demographic pressure on land resulted in undue stress on land resources and reduced the size of holdings to uneconomic levels. The proportion of marginal farmers operating less than one hectare of land is increasing at a faster rate. This has resulted in wide variations in income and living standards of cultivators. Excessive and unbalanced use of fertilizers and pesticides caused adverse effect on soil fertility (Reddy D and Srijit Mishra, 2009).

1.1.4 Sustainability of Agriculture in Dry lands

Raising agricultural productivity without endangering sustainability poses a serious challenge from two factors, namely, the growing pressure of population on land and the deteriorating quality of land resources (Vyas VS, 2003).

The prospects of sustainability for agriculture in the fragile areas are severely constrained by the specific features of their natural resource endowments. Every land resource is fragile, i.e., vulnerable to irreversible damage, when subjected to intensive use beyond its carrying capacity. The conflict between short-term intra-generational issues of poverty and inequality and long-term inter-generational issues of sustainability are quite apparent in these areas (Jodha, 1991). However, owing to the heterogeneity of habitats, agriculture in these areas is also endowed with a complex of varied opportunities for land-based activities. But being too diverse and narrow, and being constrained by marginality and inaccessibility, they cannot impart the benefits of large-scale operations.

1.1.5 Agricultural Strategy for Dry Land Areas

India has a long history of government intervention in dry land agriculture. Several national level programs such as the Drought Prone Area Programme (DPAP), Desert Development Programme (DDP), and poverty alleviation and employment generation

programs were launched by the Government of India. However, despite all these interventions, dry land agriculture did not attain much progress.

While presenting a theoretical perspective on policy making, Deshpande and Raju (2011) argued that India never had a formal and comprehensive policy on agriculture since independence. The policy is always a problem solving step taken in the context of severity of the issue; the policies did not address any long term issue facing the sector. Further, there has been a lack of coordination between the Centre and the States to achieve a well-defined set of policy objectives. They say that there was no serious effort to formulate a policy till the New Agricultural Policy (NAP) came into being in 2000.

The National Rain-fed Area Authority (NRAA) observed that there have been similarities in the development processes of various ministries and service providers. The main task of the NRAA is to pool all these programmes on watershed development and rain-fed agriculture and evolve common guidelines.

The dry land areas in India are highly heterogeneous in terms of natural and human resource endowments, types of farming systems, levels of living, livelihood patterns, and infrastructure. In view of this no uniform strategy would be appropriate for dry land areas as a whole.

1.1.6 Livelihood Diversification

Livelihood diversification is an important adaptive strategy in the dry land areas for raising incomes and reducing risk. Diversification can be on-farm diversification or can move away from farm into non-farm sector. On-farm diversification is of two types: one is the adoption of inter-cropping and mixed cropping, and the other is the combination of crop and livestock activities (Ellis, 2000). Many studies have demonstrated that mixed cropping reduces the adverse impacts of unseasonal temperatures and rainfall failure. The farmers on their own have tried product mixing by introducing crops or engaging in enterprises which could enable them to spread out the risks and ensure a steady flow of income, though not all of them succeeded in achieving this objective. In the absence of a steady flow of income, the non-poor households suffer from destitution and deprivation in different seasons. This gives rise to the problem of transient poverty (Vyas, 1996).

People in dry land areas face droughts quite often and adopt many strategies to cope with the droughts and their consequences. The evidences from micro-level studies (Laxmaiah and Vijayaraghavan, 2003; ICRISAT, 2005; and CESS, 2002) show that on-farm diversification is not seen as a prominent strategy during drought in many of the dry land areas. Drought-affected people mainly resort to borrowing, drawing down

of stocks, reduced consumption, shifting to low cost food items, and migration. All the risk management responses are coping rather than reducing and mitigating in nature.

1.1.7 Poverty and Environment

The poor are charged with over-exploitation and consequent degradation of natural resources. Poverty is seen as both a cause and an effect of natural resource depletion, in a downward spiral. Increasing population density and the consequent landlessness push people into marginal zones that cannot sustain permanent cultivation. People tend to depend more on gathering activities from the environment. The downward spiral occurs because of soil erosion and over-grazed pastures. Poor management of watersheds further intensifies the degree of poverty experienced by marginal groups and drives them towards more intensive exploitation of the resources (Ellis F, 2000). The incidence of poverty in dry land areas is transient in nature and the present situation might get transformed into severe and long duration poverty if the widespread over-exploitation of ground water is not checked (Shah and Baidyanath, 2003). Hence, dry lands characterized by intense poverty must receive more attention in a sustainable development strategy.

1.1.8 Sustainable Livelihoods

After decades of limited success in eliminating rural poverty, a number of international funding agencies are revising their rural development strategies. In order to achieve the target of reducing the number of poor by one-half by 2015, the Department for International Development (DFID) consulted widely to understand the nature of poverty and how it should be addressed. As a result of such efforts, it has brought out a sustainable livelihood framework. The Sustainable Livelihoods (SL) approach based on this framework supports poverty eradication by enhancing poor people's livelihoods (John Fanington *et al.*, 1999).

Robert Chambers and Gordon Conway (1991) proposed the following composite definition of sustainable rural livelihoods which is applied at the household level: A livelihood comprises the capabilities, assets and activities required for a means of living; a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets and provide sustainable livelihood opportunities for the next generation and which contributes net benefits to other livelihoods at the local and global levels in the short and long term.

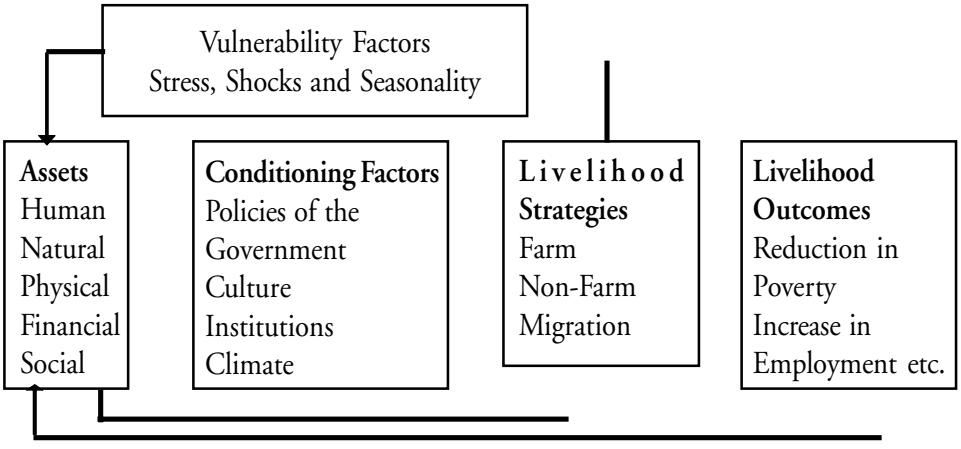
Drawing on Chambers and Conway, the Institute of Development Studies brought out its own definition: A livelihood comprises the capabilities, assets and activities required for a means of living. Scoones (1998) argued that identifying livelihood resources for different livelihood strategies is a key step in the process of analysis. He identified four different types of capital - natural, economic or financial, human, and social capital.

The broad clusters of livelihood strategies identified by the author are agricultural intensification, livelihood diversification, and migration. Further, he adds that understanding institutional processes allows the identification of restrictions and opportunities to sustainable livelihoods. Lasse Krant (2001) points out that of the various components of a livelihood the most complex is the portfolio of assets.

Different agencies used the SL approach as a strategy towards poverty alleviation. While UNDP and CARE have used it to facilitate the planning of projects and programmes, for DFID, the SL approach is more of a basic framework for analysis than a procedure for planning.

According to the SL approach, livelihood comprises the capabilities, assets and activities required for a living. The environmental conditions, programmes, and policies of the government will condition the abilities of the people in converting their assets into activities required for living. The assets have been classified into human, natural, physical, financial and social. A combination of these capitals will enable a household to pursue different livelihood strategies. Further, the outcomes of these strategies must be sustainable. That means, these strategies should enable the households to cope with and recover from stress and shocks and maintain or enhance their assets in the present as well as in the future without destroying the present environmental situation. Thus, there are five key components of the SL framework: livelihood assets, vulnerability of livelihoods to external factors, conditioning variables, livelihood strategies, and livelihood outcomes. A detailed description of the framework is presented in Chapter II.

Sustainable Livelihoods Framework



With this background on the challenges of livelihoods in dry land areas in India, the present study has set the following objectives.

1.2 Objectives of the Study

1. Asset structure is an important part of livelihoods framework. The study aims to examine the asset status of rural people in the dry lands of India.

2. Majority of the people draw their income from agriculture in the dry lands of India. Agricultural intensification is an important livelihood strategy for these people. Hence, the study examines the performance of dry land agriculture in terms of changes in the cropping pattern, yield levels, and fluctuations in the yield for the important crops identified for these areas.

3. The purpose of practicing a livelihood strategy with the help of assets that the households possess is to live a better life. Low incidence of poverty and better environment are the the expected outcomes from these strategies. Poverty-agricultural intensification-environmental degradation is a vicious spiral that poses a challenge for adopting any policy for the development of these areas. The study examines these issues.

1.3 Dry Land Areas in India

The World Atlas Desertification (Middleton and Thomas, 1997) defines dry lands as areas with an aridity index value of less than 0.65; the ratio of the long term average annual precipitation and average annual evapotranspiration is termed as the aridity index. Using these index values, the Millennium Ecosystem Assessment Report (MA, 2005) recognized four dry land subtypes: hyper-arid, arid, semi-arid, and dry-sub-humid. Dry land sub-types can also be described in terms of their land uses as rangelands, croplands and urban areas.

There is no official delineation of dry land regions in India except those adopted for identifying the districts to be covered under the Drought Prone Area Programme (DPAP) and the Desert Development Programme (DDP). Several attempts have been made in India to classify the country into agro-climatic zones. The delineation of climatically homogeneous regions has been an important aspect of agro-climatic analysis. Rainfall and soil types were considered in the attempts made by the National Agricultural Research Project (NARP) in 1979. The National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) of the Indian Council of Agricultural Research (ICAR) classified the country into 20 Agro-Eco Regions (AER) and 60 Agro-Eco Sub-Regions (AESR) on the basis of soil, bio-climatic type, and physiographic situations (Mandal *et al.*, 1999).

The agro-ecological regions fall into six major bio-climatic regions. They are:

1. Arid
2. Semi-arid

3. Dry-sub-humid
4. Moist-sub-humid
5. Humid
6. Per-humid

The areas shown under arid, semi-arid and dry-sub-humid together constitute the dry lands according to the NBSS & LUP, which is the same as that of the Thornthwaite classification. A large number of states fall under this category. However, the entire north-Indian region covering the states of Assam, Meghalaya, Nagaland, Tripura, Manipur, Mizoram, Sikkim, and Arunachal Pradesh, and the state of Uttaranchal of north India do not fall under dry lands. In addition to these, parts of Jammu & Kashmir, Himachal Pradesh, coastal areas of Karnataka, Maharashtra, Goa, and major parts of Kerala, Orissa, West Bengal, and Andaman and Nicobar Islands and Lakshadweep also do not fall within dry land region.

According to the agro-ecological classification of NBSS & LUP, the area under the sub-region codes from 2.1 to 3 is defined as hot arid; from 4.1 to 8.3 is defined as semi-arid; and from 9.1 to 10.4 is defined as dry-sub-humid. These three broad regions are together known as dry land areas of the country. The total area under dry land areas is different in the two sources, i.e., Mandal (1999) and Velayutham (1999), though both of them followed the agro-ecological classification of the NBSS & LUP. According to the former, dry land area is estimated at 223.1 million hectares which comprises 67.9 percent of the total geographical area. As per the latter, it is 57.1 percent of the total area. However, the present study estimate has shown a much lesser area with 48.5 percent (Table 1.1).

Table 1.1: Area under Agro-Ecological Regions by Different Sources: 2001

Agro-Ecological Region	Mandal		Velayutham$		Present Study$	
	Area (in Mha)	Percentage of Total	Area (in Mha)	Percentage of Total	Area (in Mha)	Percentage of Total
Arid	45.6	13.9	36.8	11.2	32.6	9.9
Semi-arid	123.4	37.5	116.4	35.4	96.8	29.4
Dry-sub-humid	54.1	16.5	34.5	10.5	30.2	9.2
Dry land$	223.1	67.9	187.7	57.1	159.6	48.5
Other land	105.6	32.1	141.0	42.9	169.1	51.5
Total	328.7	100.0	328.7	100.0	328.7	100.0

$: Excluding cold arid region.

Velayutham (1999) provides the geographical area and the names of the districts for each sub-region. On the basis of this, we have identified districts from different sub-regions and calculated the total area for broad regions. The reason for the difference in the estimation of area under dry lands between Velayutham and the present study is perhaps because the names of some of the districts were repeated in different sub-regions in the former. For the repeated districts, the broad region code may be same or different. For example, Faridkot District from Punjab is listed in 2.1, 2.3 and in 4.1, of which 2.1 and 2.3 belong to the arid region and 4.1 belongs to the semi-arid region. Since the area of Faridkot is calculated thrice to arrive at the total area, there is over-estimation of the dry land area as per this source. Apart from this, only a part of the district is mentioned in the sub-regions of the broad region codes. For example, part of Jodhpur and Ganganagar districts of Rajasthan are listed in 2.1 and 2.3. Similarly, various villages of Kutch District are formed as sub-regions 2.2 and 2.4. However, the geographical area given against the different parts of the districts listed in different sub-regions cannot be checked due to the difficulty in getting a proper source for that. The present study had taken the names of various districts that fall in different broad regions codes, i.e., arid, semi-arid, and dry-sub-humid from Velayutham (1999), and the area for each district is taken from the 2001 Census. The final list of districts under the different dry land areas is given in Appendix I to III.

In our study, Hyderabad and Chandigarh are not considered for analysis. The former is completely urban and the latter is a Union Territory; they represent a small portion of the total area of the country. Hence, there are 211 dry land districts in India, of which, arid area comprises 25 districts, semi-arid area comprises 131, and dry-sub-humid area consists of 55 districts. Overall, there are 11 states in India which have dry land districts (Table 1.2).

The arid region extends to an area of 32.6 million hectares which constitutes 9.9 percent of the total geographical area of the country. It accommodates 4.1 percent of the total population of the country as per the 2001 Census. The semi-arid region occupies 96.8 million hectares of area which accounts for 29.4 per cent of the total area of the country. It is home to 32.2 percent of the total population. The dry-sub-humid region spreads across 30.2 million hectares which consists of 9.2 percent of the total area and houses 11.1 per cent of total population of the country. Both the area and population are higher in the semi-arid region than that of the arid and dry-sub-humid regions of the country. Thus, the total dry land area of the country is 159.6 million hectares, i.e., 48.5 percent of the total area, and it houses 47.4 per cent of the total population.

Table 1.2: State-wise List of Districts having Dry Land Areas

State	Arid	Semi-Arid	Dry-Sub-Humid	Total Dry Land	Total Districts	Percentage of Total
Andhra Pradesh	1	15	0	16	23	69.6
Bihar	0	0	8	8	38	21.1
Gujarat	3	13	0	16	26	61.5
Haryana	4	0	1	5	21	23.8
Karnataka	5	11	0	16	30	53.3
Madhya Pradesh	0	14	24	38	50	76.0
Maharashtra	0	20	3	23	35	65.7
Punjab	3	5	4	12	20	60.0
Rajasthan	9	15	0	24	33	72.7
Tamil Nadu	0	15	0	15	32	46.9
Uttar Pradesh	0	23	15	38	71	53.5
Overall	25	131	55	211	379	55.7

Around 51 percent of the arid area is situated in Rajasthan; another 22 percent is located in Gujarat, and 14 percent in Karnataka. These three states constitute around 87 percent of the arid area of the country. Further, Andhra Pradesh occupies 6 percent, and Punjab occupies 3 percent of total arid area (Figure 1).

Andhra Pradesh and Maharashtra occupy 20 percent each of the total semi-arid area in the country. Gujarat and Rajasthan contribute 10 per cent; these four states together occupy 60 percent of the total semi-arid area in India. The remaining states namely, Karnataka, Madhya Pradesh, Tamil Nadu, and Uttar Pradesh have an area ranging between 8 and 9 percent of total semi-arid area in the country. Punjab occupies a very small proportion of 2 percent (Figure 2).

Madhya Pradesh occupies 61 percent of total dry-sub-humid area and Uttar Pradesh occupies around 20 percent. Other important states in this category are Bihar, Maharashtra and Punjab with 8, 7 and 4 percent respectively. Haryana occupies a very small proportion of less than one percent of the total dry-sub-humid area in the country (Figure 3).

Figure 1
Distribution of Arid Area by States

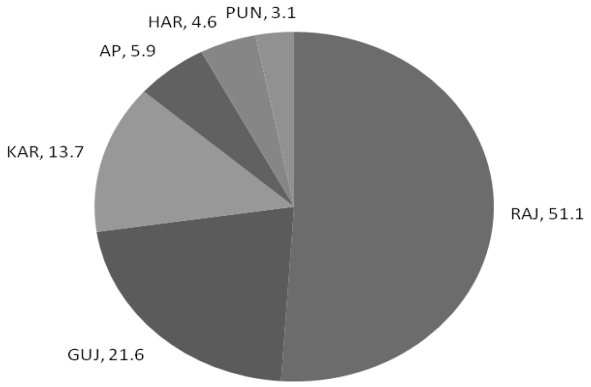


Figure 2
Distribution of Semi-arid Area by States

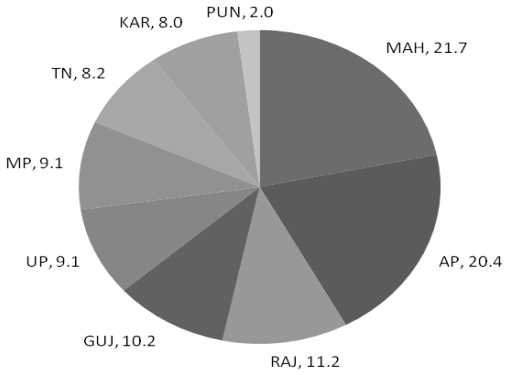
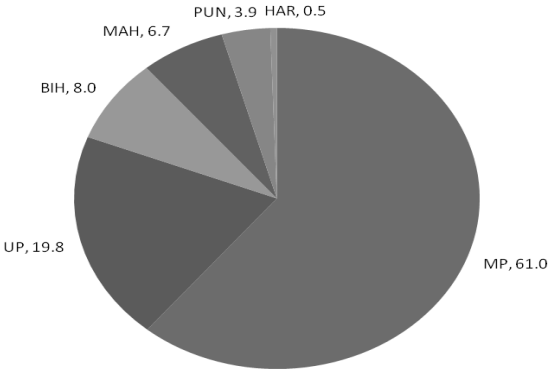


Figure 3
Distribution of Dry-sub-humid Area by States



1.4 Dry Land Typologies

1.4.1 Crop-based Typology

Agriculture practiced in the dry lands was earlier defined by aridity index alone and ignored irrigation. However, there is assured surface irrigation in larger parts of dry lands which alter the basic characteristics of the dry lands; hence, attention has been moved away from the more accepted notion of rain-fed agriculture (Sagar, 2010). The classification of dry land areas by NBSS & LUP fails to account for the importance of socio-economic parameters in land use decisions (Kelly TG, M Jayawant and P Parthasarathy Rao, 1997). The authors further argue that both natural and socio-economic parameters are essential criteria in zoning for agricultural research and development and policy purposes. They worked out a production system based on the dominant cropping pattern, degree of subsistence versus market orientation, major constraints to improving production, and so on, along with an agro-ecological and geographical approach. They also pointed out that district level information about dominant crops is a good basis for delineating homogeneous agricultural systems. Another advantage they highlighted was that such a system integrates more variables into itself than any other single variable. They also observed that such a system overlooks crop productivity and livestock production, which would provide a more complete characterization of the system. Dry land agriculture has been analysed in various studies on the basis of the dominant crops of those areas. For example, Rao (2002) analysed the status of agriculture on the basis of the performance of three groups, viz., coarse grain, pulses, and oilseeds that predominantly represent dry lands. The Central Research Institute for Dryland Agriculture (CRIDA) defines dry land agriculture with respect to the five major production systems defined as rain-fed rice, cotton, oilseeds, coarse grains, and pulses.

The present study also developed a crop-based production system on the basis of dominant crops[1] in all the districts of the dry land areas of India. All the 211 districts of arid, semi-arid and dry-sub-humid areas are divided into 6 categories, viz., rice/wheat, rice/wheat & others, coarse cereals / pulses, coarse cereals / pulses & others, oilseeds, and oilseeds & others.

Out of the 211 districts, 30.3 percent fall under rice/wheat crop-based system. This category forms 58.2 percent of all districts in the dry-sub-humid area, while it is 22.1 percent in the semi-arid areas, and only 12.1 percent of the arid districts fall (Table 1.3). Uttar Pradesh, Bihar, Madhya Pradesh, Punjab, Tamil Nadu, Karnataka, and Andhra Pradesh are the important states in this aspect.

[1] The highest proportion of area under a particular crop is considered as dominant crop. The triennium average (TE 2002) of area is taken for this purpose.

Another important crop-based category is cereals and pulses which account for 23.7 percent of the total districts. Around 32 percent of the districts in the semi-arid area come under this category, while 20 percent of the districts fall in the arid areas. The important states in this regard are Maharashtra, Rajasthan, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Karnataka, and Madhya Pradesh.

Oilseeds are dominant in 9.5 percent of the districts and they are grown mostly in the arid and dry-sub-humid areas - 12 and 12.7 percent of the districts respectively. States such as Madhya Pradesh, Maharashtra, Andhra Pradesh, Gujarat, and Rajasthan are important areas cultivating this crop.

Cereals/pulses and others occupy 46.4 percent, and rice/wheat and others occupy 43.1 percent of the districts of dry land areas in the country.

Table 1.3: Crop-based Distribution of Districts

Crop	Arid	Semi-Arid	Dry-Sub-Humid	All Areas
Rice/Wheat	3 (12.0)	29 22.1)	32 (58.2)	64 (30.3)
Rice/Wheat & Others	3 (12.0)	23 (17.6)	1 (1.8)	27 (12.8)
Coarse Cereals / Pulses	5 (20.0)	42 (32.1)	3 (15.5)	50 (23.7)
Coarse Cereals / Pulses & Others	11 (44.0)	27 (20.6)	10 (18.2)	48 (22.7)
Oilseeds	3 (12.0)	10 (7.6)	7 (12.7)	20 (9.5)
Oilseeds & Others	--	--	2 (3.6)	2 (0.9)
Total	**25 (100.0)**	**131 (100.)**	**55 (100.0)**	**211 (100.0)**

Source: www.dacnet.nic.in/lus; Figures in the parentheses are percentages of the total.

1.4.2 Irrigation-based Typology

All the districts have further been classified on the basis of the proportion of irrigated area in the total cropped area. Since productivity, returns and development depend on irrigation, this classification may throw light on the impact of irrigation on the human well-being in these areas. However, sustainable development of agriculture in these regions may be under threat if the primary source of irrigation is groundwater, and the exploitation of groundwater is not checked.

The data on irrigated area for the triennium average 2004 is considered for this analysis. Districts with more than 35 percent of irrigated area are categorized as high irrigated districts and the remaining are the less irrigated districts. More than 60 percent of the districts in the arid and dry-sub-humid areas, and around 56 percent of the districts in the semi-arid areas are categorized as high irrigated districts (Table 1.4).

Table 1.4: Irrigation-based Distribution of Districts

Irrigation Type	Arid	Semi-Arid	Dry-Sub-Humid	All Areas
High Irrigated	15 (60.0)	73 (55.7)	36 (65.5)	124 (58.8)
Less Irrigated	10 (40.0)	58 (44.3)	19 (34.5)	87 (41.2)
Total	**(100.0)**	**25 (100.0)**	**131 (100.0)**	**55211 (100.0)**

Source: www.dacnet.nic.in/lus; Figures in the parentheses are percentages of the total.

1.4.3 Occupation-based Typology

The percentage of workers in agriculture and non-agriculture drawn from the 2001 Census is used for this purpose. If the proportion of workers exceeds 75 percent in agriculture, those districts are categorized as agriculture based, and the remaining districts are categorized as non-agriculture based. Since wages are higher in non-agriculture than that of agriculture, human well-being is expected to be high among these districts. More than 60 percent of the districts in the dry land areas are agriculture based. This proportion is very high in the dry-sub-humid areas, at 75 percent. However, the share of agriculture and non-agriculture workers is more or less the same in the arid areas. In the semi-arid areas 60 percent are agricultural workers while 40 percent are non-agricultural workers (Table 1.5).

Table 1.5: Occupation-based Typology

Livelihood-based Category	Arid	Semi-Arid	Dry-Sub-humid	All Areas
Agriculture	12 (48.0)	79 (60.3)	41 (74.5)	132 (62.6)
Non-Agriculture	13 (52.0)	52 (39.7)	14 (25.5)	79 (37.4)
All Areas	**25** **(100)**	**131** **(100.0)**	**55** **(100.0)**	**211** **(100.0)**

Source: 2001 Census; Figures in the parentheses are percentages of the total.

1.5 Basic Features of Dry Lands

1.5.1 Population Density

The socio-economic profile of the dry land areas is presented by describing the basic features of these areas by the typologies defined in the earlier section. The density of population is slightly lower at 309 per sq km in the dry land areas as compared to the other areas (317 per sq km). However, the density of population is very high both in semi-arid and dry-sub-humid areas, at 342 and 378 per sq km respectively. It is also observed that the density of population varies widely across different cropping patterns in these areas. Rice/wheat growing areas have higher density across all the dry land types, at 547 per sq km, while in dry-sub-humid areas, highest density is found in areas where cotton/sugarcane crops are grown along with oilseeds; the lowest density is found in the areas where coarse cereals / pulses and other crops are grown in all the dry land types (Table 1.6). Similarly, the density of population across other typologies such as irrigation and occupation shows that high irrigated areas have higher density of population than that of the less irrigated areas both in semi-arid and dry-sub-humid areas (Table 1.7). Non-agricultural occupation has also shown higher density as compared to agriculture both in semi-arid and dry-sub-humid areas (Table 1.8).

Table 1.6: Density of Population based on Crop Cultivation

(Per sq km)

Crop-based Category	Arid	Semi-Arid	Dry-Sub-Humid	All Areas
Rice/Wheat	344	536	574	547
Rice/Wheat & Others	231	401	133	371
Coarse Cereals / Pulses	118	321	238	282
Coarse Cereals / Pulses & Others	114	246	162	186
Oilseeds	122	252	266	213
Oilseeds & Others	--	--	779	779
All Areas	**131**	**342**	**378**	**309**

Source: 2001 Census.

Table 1.7: Density of Population based on Irrigation

(Per sq km)

Irrigation-based Category	Arid	Semi-Arid	Dry-Sub-humid	All Areas
High Irrigated	119	450	548	387
Less Irrigated	148	251	208	226
All Areas	**131**	**342**	**378**	**309**

Source: 2001 Census.

Table 1.8: Density of Population by Occupation

(Per sq km)

Livelihood-based Category	Arid	Semi-Arid	Dry-Sub-humid	All Areas
Agriculture	143	293	336	278
Non-agriculture	117	430	559	359
All Areas	**131**	**342**	**378**	**309**

Source: 2001 Census.

1.5.2 Sex Ratio and Female Literacy

It is argued elsewhere that lower density of population in drought prone areas is the result of higher incidence of migration, especially male workers. This is reflected in the higher sex ratios observed in these areas. As per the present study estimates, this is happening not only in drought prone areas which are semi-arid areas, but also in arid areas, i.e., desert prone areas. For example, the lowest density is found among the arid districts where coarse cereals / pulses and other crops are grown; and a higher sex ratio is observed in the arid districts. Similarly, low density of population is found in the areas of rice/wheat cultivation in dry-sub-humid areas and areas cultivating oilseeds crops in semi-arid areas, and these areas have shown a higher sex ratio (Table 1.9). Further, wherever irrigation is not prominent, the sex ratio is found to be high in all dry land types. It can be said that male out-migration is not happening when rice/wheat is grown with more area under irrigation (Table 1.10).

Higher sex ratio cannot be considered as a development indicator since female literacy is low in such areas (Table 1.11 and Table 1.12). Further, wherever the proportion of non-agricultural workers is high, female literacy is also found to be high (Table 1.13).

Table 1.9: Crop-based Sex Ratio

(Females per Thousand Males)

Crop-based Category	Arid	Semi-Arid	Dry-Sub-Humid	All Areas
Rice/Wheat	886	915	927	920
Rice/Wheat & Others	873	953	987	947
Coarse Cereals / Pulses	940	945	913	943
Coarse Cereals / Pulses & Others	947	937	908	934
Oilseeds	936	962	924	947
Oilseeds & Others	--	-	879	879
All Areas	**931**	**938**	**921**	**933**

Source: 2001 Census.

Table 1.10: Irrigation-based Sex Ratio

(Females per Thousand Males)

Irrigation-based Category	Arid	Semi-Arid	Dry-Sub-Humid	All Areas
High Irrigated	911	928	917	923
Less Irrigated	955	954	934	950
All Areas	**931**	**938**	**921**	**933**

Source: 2001 Census.

Table 1.11: Crop-based Female Literacy

(Percentage)

Crop-based Category	Arid	Semi-arid	Dry-Sub-Humid	All Areas
Rice/Wheat	52.9	51.8	46.1	49.0
Rice/Wheat & Others	51.3	57.3	53.8	56.9
Coarse Cereals / Pulses	44.7	56.7	61.8	56.0
Coarse Cereals / Pulses & Others	45.9	53.6	48.0	51.1
Oilseeds	46.7	57.3	64.6	57.5
Oilseeds & Others	--	--	47.0	47.0
All Areas	**46.9**	**55.3**	**49.1**	**53.7**

Source: 2001 Census.

Table 1.12: Irrigation-based Female Literacy

(Percentage)

Irrigation-based Category	Arid	Semi-Arid	Dry-Sub-Humid	All Areas
High Irrigated	47.4	55.1	46.5	52.3
Less Irrigated	46.4	55.5	55.7	54.5
All Areas	46.9	55.3	49.1	46.9

Source: 2001 Census.

Table 1.13: Occupation-based Female Literacy

(Percentage)

Livelihood-based Category	Arid	Semi-Arid	Dry-Sub-Humid	All Areas
Agriculture	45.7	52.1	46.3	50.0
Non-Agriculture	48.7	59.0	56.0	57.6
All Areas	**46.9**	**55.3**	**49.1**	**46.9**

Source: 2001 Census,

1.5.3 Proportion of SC and ST Population

The proportion of Scheduled Caste (SC) population is 20 percent in the dry-sub-humid zone while it is 16 and 19 percent respectively in the semi-arid and arid zones. The proportion of Scheduled Tribe (ST) population is 7 percent in the semi-arid zone while it is 5 and 6 percent respectively in the arid and dry-sub-humid zones. The percentage of ST population is observed to be higher in less irrigated areas in all the three zones while the percentage of SC population is the same in high as well as less irrigated areas of the arid zone; and is higher in the less irrigated areas of the semi-arid and dry-sub-humid zones (Table 1.14 and Table 1.15). A major portion of the workers from both the caste groups are agriculture workers.

Table 1.14: Scheduled Caste Population

(Percentage)

Irrigation-based Category	Arid	Semi-Arid	Dry-Sub-Humid	All Areas
High Irrigated	19.0	14.7	18.8	16.1
Less Irrigated	17.9	18.0	21.9	18.6
All Areas	**18.5**	**16.0**	**19.6**	**17.0**

Source: 2001 Census.

Table 1.15: Scheduled Tribe Population

(Percentage)

Irrigation-based Category	Arid	Semi-Arid	Dry-Sub-Humid	All Areas
High Irrigated	3.7	3.8	1.5	3.2
Less Irrigated	7.2	11.4	18.2	12.1
All Areas	**5.3**	**6.8**	**6.1**	**6.5**

Source: 2001 Census.

1.6 Structure of the Report

The present chapter is an introduction to this report. It discusses the importance of the sustainable livelihoods framework in order to address the basic concerns of the world economy, viz., eradication of poverty, ensuring food security, and protection of the environment. These issues are of crucial importance for less resource endowed regions such as dry lands. It also brings out the typologies for dry lands and explains the basic features of dry lands in India. The second chapter provides a detailed explanation of the sustainable livelihoods framework and the status of assets of people in these areas. It gives a combined index for all the capitals needed for sustaining a livelihood. In the third chapter, the analysis of livelihood outcomes in the form of poverty in dry lands of India along with an account of status environment in the dry land states of India. It also attempts to understand the relationship between poverty and livelihood development. In the fourth chapter, analysis of agriculture as a main livelihood strategy is explained. Summary and conclusions are given in the fifth chapter.

CHAPTER - II
Sustainable Rural Livelihoods: Status of Assets

2.1 A Framework for Livelihoods Analysis

A framework on livelihood analysis originates from the work on vulnerability, famines, gender analysis, poverty-environment interactions, and sustainable rural livelihoods. These approaches regard the asset status of the poor households as fundamental to understanding the options open to them, the strategies they adopt for survival, and their vulnerability to adverse trends and events. The framework can be a guide to micro policies on rural poverty reduction and to trace the local level impact of macro policies. It can also be used to understand the livelihood circumstances of individuals, households, villages, communities, and even districts or large geographical zones that share important features in common (Frank E, 2000).

2.1.1 Assets

The starting point of a framework is the assets owned, controlled, claimed and accessed by the household. Based on assets, households are able to undertake production, engage in labour markets and participate in exchanges with other households. Different researchers have identified different categories of assets: Swift (1989) classifies assets into investments, stores and claims. According to Maxwell and Smith (1992), assets are in the form of productive capital, non-productive capital, human capital, income and claims. Reardon and Vosti (1995) classified assets into natural resource assets, human resource assets, non-farm physical and financial resources, and off-farm physical and financial resources. Moser (1998) divides assets into labour, human capital, productive assets, household relations, and social capital. All these classifications have some common and some new elements. The framework suggested by Chambers and Conway (1991) contains five capitals / asset categories - natural, human, physical, financial, social.

Natural capital includes land, water, and biological resources that are utilized by people to generate the means of survival. It is not confined to gathering activities such as collecting wild vegetables and hunting wild animals. It is not static. It is enhanced when it is brought under human capital. There are renewable and non-renewable resources of natural capital.

Physical capital consists of assets that are created by the economic production process. All production goods that create a flow of outputs come under physical capital such as buildings, irrigation canals, roads, tools, and machinery.

Human capital refers to the labour available to the household, its education, skills and health. Human capital is increased by investment in education and training, and the skills acquired through pursuing one or more occupations.

Financial capital refers to stocks of money to which a household has access, including access to savings and access to credit. However, neither savings nor loans are productive forms capital directly. They owe their role in the asset portfolio of households to their convertibility into other forms of capital or into consumption.

Social capital refers to claims which individuals and households have by virtue of their belonging to a social group.

2.1.2 Mediating Processes

Translation of assets into livelihood strategies is mediated by a great number of social, economic and political considerations. Scoones (1998) divides these into two categories: conditions and trends on the one hand and institutions and organizations on the other. Conditions and trends are exogenous factors. Institutions and organizations are endogenous to social norms of which households are a part.

Examples of trends include rate of population growth, density of population, rates of out-migration from rural areas, agricultural technology and its evolution over time, growth of non-farm activities in rural areas, relative prices, national economic trends, international prices, macro policies, etc. The relative importance of these trends for different rural locations is likely to vary tremendously. The trends may be fortuitous or adverse. The former category includes economic growth, slow down in population growth rate, reduction in poverty, and development of the non-farm sector. The latter includes shocks that pose a challenge to livelihood sustainability such as drought, pests and diseases. Shocks destroy assets directly, and indirectly result in the erosion of assets.

Social relations are distinguished from institutions and institutions from organizations. Social relations refer to the social positioning of individuals and households within the society. Social positioning comprises factors such as gender, caste, class, age, ethnicity and religion. Institutions are formal rules, conventions and informal code of behavior such as laws, land tenure arrangements, and markets. They change slowly and incrementally. Organisations are groups of individuals bound by some common purpose. Government agencies, administrative bodies, NGOs, and associations are examples.

Social relations, institutions and organizations are critical mediating factors for livelihoods because they encompass the agencies that inhibit or facilitate the exercise of capabilities or choices by individuals or households.

2.1.3 Activities and Livelihoods Strategies

The households adapt to various livelihood strategies when their asset status is mediated by social factors and trends or shocks. Livelihood strategies are dynamic. They respond to the changing pressures and opportunities and adapt accordingly. They consist of activities that generate the means of household survival. They are divided into natural resource-based and non-natural resource based.

Scoones (1998) identified three livelihood strategies: agricultural intensification or extensification, livelihood diversification, and migration. The first type corresponds to continued and increasing reliance on agriculture either by intensifying resource use with a given land area or by bringing new land into cultivation. The key asset here is land, and for agricultural intensification, attention is directed towards the institutions and organizations that facilitate technical changes in agriculture. The second type directs attention to non-farm rural employment as a key policy issue. The third type directs attention to migration and remittances.

2.1.4 Outcomes of Livelihood Strategies

The outcomes are divided into livelihood security and environmental sustainability aspects. Livelihood security is defined as containing some combination of attributes related to income level, income stability, reduction in adverse seasonal effect, and reduction in overall risk profile of the income portfolio. This in turn leads to people becoming less vulnerable or more vulnerable in terms of their capability to manage adverse trends or cope with shocks. Environmental sustainability refers to changes in the resilience and stability of resources such as soils, water, rangeland, forests and biodiversity.

Frank Ellis (2000) argues that this framework does not provide a set of solutions for poverty reduction. It does suggest a way of organizing the policy that identifies assets, mediating processes, activities, and the links between them. Carney (1998) proposes a schematic approach for comparing the asset status of different social groups. Scoones (1998), as quoted in ICRISAT (2005), suggests a checklist for taking forward an asset-based analysis of rural livelihoods. The checklist consists of a series of key questions to be asked about household asset portfolios such as sequencing, substitution, and clustering of assets.

Thus, sustainable livelihood approach shows how sustainable livelihoods are achieved through access to a range of capitals, which are combined in the pursuit of different livelihood strategies (Scoones, 2000). It consists of five components:

1. Livelihoods assets
2. Vulnerability of livelihoods to external factors
3. Conditioning variables that influence the ability to convert assets into a living
4. Livelihood strategies
5. Livelihood outcomes

Framework of assets is the most crucial of all the components, and the assessment of the status of assets across households helps to identify the constraints of livelihood development in dry land areas.

2.2 Asset Framework

The asset framework assesses the level and composition, clustering, sequencing and substitution of capitals, viz., human, natural, physical, financial and social in relation to the levels of irrigation facilities available. The main objective of the chapter is to assess the status of the livelihood capitals across different agro-ecological regions of the country.

2.2.1 Description of Capitals and Indicators

The analysis of the status of capitals as per the asset framework depends on the availability of data from secondary sources. The study is dependent on unit record data available in CD-ROMs of the National Sample Survey Organisation (NSSO). Table 2.1 provides the indicators for different capitals and the corresponding NSSO rounds.

The study will present the analyses for one point of time. Data from CD-ROMs of most of the NSS rounds prior to the 50th round do not provide a provision for district. Hence, the study will provide analysis for one point of time for which data from various rounds is available.

As per Table 2.1, education, health and labour force participation rates are the components of human capital. Access to government institutions for education and health is another dimension of human capital. However, due to non-availability of such information at the district level, access to education and health related infrastructure is not examined. Household owned and community owned natural resources are included in natural capital. Irrigation assets, agricultural implements, transport vehicles such as carts, motor vehicles, tractors and consumer durables at the household level are included in physical capital. The level of saving, investment and credit are the components of financial capital.

Table 2.1: Indicators of Livelihoods Capitals

Sl. No.	Capital	Indicators	NSSO Round
I	Human Capital		
	Education	Literacy rate	61st Round Employment and Unemployment Survey, 2004-05
		Female literacy	
		Middle level completion rate among children	
		Secondary and above levels of completion rate among adults	
	Health	Percentage of persons who suffered from ailments	60th Round Morbidity and Health Care, 2004
		Percentage institutional deliveries	
		Percentage of children immunized	
	Work Force	Labour force participation rate among all	61st Round Employment and Unemployment Survey, 2004-05
		Labour force participation rate among children	
		Labour force participation rate among adults	
II	Natural Capital	Percentage of irrigated land	59th Round Debt and Investment Survey, 2003
		Per capita Net Area Sown (NAS)	
		Percentage of cross-bred cows	
		Adult work animals per hectare of NAS	
		Percentage of CPR land to geographical area	District-wise Land Use Statistics for each state from Indiastat.com
		Percentage of households depending on CPRs for fodder	54th Round Common Property Resources, 1998
		Percentage of households depending on CPRs for fuel	
III	Physical Capital	Number of agricultural and irrigation assets per household	59th Round Debt and Investment Survey, 2003
		Number of transport vehicles per household	
		Number of durable assets per household	
IV	Financial Capital	Savings and investors per household	59th Round Debt and Investment Survey, 2003
		Loans receivable and outstanding loan per household	
V	Social Capital	Percentage of households having account in CBs/SHGs/Co-operatives	54th Round Common Property Resources, 1998
		Percentage of households having membership in JFM/VP	
		Percentage of households having membership in irrigation institutions	

2.3 Methodology

The status of assets/capitals has been analysed for the arid, semi-arid and dry-sub-humid regions of the country in relation to their level of irrigation facility. The districts in these regions have been categorized as high and less irrigated, based on the proportion of irrigated area to the total cropped area.

Indicators in each capital represent development or backwardness. For example, in the case of health, a component of human capital, the percentage of immunized children shows improvement in health situation while the percentage of population suffered from ailment shows the backwardness. Similarly in the case of natural capital, the percentage irrigated area shows development while the number of work animals per hectare of net area sown indicates the burden on land.

The values of identified indicators for each capital are used to construct a composite index for each capital by adopting the Human Development Index methodology of the United Nations Development Programme (UNDP). Before constructing the composite index, a dimension index is created for each of the indicators of the five capitals. To calculate these dimension indices, the minimum and maximum values are chosen for each indicator from the district level values.

$$\text{Dimension Index for Development} = \frac{\text{Actual Value - Minimum Value}}{\text{Maximum Value - Minimum Value}}$$

$$\text{Dimension Index for Deprivation} = 1 - \left[\frac{\text{Actual Value - Minimum Value}}{\text{Maximum Value - Minimum Value}}\right]$$

For each capital, one combined index is created by taking the simple average of dimension indices of indicators. For example, human capital consists of education, health and employment components. Education index is created by taking the simple average of dimension indices of the five indicators of this component. Health index is created by taking the simple average of three dimension indices. Similarly, employment index is created by taking the simple average of three dimension indices. Finally, combined human capital index is constructed by taking the simple average of education, health and employment indices. In the same manner dimension indices will be constructed for indicators of different capitals, the simple average of these dimension indices will give the index for capitals. In this process, each indicator is given equal weights. The level of development of that capital is higher if the value of the index is higher. A

correlation co-efficient is estimated to understand the relationship between the different capitals.

Districts whose composite indices are greater than or equal to the (mean + SD) are in the high developed category; districts whose composite indices are between (mean + SD) and mean are in the high middle category of development; districts whose composite indices are between mean and (mean - SD) are in the low middle level category of development; and the districts whose composite indices are lesser than (mean - SD) are in the low level category of development.

2.4 Status of Assets

2.4.1 Human Capital

Education, work participation, and health are the dimensions of human capital considered for the study. For each of these dimensions, several indicators have been identified and listed in Table 2.1 described in the earlier sections. Literacy rates are slightly lower in arid areas as compared to semi-arid and dry sub-humid areas. The percentage of literacy is 55 percent in the arid areas, while it is 60.6 and 58 percent in the semi-arid and dry-sub-humid zones respectively. Across the high and less irrigated areas, the latter have shown lower literacy rates as compared to the former in the arid zone. These rates do not differ much between high and less irrigated areas both in the semi-arid and dry-sub-humid zones. The level of female literacy rate across the zones shows the same pattern, and the level of completion of middle-level education among children also shows the same tendency except in the less irrigated areas in the arid and semi-arid zones, wherein the completion rate of middle-level education is higher than that of the high irrigated areas. The rates of completion of secondary, higher secondary, and graduation among adults are lower in the less irrigated areas in the three zones. Though arid areas have shown lower values of these indicators than the rest of the two types, the difference is not very high between them.

Work participation rates of persons, women and children are higher in the less irrigated areas for all types of eco-systems; they are lower in the dry-sub-humid areas. The performance of health indicators appears to be good in the irrigated areas of the arid and semi-arid regions (Table 2.2).

The combined index for human capital is higher in the semi-arid areas at 0.59, compared to the arid and dry-sub-humid areas, at 0.52 and 0.53 respectively. Among the three components of human capital, the performance of health indicators is better compared to education and employment. The value of health index is 0.75 in semi-arid, 0.67 in arid, and 0.69 in dry-sub-humid. This may be because immunization of children is

more than 90 percent in all these zones. However, the status of education indicators is very poor and the value of its index is 0.40 in semi-arid, 0.33 in arid, and 0.36 in dry-sub-humid regions. The value of education index is low in less irrigated areas of all the three regions despite many efforts to increase the participation of children in education. Hence, this issue needs to be taken seriously. The value of employment index is high in less irrigated areas of these three regions. The nature of employment and wage rate determine the quality of employment in these regions. While the value health index is higher in the high irrigated arid areas, less irrigated areas have shown higher value of health indices in the dry-sub-humid areas. The value remains the same in the high and less irrigated areas of the semi-arid regions (Table 2.3).

Table 2.2: Human Capital across the Regions

Indicator (Percentage)	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry-Sub-Humid
Literacy Rate	57.7	51.7	55.0	60.6	60.6	60.6	57.8	58.5	58.0
Female Literacy Rate	44.1	38.4	41.5	48.6	49.2	48.9	44.9	46.1	45.2
Middle Level Education	9.9	14.1	11.6	13.1	17.2	14.7	9.2	7.5	8.7
Secondary Level Education	16.8	14.9	16.0	17.6	16.0	16.6	17.9	11.7	16.2
Higher Secondary Level Education	7.8	6.5	7.2	8.6	7.6	8.2	9.8	8.8	9.5
Graduation	4.9	4.7	4.8	6.6	6.1	6.4	6.8	6.3	6.7
Work Participation Rate (WPR)	35.7	47.8	41.2	41.0	49.1	44.3	31.4	43.3	34.5
Female WPR	19.5	37.0	27.5	27.5	41.0	33.1	12.8	33.1	18.1
Child WPR	2.6	5.6	3.9	2.6	5.0	3.5	1.6	1.5	1.6
Immunisation	94.4	89.9	92.6	92.6	92.5	92.5	87.6	90.8	88.5
Institutional Deliveries	40.5	18.2	32.1	40.4	44.0	41.8	19.6	34.0	23.6
Ailment	7.7	26.0	7.3	9.6	7.3	8.7	9.9	6.7	9.0

Table 2.3: Human Capital Index

Agro-Ecological Region	Education	Employment	Health	Human Capital Index
AHI	0.35	0.49	0.73	0.52
ALI	0.31	0.65	0.55	0.50
Arid	0.33	0.55	0.67	0.52
SAHI	0.41	0.58	0.75	0.58
SALI	0.39	0.68	0.75	0.60
Semi-Arid	0.40	0.62	0.75	0.59
DSHHI	0.38	0.47	0.65	0.50
DSHLI	0.33	0.67	0.71	0.57
Dry-Sub-Humid	0.36	0.54	0.67	0.53
Dry Regions	0.38	0.59	0.72	0.56

2.4.2 Natural Capital

Natural resources play an important role in enhancing the livelihoods of the rural people. While some activities undertaken by the people result in over use of the existing natural resources, some activities improve the status of livelihoods. For example, irrigation increases the productivity, but excessive use of groundwater for irrigation contaminates the groundwater and the source will be exhausted after sometime in future. Similarly, availability and accessibility of common lands act as a safety net for the poor who depend on them for domestic as well commercial purposes. However, excessive grazing results in the loss of nutrients of the land.

In order to capture the effect of the actions of rural people on the natural resources and how they will contribute to the enhancement of their livelihoods, the following indicators are identified, namely, the percentage of irrigated area, per capita cropped area, percentage of cross-bred cows, work animals per hectare of cropped area, proportion of area under common property resources, and the percentage of households depending on common land for fuel and fodder. While some of the above indicators improve the status of the households, others do not. For example, indicators namely percentage of irrigated area, cropped area per person, and percentage of cross-bred cows enhance the livelihoods of households while dependence on work animals increases the pressure on land. The availability and accessibility of common land, especially to the rural poor, work as a better safety net to sustain themselves.

Common land has been defined as the area under village forests, common grazing land, and pastures in the village. The 54th Round NSS provides data on common land.

However, such land estimates cannot be made using unit record data of this round as multipliers have not been posted. The published data provides only aggregate estimates which cannot be used, as the study requires district-level estimates. Hence, the present study has taken district-wise land use statistics published by Indiastat.com for the dry land states. Earlier, some studies (Chopra et al., 1990) used the nine-fold classification of land use to estimate the area under common land, in which the area under forests, barren land, pastures and cultivable waste land were considered. Since forests include protected and unprotected forest land, the study made some adjustments to arrive at forest land accessible to people and finally presented the area under common land. However, it is mentioned in the NSS Report that (NSSO, 1999) there are differences in the estimates of the NSS and Chopra et al. (1990) study. The estimates of common land based on land use statistics for the year 2003 given in the present study are higher than that of NSSO's.

The proportion of irrigated area is very high in the dry-sub-humid zone at 62.3 percent, followed by 55.1 percent in the semi-arid zone. The proportion of irrigated area is very less in the arid zone. With regard to irrigation, it is observed that the proportion of irrigated area is higher even in the less irrigated areas in the dry-sub-humid and semi-arid zones. The cropped area per capita is found to be high at 0.36 ha in the arid zone; it is very low at 0.15 ha and 0.14 ha respectively in the semi-arid and dry-sub-humid zones. However, this land availability per person is comparatively higher in the less irrigated areas of these zones. Thus, there is heavy pressure on land for cultivation in these zones. The percentage of cross-bred cows is high in the semi-arid areas at 20.1 percent. It ranges between 9 and 10 percent in the dry-sub-humid and arid zones respectively. These proportions are smaller in less irrigated areas of all the three zones. The pressure of adult work animals on the land is higher in the dry-sub-humid and arid zones with 0.54 and 0.39 animals per hectare of cropped area respectively.

The proportion of common property resources to the geographical area is higher at 34 percent in the arid region while it is 32.7 percent in the dry-sub-humid zone and 27.1 percent in the semi-arid zone. The proportion of common land is higher in the less irrigated areas of the semi-arid and dry sub-humid zones. The dependence on common land is higher for fuel than for fodder in all three dry zones, and the percentage of households depending on common land for fuel is higher in the less irrigated areas of all the three dry zones (Table 2.4).

Table 2.4: Natural Capital across the Regions

Indicator	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry-Sub-Humid
Irrigated Land (%)	40.4	18.8	31.3	73.9	41.0	55.1	82.0	41.4	62.3
Cropped Area per Capita (Ha)	0.37	0.34	0.36	0.11	0.22	0.15	0.10	0.23	0.14
Cross-bred Cows (%)	11.1	9.2	10.3	23.6	14.7	20.1`	11.0	6.0	8.6
Adult Work Animals per hectare of Cropped Area	0.07	0.17	0.11	0.34	0.42	0.39	0.55	0.52	0.54
CPR (%)	42.2	19.2	34.0	24.4	29.3	27.1	24.8	41.7	32.7
Households depending on CPRs for Fodder (%)	9.9	15.8	12.6	13.3	11.6	12.6	16.7	9.8	14.9
Households depending on CPRs for fuel (%)	27.7	52.1	39.0	47.6	63.4	53.8	33.7	68.7	43.1
Combined Index	**0.37**	**0.33**	**0.35**	**0.39**	**0.35**	**0.38**	**0.36**	**0.36**	**0.36**

The combined index across the zones does not differ much - it is higher than 0.35 in all the three zones, and slightly higher at 0.39 in the semi-arid zone. This is due to the higher percentage of cross-bred cows, dependence on common land for fuel, and slightly less dependence of animals on land compared to the dry-sub-humid zone.

2.4.3 Physical Capital

Agricultural implements such as sickles, ploughs, sprayers, power tillers, tractors (excluding trolley), threshers, harvesters, cane crushers, oil crushers, etc.; irrigation equipment such as electric pumps and water lifting equipment; transport equipment such as carts, motor vehicles, and tractors; and consumer durables such as furniture and fixtures, electronic entertainment goods, cooking appliances, and therapeutic appliances per household are considered for assessing the status of physical capital across the agro-ecological regions.

The number of agricultural equipment per household is observed to be higher at 5.3 in the irrigated tracts of the arid region; it is also higher in the less irrigated zones of the semi-arid region at 5 per household. Furthermore, the number of irrigation equipment, transport equipment, and electrical goods per household does not vary much between the high and less irrigated lands in all the three regions. However, the number of furniture equipment per household is higher in the irrigated zones at 5, while the number of

cooking appliances is higher in the less irrigated zones of all the three regions. This shows that the possession of assets is not very much dependent on the level of irrigation in the dry lands of the country (Table 2.5). The value composite index of physical capital is observed to be the same across the dry zones.

Table 2.5: Physical Capital across the Regions

Indicator per Household	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry-Sub-Humid
Agricultural	5.3	4.2	4.8	4.1	4.7	4.3	4.2	4.3	4.2
Irrigation	1.2	1.4	1.3	2.1	1.8	2.0	3.0	1.5	2.5
Carts	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Motors	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0
Tractors	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0
Furniture	4.8	2.4	3.6	3.8	2.1	3.1	4.0	2.4	3.5
Electrical	1.1	1.0	1.1	1.1	1.1	1.1	1.3	1.1	1.2
Cooking	19.7	21.8	20.7	18.0	23.4	20.2	15.0	17.3	15.7
Therapeutic	2.8	4.3	3.5	2.4	3.3	2.8	13.7	2.6	10.0
Combined Index	**0.26**	**0.25**	**0.26**	**0.25**	**0.25**	**0.25**	**0.23**	**0.25**	**0.24**

2.4.4 Financial Capital

The average amount invested in shares, the amount of savings in terms of the average amount deposited, loan amount receivable, and outstanding loan amount per household have been considered for financial capital. The amount of loan outstanding is very high in the irrigated tracts of the arid zone estimated at Rs.37,935 per household. The average amount invested in shares is higher in the less irrigated zones of both arid and semi-arid regions while it is higher in the high irrigated zones of the dry-sub-humid region. However, the amount of loans receivable is significantly higher in the irrigated zones of all the three regions. The composite index is found to be slightly lower in the arid zone when compared to other two zones (Table 2.6).

Table 2.6: Financial Capital across the Regions (Rs.)

Indicator per Household	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry Sub-Humid
Shares	3954	6639	5648	2796	4128	3654	6074	3685	5373
Deposits	6257	5040	5813	5202	5316	5248	6949	3917	5971
Loans receivable	20312	9678	13555	23074	14360	18597	15010	4359	12957
Outstanding debt	37935	24935	31503	25665	25209	25486	20292	22298	20903
Combined Index	**0.22**	**0.25**	**0.23**	**0.26**	**0.26**	**0.26**	**0.28**	**0.22**	**0.26**

2.4.5 Social Capital

The relationship that a household develops with associations and organizations increases its accessibility to various schemes and programmes. Such association helps the households in times of crisis, and reduces their vulnerability. Hence, this is taken as the social capital. Having account in commercial banks, self-help groups, or co-operative societies, and membership in irrigation organizations and joint forest management are taken as indicators of social capital.

The status of social capital is found to be very poor across the regions. The percentage of households having an account in commercial banks / self-help groups / co-operative societies is around 31 percent in all the zones. However, the membership in other organizations such as JFM/VP and in irrigation / tank organizations is not even one percent across the zones. Overall, the index of social capital is observed to be very low and similar across the zones (Table 2.7).

The performance of all the capitals is analysed for each zone separately. In the arid zone, among the five capitals, the value of human capital is highest at 0.52, followed by natural capital at 0.35, physical capital at 0.26, financial capital at 0.23, and social capital at 0.15. Between the high and less irrigated areas, all the capitals except financial capital have shown higher values in high irrigated areas.

Table 2.7: Social Capital across the Regions

Agro-Ecological Region	Percentage of Households having Account in CB/SHG/ Co-ops	Percentage of Households having Membership in JFM/VP	Percentage of Households having Membership in Irrigation/Tank Organisations	Social Capital Index
AHI	32.8	0.2	0.1	0.15
ALI	30.7	0.1	0.6	0.14
Arid	31.9	0.1	0.4	0.15
SAHI	28.8	0.3	0.3	0.14
SALI	30.9	0.8	0.2	0.16
Semi-arid	29.7	0.5	0.3	0.15
DSHHI	35.4	0.3	0.2	0.16
DSHLI	21.2	0.3	0.9	0.12
Dry-sub-humid	31.6	0.3	0.4	0.15

In the semi-arid zone, the order of importance of capital is slightly different from the arid zone. Among the five capitals, the value of human capital is higher at 0.59, followed

by natural capital at 0.38, financial capital at 0.26, physical capital at 0.25, and social capital at 0.15. The performance of human capital is better in the less irrigated areas, while the performance of natural capital is better in the high irrigated areas, and there is no difference between these two areas in the case of physical and financial capitals.

In the dry-sub-humid zone, the order of importance of capitals is similar to that of the arid zone. While the performance of human and physical capitals is better in the less irrigated areas of this zone, the other two capitals perform better in the high irrigated areas. The performance of natural capital is same between the high and less irrigated areas of this zone (Table 2.8).

Table 2.8: Composite Indices of Capitals across the Regions

Capital	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry-Sub-Humid
Human	0.52	0.50	0.52	0.58	0.61	0.59	0.50	0.57	0.53
Natural	0.37	0.33	0.35	0.39	0.35	0.38	0.36	0.36	0.36
Physical	0.26	0.25	0.26	0.25	0.25	0.25	0.24	0.25	0.24
Financial	0.22	0.25	0.23	0.26	0.26	0.26	0.28	0.22	0.26
Social	0.15	0.14	0.15	0.14	0.16	0.15	0.16	0.12	0.15

2.5 Different Stages of Development

The relative development of the districts in all the three regions has been compared on the basis of the values of the mean and standard deviation of the composite indices as described in the section on methodology. On the basis of the values of the mean and standard deviation, the districts have been classified as high, high middle, low middle and low for all the three regions. In all the regions across the high and less irrigated tracts and for all the capitals, more number of districts fall in the middle level of development (Tables 2.9 to Table 2.13).

Table 2.9: Number of Districts on the basis of Ranks for Human Capital

Rank	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry-Sub-humid
High	0	0	0	20	18	38	1	2	3
High Middle	4	2	6	16	21	37	7	8	15
Low Middle	9	5	14	23	14	37	17	9	26
Low	3	2	5	12	5	17	11	0	11
All	**16**	**9**	**25**	**71**	**58**	**129**	**36**	**19**	**55**

Table 2.10: Number of Districts on the basis of Ranks for Natural Capital

Rank	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry-Sub-humid
High	0	0	0	14	11	25	3	2	5
High Middle	3	2	5	29	23	52	10	4	14
Low Middle	11	4	15	20	16	36	16	8	24
Low	2	3	5	8	8	16	7	5	12
All	16	9	25	71	58	129	36	19	55

Table 2.11: Number of Districts on the basis of Ranks for Physical Capital

Rank	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry-Sub-humid
High	2	1	3	9	10	19	3	2	5
High Middle	9	5	14	30	20	50	10	4	14
Low Middle	4	3	7	26	17	43	16	8	24
Low	1	0	1	6	11	17	7	5	12
All	**16**	**9**	**25**	**71**	**58**	**129**	**36**	**19**	**55**

Table 2.12: Number of Districts on the basis of Ranks for Financial Capital

Rank	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry-Sub-humid
High	0	2	2	8	9	17	8	0	8
High Middle	8	3	11	38	32	70	13	7	20
Low Middle	5	2	7	21	12	33	13	6	19
Low	0	2	2	8	9	17	8	0	8
All	**16**	**9**	**25**	**71**	**58**	**129**	**36**	**19**	**55**

Table 2.13: Number of Districts on the basis of Ranks for Social Capital

Rank	AHI	ALI	Arid	SAHI	SALI	Semi-Arid	DSHHI	DSHLI	Dry-Sub-humid
High	2	1	3	9	9	18	8	1	9
High Middle	7	2	9	17	18	35	10	3	13
Low Middle	5	6	11	38	27	65	13	7	20
Low	2	0	2	7	4	11	5	8	13
All	**16**	**9**	**25**	**71**	**58**	**129**	**36**	**19**	**55**

2.6 Relationship between Livelihood Capitals

The correlation coefficients have been calculated to understand the relationship between natural capital and other capitals. It is found that natural capital has shown a significant (1 percent level) positive association with human capital. This is found in the high irrigated semi-arid areas as well as in all high irrigated areas. In all other regions, the relationship is positive though not statistically significant except in the less irrigated dry-sub-humid zone. For physical capital, barring the arid zone, there is a positive association. The relationship between natural capital and financial capital is negative in the high irrigated areas of the arid, and dry-sub-humid zones, and all the high irrigated areas. There is a negative relationship between natural capital and social capital. The less irrigated areas of semi-arid and dry-sub-humid zones have shown positive association, though not statistically significant (Table 2.14). The values of the indicators taken for social capital are very low in all the dry land sub-types.

Table 2.14: Relationship between Natural Capital and other Capitals

Region	Human Capital	Physical Capital	Social Capital	Financial Capital
Arid High Irrigated	0.250	-0.212	-0.249	-0.354
Arid Less Irrigated	0.089	-0.257	-0.379	0.211
Arid	0.236	-0.202	-0.254	-0.207
Semi-Arid High Irrigated	0.323**	0.123	-0.139	0.126
Semi-Arid Less Irrigated	0.210	0.157	0.090	-0.065
Semi-Arid	0.212*	0.132	-0.049	0.035
Dry-Sub-Humid High Irrigated	0.131	0.211	-0.146	-0.030
Dry-Sub-Humid Less Irrigated	-0.164	0.008	0.154	0.291
Dry-Sub-Humid	0.069	0.164	-0.046	0.019
All High Irrigated	**0.302***	**0.135**	**-0.183**	**-0.013**
All Less Irrigated	**0.157**	**0.101**	**0.057**	**-0.010**
All Dry Zones	**0.200****	**0.111**	**-0.065**	**0.006**

* indicates significance at 5 percent; ** indicates significance at 1 percent.

2.7 Summary

The status of assets was analysed using the five capitals of the sustainable livelihoods framework. The composite index of human capital is found to be higher in the semi-

arid areas at 0.59 as compared to the arid and dry-sub-humid areas at 0.52 and 0.53 respectively. Among the three components of human capital, the performance of health indicators is better compared to education and employment. This may be because immunization of children is more than 90 percent in all these zones. The value of education index is low in the less irrigated areas among all the three regions, while the value of employment index is high in the less irrigated areas among these three regions; the nature of employment and wage rate determine the quality of employment in these regions.

The combined natural capital index across the zones does not differ much. It is higher than 0.35 in all the three zones, and slightly higher at 0.39 in the semi-arid zone. This is due to the higher percentage of cross-bred cows, dependence on common land for fuel, and slightly less dependence of animals on land compared to the dry-sub-humid zone. The value of composite index of physical capital is the same across the dry zones. The composite index of financial capital is slightly lower in the arid zone as compared to other two zones.

The status of social capital is very poor across the regions. The percentage of households having account in commercial banks / self-help groups / co-operative societies is around 31 percent in all the zones. However, membership in other organizations such as JFM/ VP and in irrigation/tank organizations is not even one percent across the zones. Overall, the index of social capital is very low and similar across the zones

The performance of all the capitals across the zones reveals that the values of human and natural capital are higher in all the zones irrespective of their irrigation status. The relative development of districts in all the three regions has been compared on the basis of the values of the mean and standard deviation of the composite indices. In all the regions for all capitals, more number of districts fall in the middle level of development

Correlation analysis between natural capital and other capitals reveals that both human and physical capitals are positively correlated with natural capital. Though there is a negative relationship between natural, financial and social capitals, the relationship is not statistically significant. Overall, the asset position of the households in dry zones is not very strong to support them in the event of risk and uncertainty. However, the positive relationship between the natural, human and physical capitals suggests that better use and enhancement of the available natural resources will improve the asset position of these households.

CHAPTER - III
Poverty in Dry Land Areas

3.1 Introduction

Sustainable livelihoods will meet the needs of the present generation without compromising the future generation to meet their own needs. Thus, livelihood security and environmental sustainability are the expected outcomes. Livelihood security comprises attributes related to the level of income, stability of income, and reduction in the overall risk profile of households. This in turn makes the people less vulnerable in terms of their capability to manage adverse trends or cope with shocks. Environmental sustainability refers to the stability of resources such as soils, water, rangeland, forests and biodiversity.

In order to assess the livelihood security, poverty and inequalities in expenditure across income groups are considered. People undertake various strategies in order to come out of poverty and tend to use resources extensively or migrate to different areas in search of better livelihood opportunities. Hence the relationship between poverty and environmental degradation is close. Many studies examined this relationship in the context of achieving sustainable development. The debate is discussed briefly in the following section.

3.2 The Link between Poverty and Environmental Degradation

A prevalent view in the decade from the mid-1980s to mid-1990s was that poverty and environmental degradation are intimately connected. Poor people often lack sufficient income to purchase the tools and materials required to practice environmentally sustainable techniques. They do not own resources and thus have no incentive to conserve soil, harbour groundwater, and preserve trees.

Property rights to resources such as land, water and forests are divided into open access, communal ownership, private property, and state property. These rights are prone to externalities where the costs and benefits of a particular behaviour or action are not borne by the same person. Poverty may force people to use available resources to the limit and beyond. Extreme hunger leads to desperate strategies for survival and attempts to survive take precedence in the short run over long run sustainability. The poor lose

their capacity to sustainably support themselves when their access to resources is diminished because of population pressure, construction of dams, establishment of plantation forests, etc. As a result, they may cut down forests for agricultural land and fuel wood, which can lead to soil degradation, loss of soil nutrients, flooding, sinking of groundwater levels, siltation of rivers and lakes, and other ecological problems, thus initiating a vicious spiral of environmental degradation and poverty (Prinstrup Anderson and Rajul Panday Lorch, 1994). The authors argue that population growth is the key catalyst to poverty-led environmental degradation.

Increasing population density and the consequent landlessness pushes people into marginal zones that cannot sustain permanent cultivation (Ellis, 2000). Wars, social strife, and natural disasters force population to become more mobile. Large scale migration within and between regions may not only cause environmental degradation but may also result from it (Prinstrup Anderson and Rajul Panday Lorch, 1994).

According to Vyas VS (2003), the importance of population growth and poverty is still important, but its importance has been declining relative to the pressure of the demand from affluence. The poor are increasingly becoming the victims of natural resource degradation in the form of shortage of fuel, fodder, and drinking water (Rao CHH, 2005).

Poverty need not lead to environmental degradation. It is a combination of poverty, population growth, land constraints, and lack of appropriate production techniques that result in environmental degradation (Prinstrup Anderson and Rajul Panday Lorch, 1994).

3.3 Link between Agricultural Intensification and Environmental Degradation

The inter-connected challenges for a country aiming to achieve sustainable development are alleviation of poverty, meeting the current and future food supply, and managing the natural resource base. It has been found in many developing countries that agricultural intensification addressed the root causes of poverty. However, there are growing concerns that the agricultural intensification leads to degradation of natural resources. The intensive use of fertilisers, pesticides, irrigation, high-yielding varieties, mechanical technology, excessive animal pressure on pasture lands, increased deforestation, soil erosion, desertification, water logging, and salinisation of soils. Thus, meeting the current and future food needs may be in conflict with the goal of protecting the productive capacity of the natural resource base. It has been pointed out agricultural intensification need not degrade the environment, but excessive use of water, overgrazing, and untimely applications of fertilizers can lead to environmental degradation (Ibid., 1994).

3.4 Programmes for Poverty Alleviation

Increase in productivity in irrigated regions can be expected to help reduce poverty with combined efforts to improve infrastructure and institutions for delivery of services. Migration and development of the non-agricultural sector will help in reducing poverty in less irrigated areas. However, diversification and economic growth take too long to solve the problem of poverty. Hence, anti-poverty programmes are introduced in the country to alleviate poverty in the short term; but these suffered from difficulties in targeting benefits to the poor and encouraging repayment of loans. On the other hand, employment programs have a greater capacity to help the poorest people because they can be self-targeted and also create durable infrastructure that leads to development. It has been pointed out that the asset creating impact of employment programmes was exaggerated due to the low quality of work they produce. For example, soil and water conservation programmes based on employment programmes may create only illusory gains. Thus, it is argued that the link between public employment and rain-fed agricultural development is more complex (John M Kerr, 1996).

With this background, this chapter examines poverty and environmental degradation in the dry land areas of India.

3.5 Methodology

Poverty has been examined in terms of extent, intensity, severity and consumption inequalities. The analysis is based on unit record data of the 61st Round (2004-05) of the National Sample Survey (NSS) on Consumer Expenditure. The household data is aggregated for six agro-climatic zones namely Arid High Irrigated (AHI), Arid Less Irrigated (ALI), Semi-Arid High Irrigated (SAHI), Semi-Arid Less Irrigated (SALI), Dry-Sub-Humid High Irrigated (DSHHI), and Dry-Sub-Humid Less Irrigated (DSHLI). The classification considers the level of aridity and irrigation, and takes into account the household level multipliers supplied by the NSS database. As validation for proper use of multipliers, the monthly per capita expenditure at the state level is first derived and compared with the results published by the NSS.

Poverty line is the most important parameter needed in the estimation of poverty. The study has taken the poverty lines estimated by the Planning Commission for each state for the year 2004-05. Four measures have been used, viz., Head Count Ratio, Poverty Gap, Squared Poverty Gap, and Sen's Index.

The widely used head count ratio (H) is the proportion of population whose consumption (Y) is less than the poverty line (Z). The measure is easy to understand but not sensitive to changes in income as long as these changes do not move a person from one side of the poverty line to the other.

$$H = Q / N$$

Where Q = Number of Poor Persons

N = Total Population

The poverty gap index (PG) measures the depth of poverty as it depends on the distance from the poverty line as well as the number of poor. It does not indicate the severity of poverty as it uses no weight for the gap from the poverty line.

$$PG = \frac{1}{N} \sum_{i=1}^{Q} (Z - Y_i) / Z$$

Where Q = Number of Poor Persons

Z = Poverty Line

Y = Monthly Per Capita Consumer Expenditure

N = Total Population

The Squared Poverty Gap (SPG) proposed by Foster-Greer-Thorbecke indicates the severity of poverty.

$$SPG = \frac{1}{N} \sum_{i=1}^{Q} ((Z - Y_i) / Z)^2$$

Where Q = Number of Poor Persons

Z = Poverty Line

Y = Monthly Per Capita Consumer Expenditure

N = Total Population

Sen (1976) proposed an index of poverty that combines the number of poor, the depth of poverty and the distribution of the poor within the group:

$$P_s = H G^p + PG (1 - G^p)$$

Where H = Head Count Ratio

PG = Poverty Gap Index

G^p = Gini Co-efficient of inequality among the poor

3.6 Poverty in Dry Land Areas

The estimates of poverty are presented for the agro-ecological regions of the country based on the unit level data of the 61st Round of NSS on Consumer Expenditure for the year 2004-05. For this purpose, poverty-lines defined by the Planning Commission for each state are considered and the same are used for the districts of each state. To estimate the number of poor, the monthly per capita consumer expenditure based on a uniform reference period of 30 days has been used.

The size distribution of population across the agro-climatic zones reveals that around 47 percent of the population lives in dry land areas in India. Within the dry land types, the highest proportion of population is found in the semi-arid areas with 30.4 percent, followed by 11.9 percent in dry-sub-humid areas. Arid areas have less proportion of population of 4.3 percent. The proportion of population is high in highly irrigated areas in all the dry land types. Around 41 percent of the people in dry land areas are living below the poverty line. The distribution of poor is similar to the distribution of population across the dry land types. The highest proportion of poor persons is found in the semi-arid and humid areas, with 23 and 15 percent respectively, while the share of population is 12 percent in the dry-sub-humid areas. The percentage of poor in arid areas is estimated at 3.2 percent (Table 3.1).

Table 3.1: Distribution of Rural Population and Poor across Dry Land Areas: 2004-05

Agro-Ecological Region	Population (in Millions)	Percentage of the Total	Poor (in Millions)	Percentage of the Total
Arid High Irrigated	18.4	2.5	3.7	1.8
Arid Less Irrigated	13.3	1.8	2.8	1.4
Arid	34.7	4.3	6.5	3.2
Semi-Arid High Irrigated	132.9	18.1	26.4	12.8
Semi-Arid Less Irrigated	90.4	12.3	21.1	10.2
Semi-Arid	223.3	30.4	47.5	23.0
Dry-Sub-Humid High Irrigated	64.2	8.8	20.7	10.1
Dry-Sub-Humid Less Irrigated	22.5	3.1	9.4	4.6
Dry-Sub-Humid	86.7	11.9	30.1	14.7
Dry Land	**341.6**	**46.6**	**84.1**	**40.9**
Total	**733.1**	**100.0**	**205.5**	**100.0**

The incidence of poverty is estimated at 25 percent in the dry land areas while it is 28 percent at the all-India level. Both arid and semi-arid areas have shown the same level of incidence of 21 percent while it as high as 35 percent in the dry-sub-humid areas. The incidence of poverty is higher in the less irrigated areas as compared to that of the high irrigated areas across all the dry land types. However, the difference is very significant in the dry-sub-humid areas with high irrigated areas registering 32.3 percent, while it is 42 percent in the less irrigated areas (Table 3.2).

Table 3.2: Incidence of Poverty across Dry Land Areas: 2004-05

Agro-Ecological Region	Head Count Ratio	Poverty Gap	Squared Poverty	Sen's Index
Arid High Irrigated	20.1	2.1	1.03	3.82
Arid Less Irrigated	21.2	3.7	0.99	5.22
Arid	20.6	2.5	1.02	2.66
Semi-Arid High Irrigated	19.9	3.5	0.92	4.87
Semi-Arid Less Irrigated	23.3	4.5	1.29	6.24
Semi-Arid	21.3	3.9	1.07	3.59
Dry-Sub-Humid High Irrigated	32.3	6.2	1.77	8.47
Dry-Sub-Humid Less Irrigated	41.6	9.2	2.93	12.39
Dry-Sub-Humid	34.7	6.9	2.07	6.29
Dry Land	**24.6**	**4.5**	**1.32**	**4.08**
Total	**28.0**	**5.5**	**1.62**	7.77

The other measures of poverty such as poverty gap, squared poverty and Sen's index show almost the same ranking of the regions as the head count ratio. These measures confirm that the less irrigated areas in all the regions and dry-sub-humid zones across the dry land types need special attention.

The severity of poverty across these zones has also been examined: The percentage of the poorest of poor persons is estimated at 7.3 percent in dry land areas while it is 9 percent at the all-India level. This proportion is very high in the dry-sub-humid zone at 12.2 percent, followed by 6 percent in the semi-arid areas. The proportion of moderately poor is also high at 23 percent in the dry-sub-humid zone. Both arid and semi-arid areas have shown same proportion of these people with 16 percent each. As observed earlier these proportions are higher in the less irrigated areas (Table 3.3).

Table 3.3: Severity of Poverty across Dry Land Areas: 2004-05

Agro-Ecological Region	Poorest of the Poor	Moderately Poor	Non-Poor	Rich
Arid High Irrigated	5.5	14.6	41.7	38.2
Arid Less Irrigated	4.5	16.8	43.3	35.4
Arid	5.1	15.5	42.4	37.0
Semi-Arid High Irrigated	10.4	21.9	36.5	31.2
Semi-Arid Less Irrigated	17.2	24.4	32.7	25.7
Semi-Arid	12.2	22.6	35.5	29.8
Dry-Sub-Humid High Irrigated	9.9	22.0	35.9	32.2
Dry-Sub-Humid Less Irrigated	4.9	15.0	36.1	44.0
Dry-Sub-Humid	6.9	16.4	37.4	39.3
Dry Land	**5.7**	**15.5**	**36.6**	**42.1**
Total	**7.3**	**17.3**	**36.9**	**38.5**

Poorest of the Poor: MPCE < 75% of Poverty Line; Moderately Poor: MPCE between 75% and 100% of Poverty Line; Non-Poor: MPCE between 100% and 150% of Poverty Line; Rich: MPCE >150% of Poverty Line.

The inequality in consumption expenditure across dry land areas has been calculated using the Gini co-efficient of inequality measure. While the incidence, intensity and severity of poverty vary widely between the dry land zones and between high and less irrigated areas within the dry land types, the inequality in the monthly per capita consumption expenditure ranges between 26 and 30 percent across all dry land types. The average monthly per capita consumption expenditure is estimated at Rs.561 for dry land areas. It is comparatively less at Rs.519 in the dry-sub-humid areas and even lower at Rs.432 in the less irrigated areas of this zone (Table 3.4).

Table 3.4: Inequality in Consumption Expenditure and Average MPCE

Agro-Ecological Region	Gini-Coefficient (%)	Average MPCE (Rs.)
Arid High Irrigated	26.3	596.49
Arid Less Irrigated	25.5	512.74
Arid	26.3	561.41
Semi-Arid High Irrigated	28.6	590.72
Semi-Arid Less Irrigated	28.6	557.91
Semi-Arid	28.6	577.44
Dry-Sub-Humid High Irrigated	31.0	549.31
Dry-Sub-Humid Less Irrigated	27.5	432.50
Dry-Sub-Humid	30.6	518.96
Dry Land	29.0	561.11
Total	30.0	558.80

3.6.1 Poverty across Social Groups

Poverty among the STs and SCs is 43 and 34.2 percent respectively. It is observed that poverty among the STs and SCs is higher in the dry-sub-humid areas when compared to the arid and semi-arid areas in the country. This ratio is 66.1 percent for the STs and 45 percent for the SCs in the dry-sub-humid areas. Though the percentage of SC and ST population is lower in these areas at 9 and 13 percent respectively, poverty is very high among the STs and SCs in this region. While the percentage of ST and SC population is 26 and 31 percent respectively in the semi-arid areas, the incidence of poverty is 43 percent among the STs and 35 percent among the SCs. It is observed in the earlier section that the incidence of poverty is high in the less irrigated areas. The same could be seen among social groups also except in the arid areas where the incidence is found to be very high in the high irrigated areas for the STs and SCs. While 55 percent of the ST population is poor in the high irrigated areas, it is 26 percent in the less irrigated areas. The incidence of poverty is 37 percent among the SCs in the high irrigated areas while it is 32 percent in the less irrigated areas of this region. Further the difference in the incidence between high and less irrigated areas is prominent in the semi-arid areas with just 19 percent in the high irrigated areas and as high as 43 percent in the less irrigated areas. Thus, the concentration of the STs and high incidence of poverty in the semi-arid and dry-sub-humid zones especially in the less irrigated areas requires special attention in policy making. On the contrary, the SC population is concentrated in the high irrigated areas and most of them work as agricultural labour. However, the incidence of poverty is less in the high irrigated areas as compared to that of the less irrigated areas for the SCs. From the above analysis it is found that the

incidence of poverty is higher among the STs and SCs than in the general population. Moreover the STs are mainly concentrated in the less irrigated semi-arid and dry-sub-humid areas while the SCs are concentrated in the high irrigated areas of these two zones (Table 3.5).

Table 3.5: Incidence of Head Count Poverty across Social Groups: 2004-05

Agro-Ecological Region	Scheduled Tribe		Scheduled Caste		Others	
	Incidence (%)	Population (%)	Incidence (%)	Population (%)	Incidence (%)	Population (%)
AHI	54.9	1.0	36.6	3.1	11.9	2.5
ALI	25.8	1.8	32.0	1.4	18.2	1.9
Arid	36.5	2.8	35.2	4.5	14.6	4.5
SAHI	19.4	8.1	27.2	21.7	17.3	17.5
SALI	42.9	17.5	34.7	9.6	16.3	12.7
Semi-Arid	35.5	25.5	29.5	31.3	16.9	31.0
DSHHI	60.2	1.9	43.9	10.9	27.2	8.2
DSHLI	67.6	7.2	49.3	2.3	28.7	2.8
Dry-Sub-Humid	66.1	9.0	44.8	13.3	27.5	11.8
Dry Land	**42.9**	**37.4**	**34.2**	**49.0**	**19.3**	**47.3**
Total	**44.7**	**100.0 (77.5)**	**37.1**	**100.0**	**22.7 (153.4)**	**100.0 (501.9)**

Figures in the parentheses indicate the total population of the corresponding social group in millions.

3.6.2 Poverty across Occupational Groups

Across the occupations, the highest incidence of poverty is found among agricultural labour households at 39 percent, followed by non-agricultural labour at 29 percent. The lowest percent of poor is found among the regular employees at 6 percent, and among the self-employed in agriculture at 18 percent. The same pattern could be observed across the dry land types except in the arid areas where the percentage of poor among the self-employed in non-agriculture is lower than that of agriculture (Table 3.6).

The incidence of poverty is higher among the agricultural labour households in all the zones and very high in case of the dry-sub-humid region at 60 percent. The incidence of poverty is significantly high in the less irrigated areas both in the arid and semi-arid areas while it is the same between the less and high irrigated areas in the dry-sub-humid

regions. Less irrigated areas have shown higher incidence of poverty among both agricultural and non-agricultural labour households in all the zones except in the arid areas.

Table 3.6: Incidence of Head Count Poverty across Occupational Groups: 2004-05

Agro-Ecological Region	Self-Employed		Casual Labour		Regular Employed	All
	Agriculture	Non - Agriculture	Agriculture	Non - Agriculture		
AHI	14.7	13.5	36.4	37.7	5.4	20.1
ALI	14.6	11.9	37.6	21.4	2.6	21.2
Arid	14.7	12.8	37.0	31.4	4.7	20.6
SAHI	15.8	19.4	27.6	25.1	4.7	19.9
SALI	14.5	14.8	38.9	27.6	6.0	23.3
Semi-Arid	15.3	17.9	32.9	26.1	5.3	21.3
DSHHI	23.6	30.6	59.7	32.7	9.5	32.3
DSHLI	32.2	32.8	59.7	59.1	7.1	41.6
Dry-Sub-Humid	25.9	31.0	59.7	40.0	9.0	34.7
Dry Land	18.2	20.8	39.1	29.3	6.1	24.6
Total	**21.4**	**23.7**	**44.2**	**32.6**	**8.9**	**28.0**

3.6.3 Poverty and Agricultural Productivity

Productivity of crops such as cereals and pulses is higher in the high irrigated areas of the dry land regions. It has been found in many studies that productivity and poverty are negatively correlated. That indicates that in areas of higher productivity, poverty tends to be low. The same has been found in our study also.

Estimates of poverty across crop-based and irrigation-based typologies for dry land types show that the incidence of poverty is very high in the areas of rice/wheat-based cropping pattern. A major portion of the area under these crops falls in the dry-sub-humid and semi-arid zones, which experience high incidence of poverty (Table 3.7 to Table 3.10). Poverty is observed to be higher at 32.8 percent in the dry-sub-humid region.

Further, poverty is found to be very high in the less irrigated areas of the dry-sub-humid region for all crop-based types while it is higher for rice/wheat in the less irrigated tracts of the semi-arid areas. The density of population is observed to be high in areas of wheat/rice production, and areas with another set of crops, viz., coarse cereals / pulses

have also shown higher incidence of poverty. Again the area under these crops is found to be higher among the semi-arid and dry-sub-humid regions, which are poverty-stricken areas. Lowest poverty is observed in the areas of oilseeds at 17 percent. It is observed that high level of irrigation increases productivity which in turn reduces the incidence of poverty in dry land types.

Table 3.7: Crop-based Incidence of Poverty in Dry Land Areas: 2004-05

Crop-based Typology	High Irrigated	Less Irrigated	All Areas
Rice/Wheat	27.4	45.9	28.5
Rice/Wheat & Others	15.3	35.2	16.6
Coarse Cereals / Pulses	22.6	26.0	24.8
Coarse Cereals / Pulses & Others	23.0	27.2	25.8
Oilseeds	16.8	16.9	16.9
Oilseeds & Others	25.0	--	25.0
All Areas	**23.6**	**26.3**	**24.6**

Table 3.8: Crop-based Incidence of Poverty in Arid Areas: 2004-05

Crop-based Typology	High Irrigated	Less Irrigated	All Areas
Rice/Wheat	20.5	--	20.5
Rice/Wheat & Others	17.0	--	17.0
Coarse Cereals / Pulses	18.1	13.6	17.2
Coarse Cereals / Pulses & Others	23.1	28.1	25.5
Oilseeds	--	15.1	15.1
Oilseeds & Others	--	--	--
All Areas	**20.1**	**21.2**	**20.6**

Table 3.9: Crop-based Incidence of Poverty in Semi-Arid Areas: 2004-05

Crop-based Typology	High Irrigated	Less Irrigated	All Areas
Rice/Wheat	23.7	47.6	24.2
Rice/Wheat & Others	15.2	14.2	15.1
Coarse Cereals / Pulses	23.3	25.7	25.0
Coarse Cereals / Pulses & Others	14.5	21.2	19.3
Oilseeds	10.5	11.8	11.3
Oilseeds & Others	--	--	--
All Areas	**19.9**	**23.3**	**21.3**

Table 3.10: Crop-based Incidence of Poverty in Dry Sub-Humid Areas: 2004-05

Crop-based Typology	High Irrigated	Less Irrigated	All Areas
Rice/Wheat	31.5	45.5	32.8
Rice/Wheat & Others	--	59.9	59.9
Coarse Cereals / Pulses	36.6	41.9	40.5
Coarse Cereals / Pulses & Others	51.5	45.4	47.1
Oilseeds	38.1	26.3	29.2
Oilseeds & Others	25.0	--	25.0
All Areas	**32.3**	**41.6**	**34.7**

3.6.4 Poverty and Livelihood Development Index

It has been well recognized that for addressing poverty, a comprehensive understanding of the livelihoods of rural people is essential. Through the portfolio of various assets of the rural households we can understand the status of their livelihoods. Chapter II provides a composite index of livelihood development. An attempt is made in this section to understand the incidence of poverty and the ranks of livelihood development. A correlation is run between the incidence of poverty and livelihood development index for 211 dry land districts of India. A statistically significant negative relationship was found indicating that the value of livelihood development index is higher in those areas with lesser incidence of poverty (-0.242, significant at 1 percent level). However, there are inter-state or inter-region inequalities in this respect. The ranks for livelihood development index is arrived by taking the values of the sum and difference of the mean and standard deviation of the livelihood development index (see Chapter II). The districts which are listed as rank 1 districts are compared with the data on the incidence of poverty for the year 2004-05. Out of the 211 districts, 30 districts fall under rank 1spreading across seven states namely, Andhra Pradesh, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh, Madhya Pradesh and Gujarat. In the case of Maharashtra, out of 8 districts of this category, 4 districts show higher incidence of poverty than that of the state average. All these districts belong to the less irrigated tracts of the semi-arid and dry-sub-humid zones. However, in Tamil Nadu, out of 9 developed districts, only one district has shown higher incidence of poverty (Table 3.11). The negative relationship between incidence of poverty and livelihood development index is a good indication for the overall human development of a region but the inter-regional differences need to be checked.

Table 3.11: Poverty and Livelihood Development

Area	State	District	Incidence of Poverty*	Livelihood Development Index
SAHI	Andhra Pradesh (11.2)	West Godavari	4.38	0.38
	Andhra Pradesh	Nellore	14.09	0.39
	Andhra Pradesh	Chittor	15.93	0.38
	Maharashtra (29.6)	Satara	4.88	0.37
	Punjab (9.1)	Kapurthala	4.15	0.36
	Tamil Nadu (22.8)	Erode	16.93	0.42
	Tamil Nadu	Dindigal	10.29	0.36
	Tamil Nadu	Tiruchirapalli	19.79	0.38
	Tamil Nadu	Cuddalore	14.01	0.36
	Tamil Nadu	Pudukottai	18.61	0.36
	Tamil Nadu	Madurai	18.59	0.35
	Tamil Nadu	Tirunelveli	23.63	0.39
	Tamil Nadu	Kanyakumari	19.78	0.36
	Uttar Pradesh (33.4)	Jaunpur	27.88	0.37
SALI	Andhra Pradesh	Medak	9.32	0.44
	Andhra Pradesh	Prakasam	9.87	0.37
	Gujarat	Amreli	0.49	0.36
	Gujarat	Bharuch	17.10	0.37
	Maharashtra	Jalgoan	22.76	0.37
	Maharashtra	Amravathi	39.45	0.36
	Maharashtra	Nasik	47.97	0.42
	Maharashtra	Ahmadnagar	10.31	0.35
	Maharashtra	Solapur	11.04	0.36
	Madhya Pradesh (36.9)	Khandwa	4.70	0.38
	Tamil Nadu	Salem	37.43	0.37
DSHHI	Maharashtra	Bhandara	51.23	0.39
	Punjab	Ludhiana	0.94	0.36
	Punjab	Hoshiarpur	1.73	0.36
DSHLI	Maharashtra	Nagpur	39.26	0.37
	Madhya Pradesh	Rajgarh	11.86	0.36

* *Source:* Jyothis Satyapalan, Livelihoods and Natural Resource Management in the Dry Lands of India: An Approach Paper, March, 2010, RUNLR, CESS, Hyderabad.
Figures in the parentheses indicate state level poverty ratios for the year 2004-05

3.7 Environmental Degradation in Dry Lands in India

The analysis of poverty in the above section shows that the incidence of poverty is lower in the dry land areas as compared to the all-India level. However, the less irrigated areas in the dry land zones have shown higher incidence of poverty. Not only the incidence, but other measures such as severity, intensity, and inequality of consumption expenditure are high in these areas. Further, it has been observed that where the agricultural productivity is higher, the incidence of poverty is lower. Thus, increase in the level of irrigation and productivity lead to reduction in poverty. However, high irrigation and application of fertilisers and other materials to increase productivity result in environmental degradation. Thus, the resources must be managed efficiently to avoid such degradation. The environmental degradation across the dry land states is presented in the subsequent paragraphs.

Table 3.12 presents various forms of land degradation in the country during different time periods. It shows that more than 50 percent of the geographical area was degraded in the years 1981, 1985 and 1997, and there has not been much improvement in the situation for more than a decade. However, the latest data show that the percentage of area under problem declined to 45 percent during the year 2007. Water and wind erosion is the major form of land degradation which occupies more than 40 percent of the total degraded land during the 1980s and 1990s. This has come down to 31.4 percent in 2007.

Table 3.12: Distribution of Estimated Area under Different Problems

(Percentage of Geographical Area)

Form of Degradation	1981	1985	1997	2007
Area Subjected to Water and Wind Erosion	45.6	42.9	43.8	31.4
Water Logged Area	1.8	2.6	2.6	4.4
Saline Soils	1.7	1.7	1.7	1.8
Total Problem Area	**53.2**	**53.2**	**52.8**	**44.7**

Source: Indiastat.com

The situation of land degradation across the dry land states is given in Table 3.13. Out of the 11 dry land states, Rajasthan registered a higher percentage of degraded area, with 56 percent in 1994. This is followed by Gujarat and Haryana with 43 percent each in the same period. More than 30 percent of the degraded land is found in Andhra Pradesh, Uttar Pradesh, Tamil Nadu, and Haryana. This proportion ranges between 25 and 30 in Madhya Pradesh, Maharashtra, and Bihar. Punjab has shown the lowest proportion with 21 percent.

However, the present situation has completely changed. Majority of these states have increased their share of degraded land in 2007. These states include Andhra Pradesh, Bihar, Haryana, Madhya Pradesh, Maharashtra, Punjab, Tamil Nadu, and Uttar Pradesh; Rajasthan, which had the highest percentage of degraded land in 1994, has shown less percentage (33 percent) of such land in 2007; Karnataka also gained some improvement in reducing such degradation from 43 percent in 1994 to 40 percent in 2007; in Andhra Pradesh, Madhya Pradesh, and Uttar Pradesh more than 50 percent of the land is degraded; and in Gujarat, Maharashtra, and Tamil Nadu more than 40 percent of the land is degraded. Hence, proper measures must be taken to reduce land degradation in these states.

Table 3.13: Distribution of Estimated Area under Degradation in Dry Land States

(Percentage of Geographical Area)

State	1994	2007
Andhra Pradesh	35.1	54.5
Bihar (including Jharkhand)	27.4	36.1
Gujarat	43.6	41.5
Haryana	32.6	33.2
Karnataka	43.2	39.8
Madhya Pradesh (including Chhattisgarh)	28.7	59.1
Maharashtra	24.2	42.4
Punjab	21.2	25.4
Rajasthan	55.5	33.2
Tamil Nadu	31.6	41.0
Uttar Pradesh (including Uttaranchal)	34.3	52.0

While expanded irrigation has played an essential role in meeting the food demand and removal of poverty, excessive water use has resulted in widespread water logging and salinisation. Similarly, while fertiliser use can replace soil nutrients and inhibit environmental degradation, excessive use or inappropriate application can result in water contamination. These conditions are consequences of market and policy failures, lack of knowledge of hazards involved with some inputs, and lack of knowledge of alternative techniques. It has been pointed out that poor management of irrigation has led to considerable degradation of this source, and little effort is made to engage in canal improvements, provide drainage, and improve the efficiency of water use. Increased use of groundwater for irrigation poses further environmental threat. No proper checking

of excessive use of groundwater will question the sustainability issues. As irrigation will increase food production in future, efforts must be made to address the technological and management problems that lead to water logging and salinity.

3.8 Summary

Sustainable livelihoods will make the household meet their present needs and increase their capacity to adjust and withstand any risks that come in their way of life. While meeting the present demand for food and other sources, the livelihoods should not deprive the future generation of its food requirements. Thus, environmental sustainability is essential to attain sustainable livelihoods and development. Hence, poverty and environmental problems are examined to assess the livelihood outcomes.

The incidence of poverty in dry land areas is less compared to other areas, and is estimated at 25 percent in the dry land areas while it is 28 percent at the all-India level. Both arid and semi-arid areas have shown the same level of incidence at 21 percent while it as high as 35 percent in the dry-sub-humid areas. The incidence of poverty is higher in the less irrigated areas as compared to that of the high irrigated areas across all the dry land types. The percentage of poorest of poor persons is estimated at 7.3 percent in dry lands while it 9 percent at the all-India level. This proportion is very high in the dry-sub-humid zone at 12.2 percent, followed by 6 percent in the semi-arid areas.

While the incidence, intensity and severity of poverty vary widely between the dry land zones and between the high and less irrigated areas within the dry land types, the inequality in the monthly per capita consumption expenditure ranges between 26 and 30 percent across all dry land types.

Across social groups, the incidence of poverty is higher among the STs and SCs than among the general population. Moreover, the STs are mainly concentrated in the less irrigated semi-arid and dry-sub-humid areas while the SCs are concentrated in the high irrigated areas of these two zones.

Among the occupational groups, the incidence of poverty is higher among the agricultural labour households in all the zones, and it is very high in the case of the dry-sub-humid region at 60 percent. The less irrigated areas have shown higher incidence for both agricultural and non-agricultural labour households in all the zones except in the arid areas.

Estimates of poverty across crop-based and irrigation-based typologies for dry land types show that the incidence of poverty is very high in the areas of rice/wheat-based cropping pattern. A major portion of the area under these crops falls in the dry-sub-

humid and semi-arid zones which experience high incidence of poverty, and the lowest incidence of poverty (17 percent) is observed in the areas of oilseeds.

A correlation between the incidence of poverty and livelihood development index for 211 dry districts showed a statistically significant negative relationship, indicating that the value of livelihood development index is higher in those areas with lesser incidence of poverty. However, there are inter-state or inter-region inequalities in this respect.

The analysis of poverty shows that the incidence of poverty is lower in dry land areas as compared to the all-India level. However, the less irrigated areas in the dry land zones have shown higher incidence of poverty. Not only the incidence, but other measures such as severity, intensity, and inequality of consumption expenditure are high in these areas. Further, it has been observed that where the agricultural productivity is higher, the incidence of poverty is lower. Thus increase in the level of irrigation and productivity leads to reduction in poverty. However, high irrigation and application of fertilisers and other materials to increase productivity result in environmental degradation. Thus, the resources must be managed efficiently to avoid such degradation.

The estimates of environmental degradation across the dry land states show that more than 50 percent of the geographical area was degraded during the years 1981, 1985 and 1997. The area subjected to water and wind erosion, which are the major forms of land degradation, is more than 40 percent of the total land degraded during the 1980s and 1990s. This has come down to 31.4 percent in 2007. A majority of the states have increased their share of degraded land in 2007. These states include Andhra Pradesh, Bihar, Haryana, Madhya Pradesh, Maharashtra, Punjab, Tamil Nadu, and Uttar Pradesh.

The incidence of poverty in dry land areas is lesser compared to other areas. This has been so for various measures of poverty that are examined such as poverty gap, squared poverty gap, Sen's index, Gini co-efficient of inequality of expenditure and intensity of poverty. However, in all these aspects, the less irrigated areas in all the dry land types in general and semi-arid and dry-sub-humid areas in particular have shown weak performance. Though the situation is better in the high irrigated areas, most of the dry land states have experienced a great degree of land degradation. Proper management of surface and ground water irrigation sources will enable the country to come out of the vicious spiral of poverty-agricultural intensification- environmental degradation.

CHAPTER - IV
Agricultural Intensification in Dry Lands of India

4.1 Introduction

Dry land agriculture occupies a distinct place in Indian agriculture. It spreads up to around 50 percent of the total gross area cultivated in the country. Dry land areas account for 45 percent of the total area under cereal production, 66 percent of the area under oilseeds, and 68 percent of the area under non-food crops (Shah et al., 1998). Dry land farming is a risky enterprise characterised by very highly variable and uncertain yields. Although a major constraint is deficient water, hazards such as insects, diseases, hail, high wind, and intensive rains can destroy crops. Further farmers in the dry land regions are resource-poor and these areas receive low priority in the process of policy making. In spite of these difficulties, dry land agriculture occupies an important role in the national economy and has a significant role to play in meeting the future demand for food grains.

Studies on agriculture in India examined its performance for general, rain-fed, and dry land situations. Based on the value of the index of aridity, the total area of the country is classified into arid, semi-arid, dry-sub-humid, moist-sub-humid, humid and per-humid areas. The areas shown under arid, semi-arid, and dry-sub-humid together constitute dry lands according to NBSS & LUP. The criteria used to define rain-fed areas differ among different scholars. The threshold level for both irrigation and rainfall are fixed differently by these scholars (John M Kerr, 1996). SL Bapna et al (1981) categorised those areas as rain-fed which had less than 25 percent of the area under irrigation and an average annual rainfall of 500-1500 mm. The threshold limits fixed by S Jodha (1985) are same as that of SL Bapna. Shah and DC Shah (1993) defined an area as rain-fed which has less than 25 percent of area under irrigation and average annual rainfall of 400-750 mm. SK Throat (1993) defined those areas as rain-fed where the percentage of gross cropped area under irrigation is less than 10 percent and average annual rainfall is 375-750 mm. In fact, the area under rain-fed keeps on changing as the ratio of irrigated area is increasing over time and there are frequent changes occurring in the climate.

The performance of agriculture in terms of growth of output, area, yield and utilization, and impact technology has been examined at the regional level and district-level. Macro-level studies developed their own definition of rain-fed areas or classification of states into different regions (John M Kerr, 1996; Bhalla & Gurmail Singh, 2001). In general, the terms rain-fed areas and dry lands areas have been used interchangeably in many studies.

There are three distinct phases in India agrarian history: pre-Green Revolution during the 1950s-1960s; the Green Revolution period during the 1970s and 1980s; and liberalization during the 1990s and after. Prior to the 1960s, farmers used indigenous technologies evolved over hundreds of years experience and passed it on generation after generation. Subsistence farming and sustainable agricultural practices went hand in hand. Crop selection, specialization, crop mixes, and selection of seed varieties varied in response to ecological variations. Each community or locality was self-sufficient in terms of nutrition to humans, animals and soils. Under the Colonial rule, Indian agriculture gradually retreated from sustainable to commercial agriculture. As commercial crops were grown as mono-crops, farmers became vulnerable to droughts and famines. The Bengal Famine (1943-44) was largely the result of cash crops like jute leading to rise in the prices of food grains. During the post-independence period, the Indian political leaders favoured the Green Revolution technologies to increase agricultural production (Suryakumar, 2010).

GS Bhalla and Gurmail Singh (2010) provided a district-level analysis of the growth of agriculture covering the periods of Green Revolution and reforms. The study found a significant increase in the yield and output of wheat in many districts in the irrigated north-western region of Punjab, Haryana, and western Uttar Pradesh during the period 1962-65 to 1970-73. The study observed that there was no significant growth in the non-Green Revolution eastern, central and southern regions. The authors pointed out that the level of productivity was positively related to the levels of use of modern inputs such as fertilizers, irrigation, tractors and tube-wells. For the period 1980-83 to 1990-93, the study observed a significant change in the cropping pattern away from coarse cereals towards oil-seeds and other commercial crops particularly in the central region, but to a lesser extent in the southern region. There was a shift from coarse cereals to oilseeds in the central region while there was a shift from coarse cereals to wheat and rice in the north-western and the eastern regions. Another interesting observation of the study was that agricultural output during the periods 1990-93 to 2003-06 was sustained primarily because of the rise in productivity recorded by low yield rain-fed districts in the central states of Gujarat, Madhya Pradesh, Maharashtra, and Rajasthan, and the northern parts of Karnataka, Andhra Pradesh, and Uttar Pradesh. Though,

Green Revolution helped India attain self-sufficiency in food grain production, the growth was highly unstable and subject to weather-induced fluctuations. While concluding the report, the study argues that excessive use of resources resulted in the depletion of the water table in many irrigated regions, while the disproportionate use of chemical inputs impoverished the environment posing a challenge to the sustainability of agriculture in these states. The diversification away from low value yield coarse cereals and pulses towards oilseeds, cotton and remaining crops has no doubt benefited the resource-poor farmers in the dry land central region. However, large scale diversification away from coarse cereals and pulses towards non-food crops had an adverse impact on food security and availability of animal feed. It also increased their vulnerability and risk to the vagaries of weather and price fluctuations. These risks get further aggravated after trade liberalization because the large fluctuations in international prices got transmitted to domestic markets. Such risks posed a serious problem for the livelihoods of oilseed and cotton farmers in the central region.

The spread of new technology and extensive use of modern inputs in dry land regions resulted in yield improvements which in turn caused environmental damage. Crop diversification away from coarse cereals and pulses towards non-food crops affected food security and resulted in non-availability of animal feed. The season-to-season variation in the amount and timing of rainfall was a major challenge to crop management and the applicability of new technologies in these regions. John M Kerr (1996) gave a detailed account of the technological challenges faced in rain-fed systems. The author argues that in dry areas, traditional varieties are often preferred for their higher fodder yields because of the price premium for quality. Regarding the use of fertilizer in dry areas, soil fertility is the major challenge and requires specific recommendations such as crop rotation, moisture availability, and time of planting. Further the study points out that farmers' knowledge, access to credit, and use of improved varieties affected fertilizer demand.

Since the 1920s, considerable efforts have been made to develop and extend soil and water management technologies in the rain-fed areas of India. The study has also given a detailed account of developments that took place in soil and water conservation in India. The summary of those developments is given as follows:

Bombay Dry Land Farming method focused on contouring, while other land improvement techniques gave little emphasis to agronomic and institutional issues in increasing productivity. Around the year 1970, renewed attempts were made to develop packages for dry land farming based on the micro-watershed approach, which differed from their predecessors both in technologies for soil and water management as well as

improved cropping systems and agronomic practices. In the 1980s attention shifted to integrated watershed management projects that combined the elements of micro-watershed approach with the efforts to manage the whole watershed including community lands.

The impacts of agricultural research in rain-fed areas have been uneven, with significant successes in some areas and types of technologies, and almost no impacts in other areas and technology types. Indian agricultural research tends to focus heavily on on-station work compared to on-farm work. There has been relatively little in-depth research to understand the traditional systems and farmers' rationale for following particular practices. Improved varieties can be the lead technology in the medium and highly rain-fed areas, with complementary investments in agronomic practices where the payoff will be higher. In the marginal areas, soil and water management will be the lead technology as improved varieties are unlikely to have much impact without adoption of practices to improve moisture supply and conservation. Hence, research emphasis on rain-fed areas will depend on the ecological region and over time in the same region.

4.2 Objectives and Methodology

With this background, the following objectives have been set for the study:

1. To examine the intensification of agriculture in high irrigated and less irrigated dry land areas of the country.
2. To analyse the performance of agriculture in terms of cropping pattern and productivity in the dry land areas.

Out of the 211 districts identified as dry land districts for the study, 124 districts fall under high irrigated districts which account for around 59 percent, and 87 districts are less irrigated which account for the remaining 41 percent. Districts with irrigation ratio exceeding 35 percent are categorised as high irrigated.

4.3 Agricultural Intensification in Dry Lands

An important strategy associated with the maximization of output in dry land areas is intensification of agriculture, which takes many forms, viz., irrigation, use of fertilizers, use of draught animals, mechanization, and use of improved seeds. There has been evidence of a major transformation of farming from traditional to the modern methods of cultivation. However, many studies reveal that resource degradation, as a result of modern methods of farming, remains an important challenge that needs further attention.

In order to understand the degree of intensification that has been taking place in the dry lands of India, the study uses the unit record data from 54th Round of the NSSO

for the period January 1998 to June 1998. This round collected information regarding the utilization of facilities in the field of agriculture, viz., use of improved high yielding varieties of seeds, fertilizers, manures, pesticides, etc., and the use of improved agricultural implements such as tractors, power tillers, harvesters, etc.

There are two components of advanced agricultural technology. One is the 'seed-fertilizer-water' which affects the agricultural production by raising the productivity of the land, and the other is 'mechanized technology', i.e., use of capital-intensive farm machinery such as tractors, power tillers, and harvesters. This will fasten the outturn of operations such as ploughing, weeding and harvesting with a substantial reduction in costs (NSSO Report 451, 1999). The following paragraphs describe the spread of these techniques across the dry lands of India.

Table 4.1: Percentage of Area under Crops Cultivated using Technology

Agro-Ecological Zone	Improved Seeds	Fertilizers	Manure	Pesticides	Weedicide	Tractor / Power Tiller	Irrigated Area	Harvesters
AHI	81.3	75.9	66.3	52.6	36.1	92.4	72.6	13.6
ALI	51.6	58.3	70.1	42.0	12.4	54.6	37.1	13.8
SAHI	69.0	90.7	78.2	45.9	25.0	76.6	88.1	5.6
SALI	66.7	84.7	78.2	54.0	19.7	36.2	58.3	6.2
DSHHI	48.0	89.5	78.2	47.1	33.7	63.1	87.4	4.8
DSHLI	34.0	69.5	58.6	29.0	11.7	34.8	49.9	3.2
All-India	**58.7**	**81.0**	**74.2**	**47.1**	**22.2**	**54.0**	**66.3**	**5.7**

4.3.1 Use of Improved Seeds

Since 1980, improved seed technology was spread across different crops and areas of the country. According to the survey for the period 1998, at the all-India level, around 59 percent of the area under crops used improved seeds. This proportion is higher than that of the nation in the high irrigated tracts of the arid region, and both high and less irrigated tracts of the semi-arid regions. This is as high as 81 percent in the high irrigated arid areas and 69 percent in the high irrigated semi-arid areas. The proportion of area under improved seeds is lowest in the less irrigated dry-sub-humid areas at 34 percent (Table 4.1). The tendency of using improved seeds in arid and semi-arid areas will not have much impact on production without adopting improved moisture supply and conservation practices.

At the all-India level, around 52 percent of the area using improved seeds is under certified improved seeds, and 30 percent is under home-grown improved seeds. In the

less irrigated tracts of the semi-arid region nearly 71 percent of area is under certified seeds (Table 4.2).

Further, the area under improved seeds ranges between 46 to 63 percent for different crops except for cash crops which shows 82 percent of the area under improved seeds. Among the food-grains, pulses have less area under improved seeds at the all-India as well as across the dry land types except in the arid zone (Table 4.3).

Table 4.2: Percentage of Improved Seeds Area by Type of Seed

Agro-Ecological Zone	Certified Seeds	Un-certified Seeds	Home-Grown	Others	Total
AHI	62.1	15.9	21.6	0.4	100.0
ALI	61.0	8.0	30.7	0.3	100.0
SAHI	52.6	13.4	30.7	3.7	100.0
SALI	70.4	5.2	22.6	2.1	100.0
DSHHI	40.2	14.3	43.5	2.0	100.0
DSHLI	43.3	16.0	39.1	1.5	100.0
All-India	**51.9**	**12.6**	**33.4**	**2.1**	**100.0**

Table 4.3: Percentage of Improved Seeds Area by Crop

Crop	AHI	ALI	SAHI	SALI	DSHHI	DSHLI	All-India
Paddy	77.8	60.8	71.4	65.4	48.7	10.3	52.3
Wheat	89.8	60.8	70.1	65.0	52.3	30.4	63.1
Other Cereals	88.4	60.0	68.0	65.0	50.6	57.0	63.8
Pulses	84.6	60.7	59.0	55.8	30.6	31.5	46.6
Oilseeds	86.4	45.8	71.7	64.2	30.8	47.4	58.8
Mixed Crop	87.6	24.8	61.5	61.7	23.5	36.3	50.9
Sugarcane	0.0	53.5	63.1	54.0	62.3	63.8	61.2
Vegetables	78.7	35.7	66.0	79.7	53.7	54.4	59.3
Fodder	61.1	57.4	62.7	40.5	48.9	15.1	55.8
Fruits & Nuts	100.0	0.6	68.1	49.8	66.2	72.2	47.7
Other Cash Crops	85.6	88.9	85.3	87.4	61.2	87.9	81.8
Others	79.6	2.2	49.0	40.7	28.3	30.5	45.0
All Crops	**84.2**	**48.9**	**69.0**	**66.7**	**48.0**	**34.0**	**58.7**

4.3.2 Use of Modern Inputs

In order to increase the output, another strategy followed by the farmers is the application of fertilizers and pesticides. The area under fertilizer use is estimated to be 81 percent at the all-India level. While the high irrigated zones have shown higher level of usage of fertilizers, their usage is lesser in the less irrigated areas of all the dry lands (Table 4.1). Though the area under improved seeds is the lowest in the dry-sub-humid zone, the area under fertilizers is higher than all-India. The data shows that fertilizers are being used in areas using traditional variety of seeds. While the use of fertilizers and pesticides improves productivity, they make a great contribution to natural resource degradation. The use of manure is lower than that of fertilizers except in the less irrigated tracts of the arid zone. The share of compost manure in the total area under manures is around 50 percent at the all-India level. This proportion is very less in the arid zone and the less irrigated tracts of the dry-sub-humid zones (Table 4.4). The area under pesticides is not as extensive as that of the area under improved seeds.

Table 4.4: Percentage of Area under Manure by Type of Manure

Agro-Ecological Zone	Compost	Bio-Gas	Others	Total
AHI	34.8	0.10	65.5	100.0
ALI	35.4	0.98	63.8	100.0
SAHI	54.5	1.57	44.1	100.0
SALI	57.0	4.02	39.3	100.0
DSHHI	56.6	1.84	42.0	100.0
DSHLI	40.4	1.68	58.3	100.0
All-India	**49.7**	**2.14**	**48.4**	**100.0**

4.3.3 Use of Irrigation

Cultivation based on modern methods of inputs is mainly dependent upon irrigation facilities. The ratio of irrigated area to the total cropped area is estimated to be 66 percent at the all-India level. This ratio is very high at around 88 percent both in the high irrigated areas of the semi-arid and dry-sub-humid zones. The high irrigated arid zone has slightly lesser irrigated area than the rest, at 73 percent. However, these estimates are found to be very high when compared to the estimates of the Ministry of Agriculture (www.dacnet.nic.in/lus) and Debt and Investment Survey of the NSSO for the years 2002 and 2003 respectively. This may be because even if only a part of the land was actually irrigated, the area was reported as irrigated (NSSO Report 451, 1999). The lower estimates from NSSO's Debt and Investment Survey is perhaps due to recording only owned land as an asset (Table 4.5).

Table 4.5: Estimates of Irrigation Ratio from Different Sources

Agro-Ecological Zone	NSSO 59th Round on Debt and Invest Survey, 2003	NSSO 54th Round on Common Property Resources, 1998	Ministry of Agriculture Land Use Statistics, 2002
AHI	40.4	72.6	83.3
ALI	18.8	37.1	18.7
Arid	31.3	58.5	54.2
SAHI	73.9	88.1	67.4
SALI	41.0	58.3	20.1
Semi-Arid	55.1	73.8	41.9
DSHHI	82.0	87.4	81.0
DSHLI	41.4	49.9	20.8
Dry-Sub-Humid	**62.5**	**73.0**	**56.2**

4.3.4 Mechanisation in Agriculture

Mechanised cultivation using tractors, power tillers, and pump sets, etc., spread across different parts of the country. At the all-India level, 54 percent of the land is cultivated through tractors / power tillers. This proportion is higher among the irrigated lands across the dry lands and more so in the arid zone (92 percent) (see Table 4.7). Hired tractors or power tillers tilled about 72 percent of the area at the national level. The utilization of hired tractors or power tillers is 73 percent in the irrigated tracts of the semi-arid zone, and it ranges between 60 to 68 percent in the arid and dry-sub-humid zones. However, the proportion of area under mechanical harvesting is not very high. It is only 6 percent at the all-India level. While this proportion ranges between 4 and 5 in the semi-arid and dry-sub-humid zones, it is very high at 14 percent in the arid zone.

With this rapid implementation of modern methods of production in the dry land areas the production expectations would be higher. The following section explains the performance of dry land agriculture for both high and less irrigated districts.

4.4 Cropping Pattern

It has been pointed out that since the agricultural research has been tilted towards irrigated farming, farmers in the dry land regions are pushed to grow more irrigated crops (Jodha, 1990). The sustainability of income from cultivation and resources came under threat as this kind of choice may lead to over-exploitation of groundwater resources. Further, farmers may tend to go for a highly risky investment which may result in crop failure and bankruptcy under conditions of uncertain rainfall (Shah A and Baidyanath Guru, 2003).

The present study analyses the pattern of crops grown during TE 2001 and during TE 2006 in the dry land types in India. Around 66 percent of the area was under cereals in these areas during TE 2006. Among the cereals, a major proportion (25 percent) of the area was under coarse cereals, while pulses and rice occupied 15 and 14 percent of the area respectively; the share of wheat was only 12 percent. Another important crop in these areas is oilseeds which occupied 22 percent of the area under cultivation. The proportion of area under cotton was 9.4 percent.

It is observed that the pattern of crops has not changed much since the beginning of the decade, i.e., TE 2001. However, the area under rice and wheat has declined and the area under cotton and oilseeds has increased between TE 2001 and TE 2006. Hence, coarse cereals and pulses occupy a major share in the arid zone; coarse cereals and oilseeds are predominant in the semi-arid areas; while wheat, rice and oilseeds are the major crops in the dry-sub-humid areas (Table 4.6).

Table 4.6: Cropping Pattern in Dry Land Areas

Crop	Arid		Semi-Arid		Dry-Sub-Humid		ALL	
	TE 2001	TE 2006	TE 2001	TE 2006	TE 2001	TE 2006	TE 2001	TE 2006
Coarse Cereals	30.8	30.9	24.8	25.8	7.1	8.0	22.0	24.6
Cotton	7.7	4.6	9.8	11.8	1.2	2.6	7.7	9.4
Fruits			0.1	0.3	0.0	0.0	0.1	0.2
Guar Seed	0.0	0.1	0.4	0.0	0.0	0.0	1.6	0.2
Oilseeds	8.1	0.7	18.0	20.4	16.1	22.2	18.2	22.0
Pulses	22.1	27.8	13.6	13.9	16.7	15.2	14.0	14.9
Rice	12.2	18.4	14.3	14.2	22.2	22.3	14.5	13.6
Sannhemp			0.0	0.0	0.0	0.0	0.0	0.0
Spices	0.1	0.3	0.2	0.4	0.0	0.1	0.2	0.3
Sugarcane	0.3	0.1	2.8	1.7	5.8	0.9	3.0	1.3
Tobacco			0.3	0.6	0.0	0.0	0.2	0.4
Vegetables	0.7	0.6	1.7	1.5	1.2	1.0	1.4	1.3
Wheat	12.5	11.1	14.0	9.3	29.2	27.0	16.9	11.7
All Crops	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: www.dacnet.nic.in/lus

The importance of crops between the high and less irrigated areas across the dry land types is presented in Table 4.7 and Table 4.8. Coarse cereals, wheat, pulses, and oilseeds are important crops in the high irrigated arid areas while coarse cereals, pulses, and oilseeds are the dominant crops in the less irrigated areas of this zone. Rice, coarse cereals, oilseeds, and wheat are the important crops in the high irrigated semi-arid zone while coarse cereals, oilseeds, and pulses are important crops in the less irrigated areas of this zone. For the dry-sub-humid zone, the important crops in the high irrigated areas are wheat, rice and pulses, while oilseeds, pulses, and wheat are the important crops in the less irrigated areas of this zone. The important crops identified for each zone are presented in Table 4.9.

Table 4.7: Cropping Pattern in High Irrigated Areas

Crop	Arid		Semi-Arid		Dry-Sub-Humid		ALL	
	2001	TE 2006	TE 2001	TE 2006	TE 2001	TE 2006	TE 2001	TE 2006
Coarse Cereals	24.3	25.6	16.9	17.3	3.8	5.1	14.9	17.3
Cotton	12.8	8.9	4.7	7.1	0.0	0.0	5.0	6.5
Fruits			0.2	0.7	0.0	0.0	0.1	0.5
Guar Seed	8.0	0.0	0.6	0.1	0.0	0.0	1.8	0.4
Oilseeds	14.1	1.6	12.7	16.3	8.9	8.7	12.0	15.2
Pulses	11.8	16.5	10.6	9.8	11.5	10.7	11.0	11.5
Rice	6.9	17.0	25.0	30.8	29.2	35.1	22.9	26.6
Sannhemp			0.0	0.0	0.0	0.0	0.0	0.0
Spices			0.2	0.6	0.0	0.0	0.1	0.4
Sugarcane	0.3	0.1	3.7	2.4	9.6	1.6	4.6	1.8
Tobacco			0.5	0.6	0.0	0.0	0.3	0.4
Vegetables	0.6	0.6	2.0	1.8	1.0	0.5	1.5	1.3
Wheat	21.2	21.2	23.0	12.7	35.1	36.7	25.7	18.1
All Crops	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: www.dacnet.nic.in/lus

Table 4.8: Cropping Pattern in Less Irrigated Areas

Crop	Arid		Semi-Arid		Dry-Sub-Humid		ALL	
	TE 2001	TE 2006	TE 2001	TE 2006	TE 2001	TE 2006	TE 2001	TE 2006
Coarse Cereals	38.5	35.6	31.7	30.8	11.9	10.8	29.3	29.5
Cotton	1.6	0.9	14.4	14.6	2.9	5.1	10.4	11.3
Fruits	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.1
Guar Seed	8.4	0.0	0.2	0.0	0.0	0.0	1.4	0.0
Oilseeds	31.7	37.7	22.6	22.8	26.7	35.0	24.7	26.5
Pulses	12.8	19.5	16.2	16.4	24.4	19.5	17.1	17.3
Rice	3.6	2.8	4.9	4.5	11.9	10.1	5.9	4.8
Sannhemp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spices	0.2	0.5	0.2	0.3	0.1	0.1	0.2	0.3
Sugarcane	0.3	0.2	2.0	1.4	0.3	0.2	1.4	1.0
Tobacco	0.7	0.6	0.2	0.6	0.0	0.0	0.1	0.4
Vegetables			1.5	1.3	1.4	1.4	1.3	1.2
Wheat	2.1	2.2	6.1	7.2	20.4	17.8	8.0	7.5
All Crops	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: www.dacnet.nic.in/lus

Table 4.9: Important Crops across Zones

Agro-Ecological Zone	High Irrigated Areas	Less Irrigated Areas
Arid	Coarse Cereals, Wheat, Rice, Pulses	Oilseeds, Coarse Cereals, Pulses
Semi-Arid	Rice, Coarse Cereals, Oilseeds, Wheat	Coarse Cereals, Oilseeds, Pulses, Cotton
Dry-Sub-Humid	Wheat, Rice, Pulses	Oilseeds, Pulses, Wheat, Coarse Cereals, Rice

4.5 Land Productivity

Productivity of the predominant crops in the dry land areas has been compared with the all-India level during TE 2006. It is found that for coarse cereals the productivity is higher than all-India only in the high irrigated areas of the semi-arid zone. The productivity of pulses is just above the all-India average for the less irrigated semi-arid zone while the productivity is quite high in the case of the dry-sub-humid high irrigated areas. The productivity of rice is higher in both arid and semi-arid zones while it is lower in the dry-sub-humid zone. Wheat productivity is very high in the high irrigated

areas of the dry-sub-humid zone and high in the high irrigated areas of both arid and semi-arid zones, but very low in the less irrigated areas of the dry-sub-humid zone. The difference in productivity of wheat is more than five times between the high and less irrigated areas of the dry-sub-humid zone. The productivity of oilseeds is found to be higher than all-India in the high irrigated areas of the semi-arid zone, and the productivity of cotton is very low as compared to all-India (Table 4.10). There has been change in the cropping pattern in the dry land areas, but the productivity in the less irrigated areas has been lower than all-India for crops such as coarse cereals, pulses, oilseeds, and cotton. High productivity in the high irrigated areas may be a positive indicator but majority of the irrigation is from groundwater resources, and sustainability of such resource is doubtful. Hence, proper maintenance and constant check on the usage of groundwater are required to sustain agricultural productivity.

Table 4.10: Productivity of Important Crops in Dry Lands: TE 2006

(kg/ha)

Crop	AHI	ALI	SAHI	SALI	DSHHI	DSHLI	All-India
Coarse Cereals	715	566	1820	1007	-	850	1277
Pulses	421	317	-	623	830	558	614
Rice	3805	-	3182	-	953	1653	2121
Wheat	3762	-	3714	-	9154	1555	2730
Oilseeds	-	782	1493	892	-	862	985
Cotton	-	-	-	242	-	-	396

Source: www.dacnet.nic.in/apy

Not only the yield levels but also yield fluctuations are very important in determining the returns to the farmers. Under conditions of supply of irrigation, fluctuations ought to be lower. It can be seen from Table 4.11 that, the index of instability is lower for all crops in the high irrigated areas except for coarse cereals and wheat. Across the high irrigated areas, rice and wheat are more stable crops both in the arid and semi-arid zones; and for the dry-sub-humid zone, coarse cereals and oilseeds are more stable crops. All the crops have shown high level of yield instability in the less irrigated arid zones. The lowest yield instability was recorded for coarse cereals in the less irrigated semi-arid zones and for wheat and cotton in the less irrigated dry-sub-humid zone. However, compared to the less irrigated areas in the arid zone, the instability is quite low for all crops in the less irrigated semi-arid and dry-sub-humid zones (Table 4.11).

Table 4.11: Index of Yield Instability in Dry Land Areas: 1999-2006

Crop	AHI	ALI	SAHI	SALI	DSHHI	DSHLI
Coarse Cereals	93.4	97.6	21.7	14.2	19.6	21.6
Pulses	50.4	113.9	13.2	26.7	26.8	30.7
Rice	9.5	620.2	8.4	26.3	40.3	54.0
Wheat	8.9	74.4	15.6	28.5	31.1	18.9
Oilseeds	18.7	187.8	34.9	36.0	22.3	33.0
Cotton	42.9	114.8	26.2	36.5	65.6	25.8

Index of instability is the standard deviation of annual growth rates.

4.6 Summary

Agriculture is the main livelihood for many people especially in the dry lands. Only about 47 percent of the cropped area is irrigated in India, which implies that rain-fed agriculture is more important than irrigated agriculture. Since the sources of yield growth in irrigated areas are being exhausted, the potential of rain-fed areas will increase in future. Further, for poverty reduction and conservation of the natural resource base, these areas merit increased attention. However, these areas suffer from low cropping intensity and low and highly variable yields. Though the use of modern inputs has been extensive in dry land areas, yields and input use is lagging in the less irrigated tracts of these areas. This arises from the comparisons of yields and input use between the high and less irrigated zones of the dry lands.

From the old cereal and pulses based economy, the agriculture in dry land has moved to rice wheat, oilseeds and cotton. Promotion of technology, price policy, and investment in irrigation contribute to this change. This diversification has not only benefited the resource-poor farmers in dry lands but it has also ended their vulnerability and risk to the vagaries of weather and price fluctuations. It has been pointed out that water-intensive wheat and rice crops have negatively affected the dry land economy both economically and environmentally, while the agricultural trade policy allowing import of edible oils has badly affected the north Indian dry land states.

Along with the traditional crops of coarse cereals and pulses, the irrigated areas of dry land areas are showing a tendency to grow wheat and rice. Oilseeds cultivation is growing in the less irrigated areas of the arid and dry-sub-humid zones. Productivity of crops is higher only in the high irrigated areas for most of the crops. This may be due to over-exploitation of groundwater which will not be sustainable beyond a certain level of depletion.

Intensification in the form of improved seeds and modern inputs has been taking place at a large scale across the dry land zones of India. However, the environmental effect of such practices remains a great challenge for sustainable development of agriculture. Further, given the wide fluctuations in the yield of many crops especially in the arid zone, the amount invested in such practices may not provide sufficient returns to the farmers. Moreover, these will push them into debt-trap, causing agricultural distress in these areas.

The approach to dry farming technology suffers from inadequate analysis of the physical environment, indifference to farmer circumstances, and strong bias towards crop production. The research is not sensitive to the traditional integration between private holding and CPRs which provide cost free inputs in the form of forage and bio-mass. A radical shift away from the existing approach derived from the experiences of Green Revolution is needed in these areas. For reversing the trend in the deceleration of agricultural growth and rejuvenating agriculture in different regions of India, there is a need for devising region-specific policies apart from increase in public investment in irrigation, infrastructure, agricultural research, and extension. This will not only help in increasing the production and income in agriculture but also in generating more employment in the non-farm sector through input-output and consumption linkages

CHAPTER - V
Summary and Conclusions

5.1 Introduction

Eradication of poverty and sustainable development are recognised as important dimensions of development. In order to achieve the target of reducing the poor by one-half by 2015, a number of international funding agencies are revising their rural development strategies. As a result of such efforts, a sustainable livelihood framework has been brought out. The Sustainable Livelihoods (SL) approach based on this framework supports poverty eradication by enhancing poor people's livelihoods. According to Robert Chambers and Gordon Conway (1992) a livelihood comprises the capabilities, assets and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets and provide sustainable livelihood opportunities for the next generation and which contributes net benefits to other livelihoods at the local and global levels in the short and long term. Though the framework does not clearly specify the impact of natural resources on livelihoods, such framework has been used for analyzing the livelihood status in dry lands in the present study.

5.2 Dry Land Areas

The arid region in India extends over an area of 32.6 million hectares which constitutes 9.9 percent of the total geographical area of the country. It accommodates 4.1 percent of the total population of the country as per the 2001 Census. Rajasthan and Gujarat constitute around 87 percent of the arid area of the country; Andhra Pradesh occupies 6 percent; and Punjab occupies 3 percent of total arid area. The semi-arid region extends over 96.8 million hectares which accounts for 29.4 per cent of the total area in the country. It is home to 32.2 percent of the total population. Andhra Pradesh, Gujarat, Rajasthan, and Maharashtra occupy 60 percent of the semi-arid area. The remaining states namely, Karnataka, Madhya Pradesh, Tamil Nadu, and Uttar Pradesh have an area ranging between 8 and 9 percent of the total semi-arid area of the country. Punjab occupies a very small proportion of 2 percent. The dry-sub-humid region spreads across 30.2 million hectares which consists of 9.2 percent of the total area, and has 11.1 per cent of the total population in the country. Madhya Pradesh occupies 61 percent of the total dry-sub-humid area and Uttar Pradesh occupies around 20 percent. Other

important states in this category are Bihar, Maharashtra and Punjab with 8, 7 and 4 percent respectively. Haryana occupies a very small proportion of less than one percent of the dry-sub-humid area.

5.3 Dry Land Typologies

The present study developed a crop-based production system on the basis of dominant crops in all the districts of the dry land areas of India. All the 211 districts of the arid, semi-arid and dry-sub-humid areas are divided into 6 categories, viz., rice/wheat, rice/ wheat & others, coarse cereals / pulses, coarse cereals / pulses & others, oilseeds and oilseeds & others. Further, all the dry land districts have been categorized into high and less irrigated and agricultural and non-agricultural, based on the proportion of irrigated area to the cropped area and the proportion of workers in agriculture respectively.

5.4 Socio-Economic Profile of Dry Lands

Rice/wheat growing areas have shown higher density of population across all the dry land types with 547 per sq km. In the dry-sub-humid areas, highest density was found in areas where cotton/sugarcane crops are grown along with oilseeds, and lowest density was found in the areas where coarse cereals / pulses and other crops are grown in all the dry land types. High irrigated areas have shown higher density of population than that of the less irrigated areas both in the semi-arid and dry-sub-humid areas. Non-agricultural occupation has also shown higher density as compared to agriculture both in the semi-arid and dry-sub-humid areas. It is argued elsewhere that lower density of population in drought-prone areas is the result of higher incidence of migration, especially of male workers. This is reflected in the higher sex ratios observed in these areas. As per the present study estimates, this is happening not only in the drought-prone areas which are semi-arid areas, but also in the arid areas, i.e., desert-prone areas.

Further, wherever irrigation is not prominent, sex ratio is found to be high in all dry land types. It can be said that male out-migration is not happening when rice/wheat are being grown with more area under irrigation. However, higher sex ratio cannot be considered as a development indicator since female literacy is low in these areas of higher sex ratio. Further, wherever the proportion of non-agricultural workers is high, female literacy is found to be high.

The percentage of Scheduled Caste population is 20 percent in the dry-sub-humid zone while it is 16 and 19 percent in the semi-arid and arid zones. The percentage of Scheduled Tribe population is 7 percent in the semi-arid zone while it is 5 and 6 percent in the arid and dry-sub-humid areas. A major portion of workers from both the caste groups belong to agriculture.

5.5 Status of Assets

The asset framework assesses the level and composition, clustering, sequencing and substitution of capitals, viz., human, natural, physical, financial and social, in relation to the level of irrigation facility available. The study is based on the unit record data available in CD-ROMs of the National Sample Survey Organisation (NSSO) for the data on the five capitals.

The identified indicators for each capital are used to construct the Livelihood Development Index (LDI) by adopting the Human Development Index methodology of the United Nations Development Programme (UNDP, 2002). Before constructing the LDI, a dimension index is created for each of the indicators of the five capitals. To calculate these dimension indices, the minimum and maximum values are chosen for each indicator from the district level values.

Among the three components of human capital, the performance of health indicators is better compared to that of education and employment. The value of health index is 0.75 in semi-arid, 0.67 in arid and 0.69 in dry-sub-humid areas. This may be because immunization of children is more than 90 percent in all these areas. The status of education indicators is very poor and the value of its index is 0.40 in the semi-arid, 0.33 in arid and 0.36 in dry-sub-humid regions. The value of education index is low in the less irrigated areas of all the three regions, despite many efforts to increase the participation of children in education. This issue has to be taken seriously. The value of employment index is high in the less irrigated areas of these three regions. The nature of employment and wage rate determine the quality of employment in these regions.

The combined index for natural capital across the zones does not differ much. It is higher than 0.35 in all the three zones. It is slightly higher at 0.39 in the semi-arid zone. This is due to higher percentage of cross-bred cows and dependence on common land for fuel as positive indicators, and slightly less dependence of animals on land as negative indicators compared to the dry-sub-humid zone. The value composite index of physical capital is the same across the dry zones. The composite index is slightly lower in the arid zone, compared to that of the other two zones. The status of social capital is very poor across the regions. The percentage of households having account in commercial banks / self-help groups / co-operative societies is around 31 percent in all the zones. However, the membership in other organizations such as JFM/VP and in irrigation/tank organizations is not even one percent across the zones. Overall, the index of social capital is very low and same across the zones.

The performance of all the capitals across the zones reveals that the values of human and natural capital are higher in all the zones irrespective of their irrigation status. The

relative development of the districts in all the three regions has been compared on the basis of the values of the mean and standard deviation of the composite indices. On the basis of the values of the mean and standard deviation, the districts have been classified as high, high middle, low middle, and low for all the three regions. In all the regions across the high and less irrigated tracts and for all capitals, more number of districts fall in the low-middle level of development.

Correlation coefficients have been calculated to understand the relationship between natural capital and other capitals. It is found that natural capital has shown a significant (1 percent level) positive association with human capital. This is found in the high irrigated semi-arid areas and for all the high irrigated areas. In all other regions except for the less irrigated dry-sub-humid areas, the relationship is positive though not statistically significant. For physical capital, except for the arid zone there is a positive association. There is a negative relationship between natural capital and social capital but the relationship is not statistically significant. Overall the asset position of households in the dry zones is not very strong to support them in the event of risk and uncertainty. However, the positive relationship between natural, human and physical capital suggests that better use and enhancement of available natural resources will improve the asset position of these households.

5.6 Poverty and Environmental Degradation

The analysis of poverty shows that the incidence of poverty is lower in the dry land areas as compared to the all-India level. However, the less irrigated areas in the dry land zones have shown higher incidence of poverty. Not only the incidence, but other measures such as severity, intensity, and inequality of consumption expenditure are high in these areas. Further, it has been observed that where the agricultural productivity is higher, the incidence of poverty is lower. Further, incidence of poverty is lower in the areas with high livelihood development index. However, there are inter-regional differences in this regard. This is clearly seen in the less irrigated districts of Maharashtra. Thus, increase in the level of irrigation and productivity leads to reduction in poverty.

However, high irrigation and application of fertilizers and other materials to increase productivity result in environmental degradation. Thus, the resources must be managed efficiently to avoid such degradation. Out of the 11 dry land states, Rajasthan registered higher percentage of degraded area (56 percent) in 1994, followed by Gujarat and Haryana at 43 percent each during the same period. More than 30 percent of the degraded land is found in Andhra Pradesh, Uttar Pradesh, Tamil Nadu, and Haryana. This proportion ranges between 25 and 30 in Madhya Pradesh, Maharashtra and Bihar.

Punjab has shown the lowest proportion at 21 percent. However, the present situation has completely changed: majority of these states have increased their share of degraded land in 2007.

5.7 Livelihood Strategies: Agriculture

From the old cereal and pulses based economy, agriculture in dry land has moved to rice and wheat based economy. Promotion of technology, price policy, and investment in irrigation contribute to this change.

It is found that for coarse cereals the productivity is higher than all-India only in the high irrigated areas of the semi-arid zone. The productivity of pulses is just above the all-India average in the less irrigated semi-arid zone while the productivity is quite high in the case of the dry-sub-humid high irrigated areas. The productivity of rice has been higher in both arid and semi-arid zones while it was lower in the dry-sub-humid zone. Wheat productivity is very high in the high irrigated areas of the dry-sub-humid zone and high in the high irrigated areas of both the arid and semi-arid zones, but very low for the less irrigated areas of the dry-sub-humid zone. The difference in productivity of wheat is more than five times between the high and less irrigated areas of the dry sub-humid zone. The productivity of oilseeds is found to be higher than all-India in the high irrigated areas of the semi-arid zone, while the productivity of cotton is very low as compared to all-India. High productivity in the high irrigated areas may be a positive indicator but majority of the irrigated areas depend on groundwater resources and sustainability of such resources is doubtful.

Not only the yield levels but also yield fluctuations are very important in determining the returns to the farmers. The index of instability is lower for all crops in the high irrigated areas except for coarse cereals and wheat.

Agricultural intensification is being rapidly practiced in the dry land zones. The area under improved seeds and modern inputs has been very high in the arid and semi-arid zones as compared to all-India. Intensification of agriculture increases productivity, but excessive use will create environmental as well as socio-economic problems.

Hence, the approach to dry farming technology suffers from inadequate analysis of the physical environment, indifference to farmer circumstances, and strong bias towards crop production. The research is not sensitive to the traditional integration between private holding and CPRs which provide cost-free inputs in the form of forage and bio-mass. Therefore, a radical shift away from the existing approach derived from the experiences of Green Revolution is needed in these areas. For reversing the trend in the deceleration of agricultural growth and rejuvenating agriculture in different regions of

India, there is a need for devising region-specific policies apart from increasing public investment in irrigation, infrastructure, agricultural research, and extension. This will not only help in increasing the production and income in agriculture but also in generating more employment in the non-farm sector through input-output and consumption linkages.

5.8 Measures for Sustainable Agricultural Development and to Alleviate Poverty

Research and technology can serve the dual objectives of increasing food production and protecting environment. There does not have to be a trade-off between meeting future food demands and maintaining the natural resource base. Agricultural research has already developed yield-enhancing technology for many crops such as rice, wheat and maize, which can also be intensified on regionally important crops such as coarse cereals which are very important for the dry land areas. Accelerated investment in agricultural research and technological improvements are the only options to ensure sufficient food to meet future food needs at reasonable prices without degrading the natural resource base. However, farmers lack access to technology, modern inputs, and knowledge. Development of rural infrastructure, institutions, access to credit and technical assistance will improve their access to modern inputs. Distortions in input and output markets, asset ownership, and other institutional and market distortions must be minimized. Access for the poor to productive resources such as land and capital needs to be enhanced. Improved human resources will also contribute to reduce poverty and improved food security.

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Appendix-I

List of Districts in Arid Area

State	Districts	Number
AP	Anantapur	1
GUJ	Kutch	
	Banaskantha	
	Jamnagar	3
HAR	Sirsa	
	Hisar	
	Bhiwani	
	Mahendragarh	4
KAR	Bellary	
	Raichur	
	Bijapur	
	Chitradurga	
	Tumkur	5
PUN	Faridkot	
	Bhatinda	
	Firozpur	3
RAJ	Bikaner	
	Jaisalmer	
	Barmer	
	Jodhpur	
	Ganganagar	
	Churu	
	Jhunjhunun	
	Sirohi	
	Jalor	9
All		**25**

Appendix-II
List of Districts in Semi-Arid Area

State	Districts	Number
AP	Cuddapah	
	Kurnool	
	Karimnagar	
	Rangareddi	
	Warangal	
	Khammam	
	Mahbubnagar	
	Nalgonda	
	Medak	
	Hyderabad	
	West Godavari	
	Guntur	
	Prakasam	
	Nellore	
	Krishna	
	Chittor	16
GUJ	Sabarkantha	
	Mehsana	
	Ahmedabad	
	Surendranagar	
	Junagadh	
	Amreli	
	Rajkot	
	Bhavnagar	
	Panchmahal	
	Kheda	
	Vadodara	
	Chittaurgarh	
	Surat	13
KAR	Belgam	
	Dharwad	

	Uttar Kannada	
	Gadag	
	Shimoga	
	Chikmangalur	
	Hasan	
	Mysore	
	Mandya	
	Bangalore	
	Kolar	11
MAH	Pune	
	Satara	
	Sangli	
	Solapur	
	Osmanabad	
	Bid	
	Ahmadnagar	
	Dhule	
	Nasik	
	Jalgoan	
	Aurangabad	
	Jalna	
	Parbhani	
	Nanded	
	Latur	
	Buldana	
	Akola	
	Amravathi	
	Yavatmal	
	Kolhapur	20
MP	Morena	
	Gwalior	
	Datia	
	Shivpuri	
	Bhind	

	Ujjain	
	Ratlam	
	Jhabua	
	Indore	
	Dhar	
	Dewas	
	Khandwa (East Nimar)	
	Kargone (West Nimar)	
	Mandsaur	14
PUN	Amritser	
	Kapurthala	
	Sangrur	
	Ludhiana	
	Patiala	5
RAJ	Ajmer	
	Tonk	
	Bhilwara	
	Udaipur	
	Dungarpur	
	Alwar	
	Bharatpur	
	Jaipur	
	Sawai Madhopur	
	Dhaulpur	
	Bundi	
	Chittaurgarh	
	Banswara	
	Kota	
	Jhalawar	15
TN	Coimbatore	
	Dindigal	
	Madurai	
	Virudhnagar	
	Tirunelveli	

	Kanyakumari	
	Vellore	
	Dharmapuri	
	Salem	
	Cuddalore	
	Kanchipuram	
	Erode	
	Tiruchirapalli	
	Pudokottai	
	Thoothukudi	15
UP	Ghaziabad	
	Bulandshahar	
	Aligarh	
	Mathura	
	Etah	
	Agra	
	Mainpuri	
	Moradabad	
	Badaun	
	Shajahanpur	
	Fatehgarh (Farrukhabad)	
	Hardoi	
	Unnao	
	Etawah	
	Kanpur	
	Jalaun	
	Rai Bareily	
	Fatehpur	
	Bela (Pratapgarh)	
	Jaunpur	
	Allahabad	
	Varanasi	
	Lalitpur	23
All		**132**

Appendix-III
List of Districts in Dry-Sub-Humid Area

State	Districts	Number
BIH	Bhojpur	
	Rohtas	
	Jehanabad	
	Patna	
	Nalanda	
	Aurangabad	
	Nawada	
	Gaya	8
HAR	Ambala	1
MAH	Wardha	3
	Nagpur	
	Bhandara	
MP	Guna	
	Sagar	
	Bhopal	
	Damoh	
	Vidisha	
	Rajgarh	
	Shajapur	
	Sehore	
	Raisen	
	Jabalpur	
	Narsimhapur	
	Hoshangabad	
	Betul	
	Tikarmgarh	
	Chhattarpur	
	Panna	
	Satna	
	Rewa	
	Sidhi	
	Shahdol	

	Chhindwara	
	Seoni	
	Mandla	
	Balaghat24	
PUN	Gurdaspur	
	Hoshiarpur	
	Jalandhar	
	Rupnagar	4
UP	Saharanpur	
	Bijnor	
	Muzaffarnagar	
	Rampur	
	Bareily	
	Pilibhit	
	Lakshimpur (Kheri)	
	Sitapur Lucknow	
	Barabanki	
	Faizabad	
	Sultanpur	
	Azamgarh	
	Ballia	
	Ghazipur	15
All		**55**

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