LINKAGES AMONG IRRIGATION, CROPPING PATTERN AND EMPLOYMENT: A CASE STUDY OF GANG CANAL REGION

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DECLARATION

This is to certify that the thesis entitled "Linkages among Irrigation, Cropping Pattern and Employment: A Case Study of Gang Canal Region" submitted by me for the partial fulfilment of the requirements for the award of the Degree of the Doctor of Philosophy is an original work and has not been submitted, in part or in full, for the award of any other degree of this university or any other university.

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Acronyms

AIBP	Accelerated Irrigation Benefits Programme
APEDA	Agricultural and Processed Food Products Export Development Authority
CACP	Commission on Agricultural Cost and Prices
CAD	Command Area Development
CAGR	Compound Annual Growth Rate
CCA	Culturable Command Area
CCPC	Cost of Cultivation of Principal Crops in India
CPI (AL)	Consumer Price Index for Agricultural Labourers
DDP	Desert Development Programme
DES	Directorate of Economics and Statistics
DPAP	Drought Prone Areas Programmes
EARAS	Establishment of an Agency for Reporting of Agricultural Statistics
ERM	Extension, Renovation and Modernisation
FAO	Food & Agricultural Organisation
FAS	Foundation for Agrarian Studies
FYP	Five Year Plan
FSL	Full Supply Level
GCA	Gross Cropped Area
GDP	Gross Domestic Product
GIA	Gross Irrigated Area
GOI	Government of India
GVO	Gross Value of Output
Ha	Hectares
HYVP	High Yielding Variety Programme
IWMI	International Water Management Institute
IWDP	Integrated Wastelands Development Programme
LHS	Livestock Holdings Survey
LUS	Land Use Statistics
LFPR	Labour Force Participation Rate
MAF	Million Acre Feet

MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MI	Minor Irrigation
MSP	Minimum Support Price
NSA	Net Sown Area
NSDP	Net State Domestic Product
NSS	National Sample Survey
NSSO	National Sample Survey Organisation
OBC	Other Backward Caste
PARI	Project on Agrarian Relations in India
RNFE	Rural Non-Farm Employment
SAS	Situation Assessment Survey of agricultural households
SC	Scheduled Caste
ST	Scheduled Tribe
UPA	United Progressive Alliance
WPR	Workforce Participation Rate

Glossary

Access index	A ratio of the proportion of total area irrigated falling in a particular size class of holding to the proportion of total households belonging to that particular class
Bajra	Pearl millet
Bharai	Filling time
Bigha	A unit of land area and in Gang canal region 1 bigha is equal to 0.625 acre
Chaks	Land block
Cost A2	The paid out cost on various inputs such as manure, seeds, chemical fertlisers, irrigation, plant protection, hired manual labour and machine labour are calculated
Decile	The partition values which divide the set of observations into ten equal parts
Gang canal region	The area irrigated by the Gang canal, which falls in the Sri Ganganagar district of Rajasthan
Guar	Cluster beans
Jagir	Land grants to influential people who were either relatives of the Maharaja or got land because of their past services to the state
Kapas	Local variety of cotton
Khalsa	The villages were under the direct control of the state, and were areas which had the best agricultural land
Khatwar	Areas where the land titles, i.e., *patta*s were given to individuals and they were made responsible for paying the revenue and tax to the state
Kinnu	Citrous fruit
Major irrigation scheme	Culturable command area is more than 10,000 hectares
Medium irrigation scheme	Culturable command area is more than 2,000 hectares and upto 10,000 hectares
Minor irrigation scheme	Culturable command area is upto 2,000 hectares individually
Moga	Water outlet
Moong	Green gram

Net worth	Net worth is calculated after deducting the amount outstanding of loans from the total value of all assets
Nikai	Emptying time
*Patta*s	Land titles
Pucca *warabandi*	The water turns of each plot of land are allotted and officially recorded
Rekh	Additional cesses
Sasan	The land was given by the state for religious purposes and no tax was charged on that land
Thikanedars	Sub infeudatories
Warabandi	Time-bound water turns
Zaildars	Officers-in-charge
Zamindar	Landlord

Chapter 1

Introduction

1.1 *Introduction*

In India, about 70 per cent of the total population resides in the rural areas. The majority of rural households are employed in agriculture in various forms, either in direct cultivation and wage labour or in activities with forward and backward linkages with agricultural production. The development of agriculture was accelerated by the large scale government investment in agriculture and allied sectors in the post-colonial period. Production levels and productivity were further accelerated with the launch of the Green Revolution. Subsequently, the agricultural sector registered a slow down starting in the 1980s due to a variety of reasons. Amongst these a decline in public investment in the 1980s and the policy shift due to the introduction of new economic policies from the 1990s onwards are the most prominent. The main focus of this study is to understand the role of irrigation and relative price shifts in cropping pattern changes and its impact on various other economic indicators.

Land and water resources, which are limited in supply, are central to agricultural production. Irrigation which is a land augmenting technology minimises the production instability. The methods and sources of irrigation have changed over the years from the traditional (persian wheel, pulley system, stepwell etc) to the new forms of irrigation through tubewell or borewell and canal irrigation. Public investment on major and medium irrigation schemes during the initial plan years, helped its spread to the different regions of the country. It also induced private investment in irrigation, mainly in ground water resources. But over the years, the area under groundwater irrigation has increased sharply when compared to that under surface irrigation (detailed discussion in chapter 3). That has led to larger inequalities in the distribution of water resources in rural regions which already reflected large differences in access to land and water resources, in cropping pattern and production levels, in labour use and employment generation, in

access to markets etc. along with the differences in socio-economic structure (see Dhawan 1994a and 1984, Bhalla 2007, Rawal 2001b and 2013, Bhalla S. 1989, Stone 2004, Krishna Rao 1993, Jairath 1984 and 1986, Jaglan 1990, Shah and Kumar 2008). As the investments required for the installation and maintenance of groundwater resources make it a capital intensive technology, the households with smaller size holdings have lower access to ground water as compared to households with large holdings.

As a result of irrigation development, multiple crops are cultivated on the irrigated land and with this not only has gross cropped area increased but also the employment opportunities in rural India have increased (Dhawan 1994a and Bhalla 2007, and Bhalla S. 1989). Irrigation along with the adoption of new technology affected the employment structure in the farm and non-farm sectors through forward and backward linkages.

1.2 *Significance of the Study*

The present study examines a canal region to understand sources of variation in the access to irrigation by analysing both canal and tubewell irrigation across households belonging to different size classes of holding in two villages; one in the middle reaches of a canal and another at the tail end. The data collected through secondary sources do not provide detailed information on irrigation sources for each plot of land. And the information on the land which is irrigated by multiple sources of irrigation in an agricultural year is not clearly specified in these secondary data sources. Also, these secondary data sources lack information on the quality of water resources.[1] However, few detailed village level studies discuss issues related to efficiency of irrigation, which includes quantity, quality, and distribution of the water supplied, along with its impact on cropping patterns and productivity in some regions of country. The objective of this study is to reflect upon the debate on efficiency of irrigation resources based on a micro-level analysis of two villages situated at different reach points of the canal. In order to

[1] Quality of irrigation is measured here by the quality of water and also by the accessibility of these resources.

understand the quality of irrigation across farm sizes in a canal region, a household level study was conducted in these two villages.

This study is an attempt to understand the changes in irrigation water distribution, and its impact on cropping pattern, the availability of employment and on asset accumulation in the canal region of Rajasthan. Rajasthan is among the states which have high variation in the land quality, cropping pattern, water resource availability, and employment in agriculture. The western part of the state, particularly Bikaner zone has semi-arid soil but is also relatively agriculturally developed due to canal irrigation. The irrigation system also helped this region to adopt mechanisation, as comparison to other regions of the states. In this Zone Sri Ganganagar and Hanumangarh districts in particular have achieved remarkable progress in yield and employment generation, in ways similar to that seen in the other canal colonies in the past. Due to this, the economic condition of the farmer households in that zone is far better than the other areas in the state. There is no study to assess the quality of irrigation after the introduction of canal irrigation. The issue of relative access of tail-end farmers in the distribution of water has not been addressed yet. Besides addressing these issues, the broader purpose of this study is to understand the development process of the agrarian economy by analysing both social and economic conditions in these two villages, and investigating the impact of changes in relative prices of different crops with differential moisture requirements.

1.3 *Objectives of the Study*

The specific objectives of this research are the following:

a) to examine the role of the state in the development of irrigation resources in the post-colonial period with the evaluation of both the budgetary and physical impact of irrigation;
b) to study the evolution and nature of expansion of the irrigation system during the colonial and post colonial period in the Gang canal region;

c) to examine the impact of irrigation development on cropping pattern along with the analysis of relative costs and benefits of different crops across size class of operational holdings;
d) to examine the impact of irrigation and other agricultural technologies on employment and wealth accumulation;
e) to examine the impact of differential price movements on cropping patterns and agrarian change.

1.4 *Scope of the Study*

This study discusses the development of irrigation resources and its impact on crop production in a rural region. The Gang canal region has witnessed the Green Revolution and the associated development of capitalism in agriculture. In Sri Ganganagar district, 75 per cent of the net cropped area is irrigated and the share of canal irrigation in total irrigated area is 99 per cent. With the limited use of ground water resources, due to salinity, the agriculture in the region, is primarily dependent on canal irrigation. The access to irrigation resources remains an important determinant of the performance of agriculture and influences the cropping pattern in the region, necessitating a study of the distribution of canal water across households and villages in the region and its implications for access to and quality of the public water system. The comparative analysis of the two villages situated at middle reaches and tail end of the canal will help in understanding the impact of irrigation as a factor of production on agrarian relations in rural India, and on the social and economic structure of the villages.

Also, in the recent period, since the cropping pattern in the region shifted towards a less water intensive crop in kharif season, the study would shed light on different factors (such as relative prices and irrigation) in determining cropping patterns and other aspects of the rural economy. Finally, the study explores the impact of social relations on the distribution of land and water resources at the micro level.

1.5 *Data and Methodology for Study*

Both primary and secondary data are used for the analysis. The information on irrigation and related statistics are obtained from diverse sources: a) Crop statistics collected by the Directorate of Economics and Statistics, Ministry of Agriculture, b) The publications of Ministry of Water Resources, c) Agriculture Census data collected quinquennially since 1970-71 (the data on ownership and operational holdings is collected by sample method). d) Land use statistics Directorate of Economics and Statistics (DES), Department of Agriculture and Cooperation, Government of India, e) Village reports on the earlier survey in 25 F by Foundation for Agrarian Studies are also used.

Further, to understand the changes in cropping pattern and employment due to irrigation, primary data was collected in a census type survey, in two villages in the command area of the Gang Canal in Sri Ganganagar district. One village from the middle reaches (25 F Gulabewala) of Gang canal and a second one from the tail end (63 F), were surveyed. The first village was selected because it has been surveyed and studied before. 25 F (Gulabewala) was surveyed by the Foundation for Agrarian Studies as part of their project on Agrarian Relations in India so the village was selected for this study. The second village for the study was selected on the basis of caste composition and according to the number of households in the village, taking into consideration the overall situation in the district.

The census survey across all households was conducted in both the villages during July 2015 to December 2015. In the survey, detailed information on land holding, irrigation access and uses, cropping pattern, production levels, input use, farm and non-farm employment and assets was collected. For purposes of analysis, the households were divided by size class of operational holdings and caste group as done in the agricultural census.

Basic Statistical tools are used to understand the role of irrigation and relative price shifts in cropping pattern changes and employment. To understand the role of irrigation on

assets accumulation, households are categorised in different classes using income, labour and land creteria. Further Gini coeffiecient are used to understand the inequality in the asset disribution. Gini is an aggregate numerical measure of inequality, which ranges from zero to one. Zero in Gini coefficient represents perfect quality and one is for perfect inequality. Further, the method of gini decomposition developed by Yitzhaki is used to understand the determinant of asset inequality.

1.6 *Chapter Outline:*

Chapter 1: Introduction: This chapter explains the overall concerns of the thesis, covering objectives, scope, methods and data used.

Chapter 2: Issues Related to Irrigation Development: An Overview of Literature: This chapter reviews the existing literature on irrigation, and its linkages with cropping pattern and employment.

Chapter 3: The Development of Irrigation in India and Rajasthan: This chapter examines the expansion of irrigation in the country as a whole, and Rajasthan in particular. The impact of irrigation development is analysed by referring to the area irrigated with different sources and access to irrigation across different classes and caste, along with impact of irrigation on cropping pattern. The chapter is divided into two parts; the first part examines the budgetary spending on irrigation development; the second part is a discussion of the physical impact of the budgetary spending based on an analysis of secondary data collected by different government agencies from both the village/local officials as well as from households. A brief analysis of the development of irrigation systems in pre- and post-independence periods has been undertaken.

Chapter 4: Nature of Expansion of Irrigation in Gang Canal Region and Description of Study Area: The chapter details the history of the region and the development of its irrigation potential. It provides a description of villages which are surveyed for this study. It also discusses land use and the cropping pattern in the Bikaner state before the

development of canal irrigation, and assesses the immediate impact of canal irrigation on cropping pattern and land ownership.

Chapter 5: Linkages between Irrigation and Cropping Pattern: In this chapter, the distribution of access to irrigation resources is discussed by analysing the use and availability of irrigation resources across different sections of peasantry and caste groups for both the surveyed villages. The chapter points out that even with the higher per acre income from Cotton when compared with Guar in the survey year, a larger proportion of area was under Guar cultivation as it is a less water intensive crop and also increases cropping intensity. Further, this chapter discusses productivity across the middle reaches and tail end villages of Gang canal by analysing crop yields.

Chapter 6: Inter-Linkages between Irrigation, Agricultural Technology and Employment: Insights from Survey Villages: The chapter argues that improved irrigation facilities bring possibilities of adoption of agricultural technology (both bio-chemical as well as mechanical-technology). Adoption of newer types of agricultural systems open up new windows of employment opportunities in farm as well as non-farm sectors through forward and backward linkages. The chapter tries to prove this argument by providing evidence of micro-processes at the village level with the help of empirical analysis and existing studies.

Chapter 7: Asset Ownership and Distribution: This chapter analyses the effect of public water availability and agrarian structure on the accumulation of productive assets in different size classes and the change it brings in the agrarian relations in the region.

Chapter 8: Summary, Conclusions and Policy Implications: This chapter provides concluding remarks based on this research with some policy suggestions.

Chapter 2

Issues Related to Irrigation Development: An Overview of Literature

2.1 *Introduction*

The uses of artificial irrigation for cultivation increased during the 19th century when the agrarian economy witnessed consecutive famines. Irrigation was introduced in the areas where land was not providing even a minimum rate of return (Bhalla 2007). This was because the major objective of adopting irrigation during the colonial period was to increase revenue, whereas after independence, irrigation was developed to improve the performance of the agriculture sector. The development of irrigation not only improved cropping intensity, yields and incomes levels of rural households but also indirectly affected the rural economy (Gadgil 1961).

The literature on irrigation discusses mainly two important issues. The first is the cost of different kinds of irrigation projects. And, the second is the efficiency of irrigation resources, which deals with the quantity, quality, and equality of the water supplied, along with its impact on cropping patterns and productivity in different regions of country. In the case of both these issues, the role of institutions—public and private—has also been discussed in the literature.

There are two types of economic costs of irrigation systems considered in the literature, capital and operational. The capital cost in major and medium projects is the cost of construction and the operational cost is that incurred after the construction of the project. The comparison of the cost of alternative irrigation projects is based on cost per unit of irrigated land after the development of the irrigation system (Dhawan 1990c).

Dhawan (1990c) analysed the capital and operational (maintenance, administration and repair) costs for major/medium and minor irrigation projects in order to understand the expenditure incurred on these irrigation projects, since the high levels of expenditure on

major/medium irrigation projects has been one of the criticisms made of these projects. Per hectare operational cost for major and medium irrigation projects was Rs. 60, whereas in the case of minor irrigation projects the cost was between Rs. 637 to Rs. 849 (Dhawan 1990c). Similarly the trends in case of capital cost incurred, were tilting against the minor irrigation projects (*ibid.*). Dhawan (1989) argued in favour of major irrigation projects on the bases of two criteria, firstly the replacement period for major and medium projects is around 100 years, whereas in case of minor irrigation projects replacement cost occurs every 15-20 years. Secondly, the cost of pumping the ground water in minor irrigation project is huge, whereas there is no such expenditure on surface water in major and medium projects (ibid).

These results were criticised by Mitra (1990b) for the methodology used in the calculation, i.e., the study does not include the cost incurred due to the leakages in the major and medium irrigation projects. It also excludes the expenditure on bringing the water from distributory to the field which is borne by the peasants themselves (Mitra 1990b). The cost structure of major and minor irrigation projects is very different. Therefore, to compare the cost and benefits of irrigation systems, such as major and minor, the current measure of operational cost underestimates the cost of the major irrigation project. The operational cost on major and medium projects is calculated from the plan outlays of the government, whereas the cost on minor irrigation is borne by the households using the ground water resources. However, detailed information on the capital and operational costs of minor irrigation projects is not available and for comparing the cost of minor and major irrigation schemes, the adjustments in the plan statistics are made by the scholars (Dhawan 1989). Census on minor irrigation also does not collected detailed information on the capital and operational costs.

Gadgil (1961) recommends the use of economic criteria for evaluating the performance of major irrigation projects rather than the financial expenditure on it. The data available with various agencies have reported the contradictions in the reported government data on irrigation. The current data on irrigation and land records is made available on a quinquennial basis. As a result, the planning for irrigation development depends upon the

data provided by the State agencies. The reassessment and timely collection of data would show a decline in the actual area irrigated (Parikh, Vora & Alagh 1993, Dhawan 1993 and Rao 1984).

The absence of canal lining in the tracts with sandy soil leads to water logging and also salt accumulation in the crop root zones (Dhawan 1988). The delay in the construction of the water distribution system increases irrigation intensiveness in the canal upper reaches (*ibid.*) As a result the upper reaches have higher levels of seepage and a rise in the water table (*ibid.*). The extensive distribution of limited water resources, increases the production level, along with providing equality in the distribution of public investments (Dhawan 1988).

With the current irrigation resources it is impossible to provide irrigation to all of India's cultivable area (Dhawan 1989). Both surface and ground water resources are hydrologically inter linked and emphasis on conjunctive use of both ground and surface water is given by the water resource planners. The access to water in tubewell irrigated areas is in the control of households with large operational holdings because the installation and operational cost of ground water resources is capital intensive and therefore investments in it is not economically viable for the households with marginal and small holdings (Nagaraj & Chandrakanth 1997 and Dhawan 1991 & 1993). In other words, due to the capital intensive nature of ground water resources, these resources are primarily accessible to households with large land holdings (Shah 1993). With small size of holdings, lower incomes, and lack of access to extension services and institutional credit, it is very difficult for small and marginal farmers to install tubewells for extracting ground water resources (Dhawan 1997). Control over ground water resources, rent of ground water, depletion of water along with other geographical and environmental factors determine the access to ground water among households with marginal and small size of holdings (Nagaraj & Chandrakanth 1997 and Dhawan 1991 & 1993). Availability of ground water resources is dependent on private investment, and so unequal in distribution, whereas surface water resources, operated by government agencies, provide more equitable and sustainable irrigation for cultivator households (Sundar 1993). The

public tubewell has also provided equitable irrigation to small and marginal land owners in West Bengal (*ibid.*). The purpose of a public irrigation system is to distribute the water equally across the households, though it may not be able to meet the water requirement of various crops cultivated in a command region (*ibid.*).

The studies comparing ground water and surface irrigation make a case for focusing on ground water resources and point out that ground water resources provide greater access to irrigation for small and marginal farmers who were earlier dependent on rainfed cultivation in canal command areas (Shah 2006 and Shah *et.al.* 2009). This is because the households with small and marginal holdings can purchase water from tubewells according to the requirement of crop (*.ibid.*). However, the above studies have not discussed the quantity of water accessible to marginal and small farmers and also the increase in the cost of cultivation because of purchase of water from private owners. Kumar and Singh (2009) have countered the above argument by pointing out that droughts cannot be mitigated by ground water resources and surface irrigation has contributed remarkably in drought proofing in country. The balanced development of both surface and ground water resources is, therefore, crucial (*ibid.*).

The over exploitation of ground water, particularly in Rajasthan, Punjab, Tamil Nadu, Karnataka and some areas of the Indo-Gangetic plain region, has led to a decline in the water table (Shah 1985& 1993, Moench 1992, Singh 1991, Dhawan 1995, Janakrajan 1996, Bhatia 1992, Sharma & Sharma 2004, Dubash 2000). The cultivation of highly water intensive crops has resulted in the decline of the water table (Nagaraj & Chandrakanth 1997). With the decline in the water table, the control of large farmers of the ground water resources seems unavoidable (Singh 1991). The terms of water purchase depend upon various factors such as depth and availability of ground water, farm size and fragmentation, cropping pattern, prices of electricity and diesel, and development of water markets along with other social factors (Janakarajan 1993 and Shah & Ballabh 1997). These conditions for purchase of ground water are unfavourable for small and marginal farmers.

The available literature on ground water does not clearly point out the role it plays in the sustainable and equitable distribution of ground water resources. Some scholars have pointed out that inequalities in water access decline with the use of ground water (Shah 2006 and Shah *et.al.* 2009). On the contrary, other studies have pointed out that with the development of ground water markets the extraction of ground water also increases (Singh 1998). Therefore, the sustainability of ground water resources is in question because the over extraction of water lowers the water table (Singh 1998). There is no regulation on the extraction or use of ground water resources and also the control over the prices of water is in the hands of private owners (Sarkar 2008 and Prasad 2000).

With the available statistics, it is impossible to estimate the actual cost of either form of water resource, particular ground water resources. The sustainability of irrigation resources depends upon the capital and operational cost, environment impact, and the access to households. A sole emphasis on the development of ground water resources will not be sufficient to irrigate land in the drought prone areas and in the areas with saline ground water. The private control over the ground water resource in most regions in India also leads to the exploitation of marginal and small cultivator, who cannot afford to invest in these resources. In the distribution of public water via canal in a command region too, households with greater access to land have also greater access to water resources. The distribution of water via canal is not only affected by the size class and location of land but is also impacted by socio-political factors.

2.2 *Irrigation Efficiency*

The efficiency of irrigation is assessed in the literature by analysing the quantity, quality and equality of irrigation resources. Different measures have been used by researchers to estimate and assess the efficiency of water distribution. The efficiency of ground water resources is considered higher than that of canal water as it provides greater flexibility to the cultivator households in terms of timing and quantity (Vaidyanathan & Sivasubhramanium, 2004, Pant 2005, Vaidyanathan 1993, Shah 1993, Jairath 1984, Malhotra, Raheja & Seckler 1984a and 1984b, and Moench 2000). "Productivity" and

"equity" are used as indicators to assess the distribution of irrigation via large scale irrigation projects (Lenton 1984). The timing and quantity of water supplied is analysed by using "productivity" as a measure, and variability between irrigation water delivered and crop produce at different locations of an irrigation system is used to understand the "equity" in water distribution (Lenton 1984).

In a study on a water distributory in Haryana, Malhotra, Raheja and Seckler (1984a and 1984b), pointed out that the water received in the *warabandi* system can irrigate only 25-30 per cent of the area of a chak (land block) if it receives 3-4 rounds of irrigation, and the balance 70 per cent remains unirrigated. For assessing quantity and equality, the authors have used the criteria of irrigation intensity across the different areas of the CCA (Culturable Command Area). The quantity of water received by cultivators starts declining towards the lower reaches of a distributory, i.e., the CCA is lower in the tail ends as compares with the head reaches of the canal (*ibid.*). However, in a study based on a irrigation system in Sri Lanka, Murray-Rust *et.al.* (1984) found that the equity in irrigation water distribution via canals is affected by other factors such as quality of soil, size of channels etc., other than the availability of water in the canal. The water distribution in a canal region, is considered equitable if the irrigation intensity across the land located in the head, middle and tail end, is similar (*ibid.*).

Dhawan (1985, 1988, and 1993) pointed out that the benefits of irrigation will be similar for small farmers and large farmers with equal access to irrigation and in that condition any difference in production will be due only to higher use of fertilisers along with irrigation. In reality the access to irrigation varies across farm sizes, as households with large land holdings have greater access to irrigation as well (*ibid.*). The use of fertilisers in crop production also depends on the access to institutional credit and farmers' access to subsidised fertilisers, seeds etc and extension services on agriculture. Similar access to irrigation among small size holding households is only possible with the increase in water allotment and with the higher access to institutional credit and extension services (*ibid.*). Further, the redistribution of land to landless households and also to small and marginal cultivators, will also eliminate the tilt of public irrigation towards households with large

operational holdings (*ibid.*). The use of irrigation has relatively stabilised production in six out of seven states studied, though the stability in production showed inter-state variations (*ibid.*). In states which experience low to medium rainfall, the development of canal irrigation has helped increase the quantity of groundwater, which in turn increases the use of groundwater water resources, particularly in areas under-irrigated with surface resources such as tail end areas (*ibid.*).

2.3 *Irrigation, Agricultural Growth and its Impact on Farm Incomes*

Irrigation has a direct impact on the growth rate of agriculture, as the area with higher access to irrigation records higher growth of agriculture (Dantewala 1978). Extensive and better quality irrigation increases the use of other inputs such as fertilisers and high yielding seeds, which improves crop production (Vaidynathan 1999, Rajgopal 1992 and Ghosh 1998). In a study based on time series data on production levels on irrigated and unirrigated lands, Vaidyanathan (1999) pointed out that the gap in the productivity of these two types of land has widened. The production level in the irrigated areas is more stable as compare to that on unirrigated land (*ibid.*). Irrigation is crucial particularly in the dry season (Narain and Roy 1980). The studies of regions such as Punjab, which have both canal and ground water resources point out that the use of groundwater resources increases the production level by increasing input use (Kaul 1991, Sidhu, Chand and Kaul 1999, and Jairath 1986).

The development of tubewell irrigation has occurred mainly in the regions which have had public irrigation. The inadequate canal water supply during the peak season resulted in the higher use of ground water resources (Janakrajan 1993). The state also provided assistance in the form of loans to develop ground water resources and in certain regions for tubewell construction as well. The impact of ground water resources and surface irrigation varies from state to state (Dhawan 1998). Agricultural incomes have increased by bringing irrigation to unirrigated areas and with the increase in the productivity from irrigated land (Dhawan 1985). However, even with the decline in public investment in the

recent planning years, irrigation still remains an important factor in the production process (Desai 1991).

A study by Singh and Singh (1962) found that production conditions have stabilised with the improvement in irrigation facilities. Ray (1971) pointed out in her study that in the initial phases of investment in irrigation in 11 states from 1970-71 to 1983-84, irrigation emerges as a significant factor in the growth of output by reducing instability in area and yield. The effect of adverse climate conditions such as drought or inadequacy of rainfall had lower impact in the areas with stable irrigation. The coefficient of variation for food crops output has declined from 11.5 per cent to 5.4 per cent, and for yield of all crops from 9.3 per cent to 4.3 per cent (Dhawan 1988).

2.4 *Cropping Pattern and Intensity*

Stable irrigation increases productivity (Epstien 1961). Bharadwaj (1974) in her regression analysis on the effect of irrigation, found that cropping intensity increases with the increase in the area under irrigation but there is no consistent relationship between the size of holding and per acre output while comparing the data from both irrigated and unirrigated land. There was a positive relation between per acre output and area irrigated (*ibid.*). In other words, the output from land is positively related with irrigation but it does not have any consistent relationship with size of holdings.

Further Rao and Thamara (1978) found that cropping pattern and output are affected by irrigation. The difference between the output from irrigated and unirrigated land in case of cereals (rice and wheat) is as high as 50 per cent to 100 per cent (*ibid.*). Irrigation is one of the important inputs in agriculture and the benefits of other inputs such as high yielding seeds or fertilisers are not obtained without irrigation (IIM 2008). As land resources are very limited, the only way to increase the quantity of production is to improve the productivity level per acre by using irrigation (*ibid*.).

In case of ground water resources, the unregulated use of ground water resources has also led to the over exploitations of these resources (Shah 1991 & 1993, Pant 2005, Vaidyanathan 1996 and Moench 1992). The declining water table in many areas due to over exploitation of ground water resources, higher cost of installation and maintenance with the decline in water table and salinity of water etc, make the ground water use unsustainable (Dhawan 1990a and 1990b, Mitra 1990a, Pant and Dharamadhikary 1990, Sengupta 1990, Shah 1985 & 1993, Moench 1992, Singh 1991, Dhawan 1995, Janakrajan 1996, Bhatia 1992, Sharma & Sharma 2004, Dubash 2000). Shaheen and Shiyani (2005) pointed out that the over exploitation of ground water is a growing problem for equity and sustainability.

2.5 *Equity and the Distribution of Costs and Benefits*

The development of irrigation and its distribution is extremely unequal across rural households (Sampath 1990). The skewed distribution of land among households in most Indian states, leads to further inequality in water distribution as government policies are based on the proportional equality principal (*ibid.*). In order to provide higher water access to households with marginal and small operational holdings, Sampath (1990) recommends either adoption of a policy of regressive equality, where land and water access are inversely related, or the equal distribution of land. But, given the current situation, inequality among rural households will only worsen since the distribution of irrigated land is more skewed than that of unirrigated land (*ibid.*). However, this is not to say that the marginal and small farmers have not benefited from the public irrigation system, but to point to the inequality in water distribution. In some areas, around 40 per cent of households are from small and marginal size classes (Joshi 1997). While the access to water via the public distribution system does provide access to irrigation to these households with marginal and small sized holdings, inequality increases because the benefit of irrigated land is higher among the households with higher ownership and operational holdings. Finally, the distribution of water in the head and tail end of the canal is also unequal (Lele & Patil 2006).

2.6 *Other Impacts on Rural Economy*

Other than contributing to agricultural production, irrigation also contributes to employment generation and rural livelihoods (Bhattarai *et.al.* 2002 and Mellor 2001). Assured irrigation increases the number of working days in the village and also leads to an increase in the wage rate which benefits the landless households in the villages and lowers the incidence of migration towards the cities (Chambers 1988). But the overexploitation of ground water resources in the recent period has led to changes in the cropping pattern towards less water intensive crops (Shaheen & Shiyani 2005). And, due to water scarcity a number of households have either started working in small businesses or have moved to work as wage workers in neighbouring towns (*ibid.*).

The areas which have had access to assured irrigation also have stable farm incomes and as result can invest in other sectors (Shariff 2006). The access to a assured and stable irrigation system also improves the resale value of land. However, the current level of inequalities in access to ground water expands the difference in income and assets holdings (Nagaraj & Chandrakanth 1997). Several research studies have also pointed out that the households from the upper castes have control over irrigation assets (Kripa 1992, Bhatia 1992, Singh & Singh 1998, Shah & Ballabh 1997).

Chapter 3

The Development of Irrigation in India and Rajasthan

3.1 *Introduction*

Various research studies on the development of irrigation practices in India have been conducted post-independence, and it has been found that production levels have increased as a result of the conversion of dry land to irrigated land, with consequent increases in the cropping intensity, crop yields, etc. (see Dhawan 1994a and 1984, Bhalla 2007 and 2003, Stone 2004, Krishna Rao 1993, Jairath 1984 and 1986, and Jaglan 1990, Gulati *et.al.* 2005). The objective of this chapter is to track the expansion of irrigation in the country as a whole and also in the state of Rajasthan. An attempt is also made to explore the budgetary and physical impact of irrigation. The chapter is divided into two parts: the first part examines the budgetary spending on irrigation development; the second part is a discussion on the physical impact of the budgetary spending based on an analysis of secondary data collected by different government agencies from both the village/local officials as well as from households. A brief analysis of the development of irrigation systems in pre- and post-independence periods is also provided.

3.2 *Development of Irrigation System before Independence*

The present system of irrigation came into being after a long history of development of irrigation and has gradually evolved during the rule of various dynasties in India. As Bhalla (2007) points out, irrigation through tanks was adopted in the 5th century by the Cholas, Cheras, and Pandyas. The Mughals introduced canal building through the "large-scale river schemes" implemented during their rule. In the beginning of the 19th century, southern India had witnessed development of well irrigation (Bhalla 2007). These developments were further advanced when the canal-building projects were started in 1817 by the British in the northern part of the country (Stone 1984). These were projects in which river water was diverted for irrigation through the canals to the dry and

unirrigated plains. After the three famines of 1876-78,1897-98 and 1899-1900, the work on irrigation projects was further accelerated (Gulati *et.al.* 2005). The regulation of water distribution was done through the First Irrigation Commission set up in 1902-1903, with the design prepared under Sir Colin Scott-Moncrieff. The stated purpose of the development of irrigation was to increase food grain production, which was emphasised initially by the Irrigation Commission (1902-03) and later by the Royal Commission on Agriculture (1928). According to the report of the National Commission on Agriculture (1986), the amount spent on the development of public irrigation almost doubled between 1903 and 1920-21 (from Rs. 40 crore to Rs. 79 crore). This expenditure led to an increase in irrigated area from 7.6 million hectares in 1900 to 10.4 million hectares in 1920-21. By 1945, 13.5 million hectares had been irrigated by public irrigation sources (*ibid.*).

3.3 *Development of Irrigation after Independence: Budgetary Impact*

A modern system of irrigation was first introduced during British rule (Bhalla 1997 and 2003). Under this system water is sourced and delivered through major, medium or minor scheme[2] for surface irrigation, the purpose being to utilise the available hydrologic cycle. The surface water through deep percolation and canal seepage replenishes the ground water resources. After independence, in the initial five year plans, emphasis was laid on the development of irrigation. As a result a large amount of government expenditure was spent on major irrigation schemes like dam building and canal construction. The states were also encouraged to develop water related projects for drinking water facilities, industrial use, hydroelectricity, and so on,[3] particularly in the north western part of the country. The programme slowly spread to the eastern regions. Importance was also given to water storage.

In the First Five year Plan, the expenditure on the development of irrigation was 22.5 per cent of the total planned expenditure. A total of 221 projects (major, medium and

[2] The irrigation schemes are broadly divided into three categories: a) Minor irrigation scheme, where culturable command area is upto 2,000 hectares individually; b) Medium irrigation scheme, where culturable command area is more than 2,000 hectares and upto 10,000 hectares; and c) Major irrigation scheme, where culturable command area is more than 10,000 hectares.

[3] See Ramaswamy (2007) for the use of water.

Table 3.1: *Public expenditure on irrigation and flood control in consecutive plan years, all India*

Plan Period	Major & medium irrigation	Minor irrigation/ minor irrigation (MI) & command area development (CAD)	Total expenditure on irrigation	Flood control	Total plan expenditure in all sectors	Agricultural GDP at current prices*	Percentage expenditure on Irrigation (per cent)	Expenditure on irrigation as proportion to the agricultural GDP
	Rs. in crore						Per cent	Per cent
1	2	3	4	5	6	7	8 (4/6)	9 (4/7)
First (1951-56)	376.2	65.6	441.8	13.2	1960	26016	22.54	1.7
Second (1956-61)	380	161.6	541.6	48.1	4672	32963	11.59	1.64
Third (1961-66)	576	443.1	1019.1	82.1	8577	46259	11.89	2.2
Annual (1966-69)	429.8	560.9	990.7	42	6625	45331	15.04	2.19
Fourth (1969-74)	1242.3	1173.4	2415.7	162	15779	104192	15.31	2.32
Fifth (1974-78)	2516.2	1409.6	3925.8	298.6	28653	126939	14.22	3.09
Annual (1978-80)	2078.6	1344.9	3423.5	330	22950	75718	14.27	4.52
Sixth (1980-85)	7368.8	4159.9	11528.7	787	109292	307817	10.55	3.75
Seventh (1985-90)	11107.3	7626.8	18734.1	941.6	218730	517118	8.56	3.62
Annual (1990-92)	5459.2	3649.5	9108.7	460.6	123120	334663	7.4	2.72
Eighth (1992-97)	21071.9	13885.3	34957.2	1691.7	483060	1353735	7.59	2.58
IX Plan (1997-02)	49289	13760	63049	3038	941041	2219658	6.7	2.84
X Plan (2002-07)	83647.1	16549	100106	4344.2	1618460	2955930	6.2	3.39
XI Plan (2007-12)	165350	46350	211700	20100	3644718	31635107	5.8	0.67

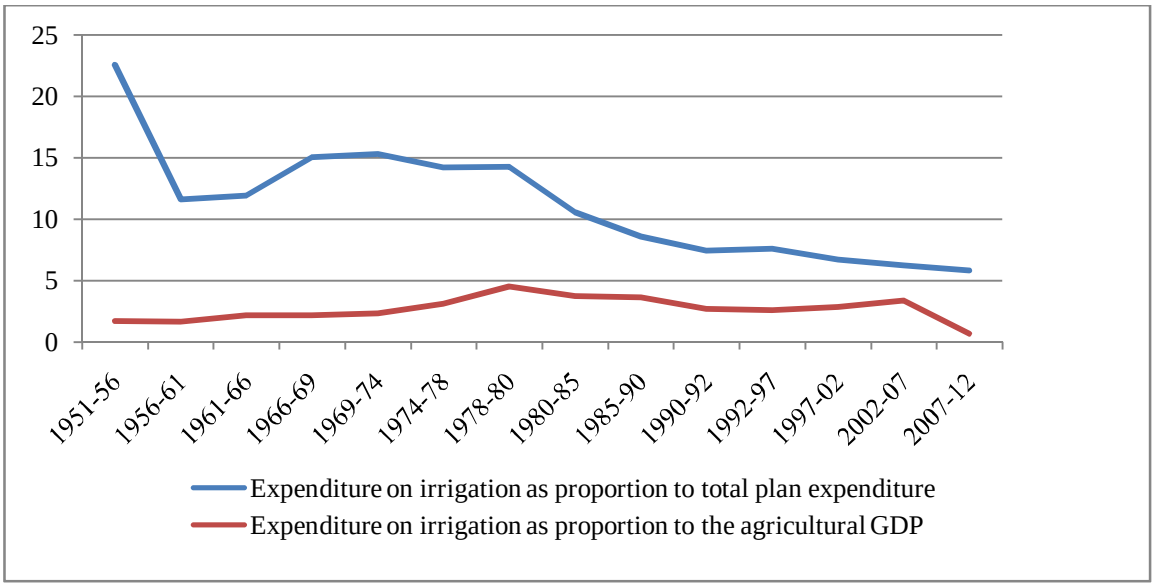
Note: *Agriculture GDP is including livestocks.

Sources: *Report of the Working Group On Water Resources for the XI Five Year Plan (2007-12)*, Ministry of Water Resources, Government of India (2006), for data of 10th plan is taken from, Central Water Commission (2013), W*ater and Related Statistics*, Water Resources Information System Directorate, Information System Organisation, Water Planning & Project Wing, December, and National Accounts Statistics, CSO, back series 2011.

extension, renovation & modernisation) were taken up but only 19 per cent (42 projects) of these were completed during the plan years (GOI 2006). Only 34 medium scale projects were completed during this period (GOI 2006).

Most of the incomplete projects were completed in the succeeding FYPs. In the 1970s, during the period of the Green Revolution when a seed-fertiliser-irrigation technology package was adopted, along with public expenditure on irrigation, the State also provided subsidies for private investment in irrigation, as well as for pesticides and fertilisers etc. This led to an increase in private investment in minor irrigation schemes. But after the introduction of the policy of neoliberal reform in the 1990s, the public expenditure on irrigation and the rural economy as a whole has gone down (see Athreya 2013 and Jha and Acharya 2011). Along with that private investment in irrigation also decreased (see Gulati *et.al.* 2005 and Bhalla 1993).

Chart 3.1: *Share of expenditure on Irrigation in the total plan expenditure and in the agricultural GDP, by plan years* in per cent



Sources: *Report of the Working Group On Water Resources for the XI Five Year Plan (2007-12)*, Ministry of Water Resources, Government of India (2006), data of 10th plan is taken from, Central Water Commission (2013), *Water and Related Statistics*, Water Resources Information System Directorate, Information System Organisation, Water Planning & Project Wing, December, and National Accounts, CSO back series 2011.

Table 3.1 provides details on the public expenditure on irrigation projects in India. It is evident that the share of public expenditure on irrigation as a proportion of total plan expenditure has gone down to 6.8 per cent from 22.5 per cent during 1951-56. The expenditure on irrigation has hovered around 7 per cent of the total public expenditure since the annual plans of 1990-91 and 1991-92. The expenditure on irrigation as proportion of agricultural GDP, has also remained between 2.5 to 3.5 per cent from 1990-92 to 2007-12 (Chart 3.1).

As mentioned earlier, during the first few five years plans the focus was on the development of irrigation by the government, and from the Fifth FYP onwards, there was also some emphasis on extension, renovation & modernisation (ERM), since the utilisation of irrigation facilities was significantly less than the potential created and this was reemphasised again in 2004 (GOI 2013). Apart from Extension, Renovation and Modernisation (ERM), a programme for Command Area Development (CAD) was also initiated in 1974-75 for the utilisation of the irrigation potential created in order to help increase crop production in some command areas (GOI 2013). And later in 1996-97, an Accelerated Irrigation Benefits Programme (AIBP) was also started to accelerate the completion of the major and medium projects which were in their advanced stages. The focus was on the irrigation projects which were started in the 5th plan period or earlier. Also, a few programmes were started for the drought prone areas and these were: DPAP (Drought Prone Areas Programmes) in 1973-74 for the areas which had experienced droughts constantly, DDP (Desert Development Programme) in 1977-78 to mitigate the adverse effects of desertification, and IWDP (Integrated Wastelands Development Programme) in 1989-90 for the drought-prone areas which were not covered in DPAP and DDP (GOI 2013). Despite these programmes, the gap between potential created and utilised was increasing in India (GOI 2013). The reasons for this underutilisation are, according to Bhalla (2007), “lack of command area development, cropping pattern changes, lack of field channels ... over estimation of run-offs in hydrological planning leading to reservoirs not being filled, losses due to disrepair of system.” The other reasons behind the underutilisation are the problems of silting and weeds in the canals, and the lack of extension services for agriculture and utilisation of irrigation. Bhalla

further points out that available data on the utilization of irrigation were not reliable because there are no proper data sources on utilisation.

The *Report of the Working Group On Water Resources for the XI Five Year Plan (2007-12)* reports the gap between potential created and utilised during the plan years. This gap started increasing from the 9th plan onwards. The gap was 21.52 million hectares in the 11th FYP (2007-12) which is much higher than the 1.22 million hectare-gap in the 1st FYP (1991-56). During the 11th FYP, the gap was more in the case of major and medium irrigation projects. Also, there are many incomplete irrigation projects. Some of the projects have been abandoned and some are still in the course of completion (GOI 2013). Vaidyanathan (1991) noted that "the government tends to start far more projects than can be accommodated within the amount of investment available for irrigation (p. 13)."

However, there are high inter-state and intra-state variations in the distribution of land and water resources and the expenditure on resource development also varies across states. A study by Jha and Acharya (2011) on expenditure on the rural economy shows that such expenditures were given more priority in the state budgets of industrially developed states, i.e., Maharasthra and Gujarat than in the agriculturally developed states i.e., Punjab and West Bengal and states such as Bihar, Uttar Pradesh, Madhya Pradesh and Rajasthan. A focus on agriculture was absent in Rajasthan in the initial five year plans as the state didnot have resources, and it lags behind in irrigation development and suffers acutely in terms of shortage of irrigation resources.

Rajasthan which has arid to semi-arid land, is a State where the maximum irrigated area is under wells, canals, and tubewells. In the eastern region of the state, groundwater is the main source of irrigation, while in the north western plain zone, canals are the main source of irrigation (GOI 2006). The depth of the ground water is less in the eastern region than in the western region of the state. While, on the one hand, the ground water department has placed few districts of the state in the category of over-exploitative, critical, and semi-critical (GOI 2006), on the other hand the annual average share of both plan and non-plan expenditure on the rural economy which was 17.48 per cent in 1991-

92 to 1999-2000 declined to 12.3 per cent during the period 2000-01 to 2009-10 (Jha and Acharya 2011).

Table 3.2: *Annual average plan and annual average combined plan and non-plan expenditure on irrigation, for Rajasthan state, for different years* in per cent

Year	Expenditure on irrigation	
	Annual average share of plan expenditure	Annual average share of combined plan and non-plan expenditure
From 1990-91 to 1994-95	5.91	5.72
From 1995-96 to 1999-2000	8.01	7.23
From 2000-01 to 2004-05	6.98	6.98
From 2005-06 to 2009-10	7.91	3.76
From 2010-11 to 2014-15	4.74	1.43

Notes: 1) For the year 2008-09 the revised estimates have been used, and for the year 2009-10 the budget estimates are used.
2) Both capital and revenue expenditure are calculated for the state.
Source: Calculated from RBI (2010), *Handbook of Statistics on State Government Finances.*

In Rajasthan, the combined plan and non-plan expenditure on irrigation has gone down sharply during the period 2005-06 to 2009-10 as shown in Table 3.2, despite a marginal increase in the plan expenditure. The share of plan expenditure on irrigation in the plan budget witnessed an increase in the period from 2005-06 to 2009-10. In the period of UPA I, expenditure on various activities relating to the rural economy recorded marginal increases in India . Ramakumar (2012) points out that between 2004-05 to 2006-07, there was a marginal increase in public expenditure on agriculture in India which started declining afterward.

3.4 *Physical Impact of Expenditure on Irrigation*

To understand the impact of the irrigation potential created and the public investment undertaken, one needs to further look at the area irrigated by different irrigation sources. This is important because the proportion of area irrigated by privately owned sources, has been increasing in recent years as compared to the area irrigated by public sources (Table 1A.1). There are two sets of agricultural statistics, one that is collected from local

government bodies and another that is collected from the households through sample or census surveys. These datasets, which have information on land use, area, irrigation, cropping pattern and production etc, are collected by the following sources:

a) The Directorate of Economics and Statistics, Ministry of Agriculture, collects information on area statistics including the information on irrigation facilitates, by dividing the states into three categories. The first category includes the states and UTs where the data is collected through cadastral surveys and these states are also known as temporary settled or land record states (GOI 2014). The second category includes the permanent settlement areas of Kerala, West Bengal, and Orissa where the data is collected through sample surveys under the Establishment of an Agency for Reporting of Agricultural Statistics (EARAS) scheme, which was applied later also to Arunachal Pradesh, Nagaland, Sikkim and Tripura (GOI 2014). For the other remaining states, where no agency collects data, estimates are conventionally made available by village headmen (GOI 2014).

Table 3.3: *Total cultivated and irrigated land, all India, 1950-51 to 2014-15* in million hectares

Year	Cultivated land	Net irrigated area	Net irrigated area as proportion to the cultivated land (%)
1950-51	129.4	20.9	16.1
1954-55	139.8	22.1	15.8
1959-60	144.9	24.0	16.6
1965-66	149.4	26.3	17.6
1970-71	151.5	31.1	20.5
1975-76	154.2	34.6	22.4
1980-81	155.1	38.7	25
1985-86	155.8	41.9	26.9
1994-95	156.2	53.0	34
1999-00	156.1	57.5	36.9
2004-05	155.4	59.2	38.1
2009-10 (p)	155.2	61.9	40.1
2014-15 (p)	155.2	68.4	44.1

Note: (p): Provisional.

Source: Directorate of Economics and Statistics (DES), Department of Agriculture and Cooperation, Government of India.

The expansion of the area under irrigation occurred initially when greater importance was accorded to its expansion. The land use records collected by the Directorate of Economics and Statistics (DES), Department of Agriculture and Cooperation, show, the total area under irrigation has been growing at a very slow rate (Table 3.3). The reasons for the slow rate of growth are delay in the completion of projects, inter-regional disparities in resources, water logging, salinity, increasing cost of irrigation, and so on. The ratio of the net irrigated area to the cultivated area was 16.1 per cent in 1950-51, which increased to 37 per cent by 1999-00, i.e., the area being irrigated by different sources doubled relative to the 1950s. And the provisional figures for the next few years point to a further increase in the area irrigated.

It can also be seen that the proportion of area irrigated by government canals has gone down (see Table 3.4). On the other hand, privately owned tubewells were being used on a large scale and the area under tubewells has gone up. The reason behind the increase in tubewell use in the areas which have had development of public irrigation is the uncertainty and irregularity of supply of water through canals (Shah and Kumar 2008). The initial increase in the irrigated area was due to public policies relating to irrigation and rural development, while the period after 1980s witnessed an increase in private investment in irrigation. With private investment, the area under irrigation increased but was accompanied by greater inequalities in the access to irrigation resources.

b) The Agricultural census, is also conducted by The Directorate of Economics and Statistics, Ministry of Agriculture on a quinquennial basis since 1970-71. It collects information on different aspects of operational holdings. The information is collected in three phases. In phase I information on land, social group, etc are collected. Phase II collects information on land, tenancy, irrigation, cropping pattern etc. The data on social groups, land, tenancy, irrigation cropping patter etc., collected as part of phase I and II, are re-tabulated from village statistics in temporary settlement states which maintain a record of cadastral surveys. For permanent settlement states, a household level survey is

conducted in a 20 per cent sample of villages as detailed records of cadastral surveys are not available in these states. And in Phase III, what is known as the input survey is conducted in a 7 per cent of sample of villages, with detailed household-level questions on input use. As true of the DES, the agricultural census also collects information on operational holdings.

Table 3.4: *Proportion of area irrigated by different sources, all India* in per cent

Survey year	Proportion of area irrigated	Area irrigated					
		Canals	Tanks	Wells	Tubewells	Other sources	Total
1990-91	27.6	34.3	6.5	19.9	32.2	7.2	100
1995-96	32.4	30.4	5.1	20.7	37.2	6.5	100
2000-01	33.9	28.2	4.4	17.9	40.1	9.4	100
2005-06	41.1	27.3	3.9	16.8	43.6	8.4	100
2010-11	40.5	26.2	3.5	18.5	45.2	6.7	100

Source: Calculated from Agriculture census data.

The data from various agricultural censuses show that the proportion of area irrigated in the last two decades has increased from 27.5 per cent to 40.5 per cent and the important reason for the increase is the rise in the area irrigated by tubewells (Table 3.4). The area irrigated by tanks has gone down but the area irrigated by wells has remained almost the same as it was in 1990-91.The area under canal irrigation has remained almost stagnant since 1990s (Appendix 3A.1). Therefore, with the increase in the area under tubewell irrigation, the share of area irrigated by canal irrigation in total irrigated registered a decline from 1990-91 to 2010-11.

The agricultural census provides information on partially and wholly irrigated areas. "If the entire net area sown in an operational holding is equal to net area irrigated, such holdings are considered as wholly irrigated holding. In case part of the net sown area is irrigated, it will be partly irrigated and if the entire sown area has not received any irrigation during the year of reference, such holding would be wholly unirrigated." GOI (2010)

Table 3.5: *Proportion of irrigated and unirrigated area as proportion to the total estimated area of holdings, all India* in per cent

Year	Area of wholly irrigated holdings	Area of wholly unirrigated holdings	Partly irrigated holdings		Net irrigated area of holdings receiving irrigation
			Total area	Irrigated area	
1990-91	17.5	44.0	23.4	10.1	27.6
1995-96	23.0	42.0	21.4	9.4	32.4
2000-01	26.6	44.3	16.1	7.2	33.9
2005-06	32.5	37.9	17.3	8.6	41.1
2010-11	32.3	40.7	15.5	8.2	40.5

Source: Calculated from Agriculture census data.

An important feature, revealed in Table 3.5, is that in the last two decades, the proportion of wholly irrigated holdings has increased in the areas receiving irrigation, i.e, the holdings which were partially irrigated, have now got greater access to irrigation. In other words, the private investment in irrigation occurred in the areas that already had access to irrigation resources earlier. However, this data does not provide any information on the quality of irrigation.

Moreover, this data has been criticised by various scholars for its lack of reliability and for the methodology used as the data in agricultural census is collected from the village and local bodies instead of the households cultivating or operating land. Bakshi and Ramachandran (2008) have provided a detailed critic of these data sets since the information collected through cadastral surveys, as part of seasonal updates in the *khasra* register across the state by the *patwar*i, give different information from that collected through the sample surveys by different agencies at an interval of 5 years.

c) The National Sample Survey Organisation collects information through sample surveys in all the states in India. Earlier, it collected information on land holdings, as a part of a survey on world agriculture by FAO (Food & Agricultural Organisation), in its eighth round (July 1954-April 1955) and then as part of a world census. A similar type of

survey was done in the 16th round (July 1960 - August 1961) and 17th round (September 1961 -July 1962). Since then information on different socio-economic aspects such as land, livestock, and debts was collected approximately every 10 years, in the 26th round (July 1971 - June 1972), 37th round (January - December 1982), 48th round (January-December, 1992), 59th round (January-December, 2003) and 70th round (January-December, 2013) from households. The data from earlier rounds of the NSSO is not comparable with the 48th and subsequent rounds, as the sample allocation of earlier rounds was based on both central sample and state sample.[4] The sample selection for the 48th round was also allocated to the centre and states but later only a central sample was used (GOI 1990). For the 59th and 70th round, the sample selection was based on a central sample only. In these rounds detailed information on irrigation is collected in the Land and livestock holdings survey (LHS) and situation assessment survey of agricultural households (SAS), from 59th round onwards. Land and livestock holdings survey (LHS) collects information on sources of irrigation on the different plots which are operated by the households including kitchen gardens. The data does not give any information on mortgage of land. The Situation Assessment Survey of agricultural households (SAS), collects information on the four major crops cultivated by the household, along with the source of irrigation and production of the crops. Except for the situation assessment survey in the 59th round of NSSO, no other NSSO round gives information regarding the adequacy of water for irrigation.

NSSO (as part of Land and livestock holdings survey) collects detailed information on land owned, leased out and leased in. For operational holdings,[5] the data on land size, type of possession, land use, availability and sources of irrigation, and drainage facilities is collected. Information on irrigation facilities and land use is not collected for the land which is leased out by the household through annual contracts. Also, there is no information on the land mortgaged in. The information on mortgaged out (usufructuary mortgage) land is recorded as part of leased out land.

[4] "Central sample - the part surveyed mainly by the NSSO field staff - and the rest to the state sample - the part surveyed by the state agencies. " GOI (1992).

[5] Operational holding: "An operational holding is defined as a techno-economic unit used wholly or partly for agricultural production (defined below) and operated (directed/managed) by one person alone or with the assistance of others, without regard to title, size or location." (GOI 1997).

From the 59th round onwards the information on cropping pattern and production, crop insurance, expenditure on agriculture, extension services, technological development etc., is collected as part of the situation assessment survey. The two rounds of situation assessment surveys differ with respect to type of household canvassed because of the change in the definition of "farmer households" which in the 59th round excluded the households which did not own or possess any land. This excluded households which would have been involved in agriculture but included in activities such as “other” etc. This definition of farmer households has been later replaced in the 70th round with "agricultural production unit" (GOI 2014), i.e., the household which does not own or possess land and was involved in farm activity could also be included in agricultural households. Secondly, the information on cropping pattern and production is collected for four major crops.

The data, for Land and Livestock Holdings Survey (LHS) and Situation Assessment Survey of agricultural households (SAS), is collected from the different sets of households from the 59th round onwards by the NSSO. In the 48th and 59th rounds, the NSSO collected information from both rural and urban households in two visits. But in the 70th round the information was collected only for the rural households. This chapter is primarily based on the recent round (January-December, 2013) of the land and livestock holdings survey. However, when necessary, comparisons with the earlier rounds have been made. Also, the data from the situation assessment survey (January-December, 2013) is used for calculating expenditure on irrigation. Only data for rural households is presented in the chapter.

In the official definition of NSSO, an operational holding is defined as land possessed (both owned and leased in) on which any agricultural production (wholly or partially) is carried out during the year by the household. It also includes the land on which vegetables or flowers are grown, as also the land on which animal or poultry are raised or pisciculture is carried out. These are considered to be part of the operational holding. But this study, for its analyses, takes into account only the land which is possessed by the

household (owned or leased in) on which agricultural production (wholly or partially) is carried out during the year(even for a season) by the household, when identifying an operational holding. However, the current fallows are not included in this operational holding as the data on irrigation is not collected for these by the NSSO. Also the land which is recorded as homestead land with some crops being cultivated on that land is not added to the operational holding, as in the 59th and 48th round the definition of homestead land was not clear (Rawal 2008). Also using the NSSO definition for landless households, households possessing land below 0.002 hectare are not included in the analysis.

3.4.1 *Structural changes in the distribution of irrigation resources:*

The data from the NSSO's 48th, 59th and 70th rounds show that a large proportion of area remained unirrigated in the kharif season in both Rajasthan and India. The data in Table 3.6 show that the area irrigated in the rabi season is more than double the area irrigated in the kharif season in Rajasthan. An important reason for this increase is the availability or access to ground water during the rabi season. Also, during the period from 2002-03 to 2012-13, the share of area irrigated by canals has increased in the rabi season for both India and Rajasthan. But in the kharif season, a larger proportion of the operational holding remains unirrigated, particularly in Rajasthan. In the year 2013, 63.8 per cent of operational holding area was unirrigated in the kharif season in Rajasthan and 51 per cent in all of India.

There are high inter-state variations in the area irrigated shown in these three NSSO rounds. In the 70th round, States like, Punjab, Uttar Pradesh, Bihar, and Haryana have 99.5%, 95.8%, 93.9%, and 93.2 % area irrigated respectively in the rabi season. In contrast states like Sikkim and Manipur lag far behind and have only 1.8% and 7.4% area irrigated respectively (GOI 2013). Tables 3A.1 to 3A.7 in the appendix show the area under operational holdings irrigated by different sources in the 48th, 59th and 70th rounds of land and livestock holdings surveys.

Table 3.6: *Proportion of irrigated operational holdings by source of irrigation, all India and Rajasthan, rural households*, in per cent

		Proportion of area irrigated	distribution of irrigated operated area by sources of irrigation								
			Canal	Tank*	Tubewell	Well	Ground water (tube well, well)	Combination of canal, other surface water and groundwater	Others	n.r.	All
All India											
48th round	Kharif	42.1	25.1	4.8	36.9	18.1	55	-	9.7	5.4	100
	Rabi	65.4	25.9	3	42	18.4	60.4	-	7.4	3.3	100
59th round	Kharif	41.8	21.9	3.5	51.9	17.2	69.1	-	5.4	0.1	100
	Rabi	66.2	16.4	2.3	59.3	16	75.3	-	5.8	0.2	100
70th round	Kharif	49	20.8	5.4			66.7	4.2	2.9	-	100
	Rabi	73	17.1	6.3			70.5	3.4	2.7	-	100
Rajasthan											
48th round	Kharif	29.9	36.1	1.6	20.2	34.4	54.6	-	3.5	4.2	100
	Rabi	66.1	35.3	2.1	23.4	32.6	56		2.1	4.5	100
59th round	Kharif	19.3	28.4	1.5	42.8	26.2	69		1.1		100
	Rabi	78.9	18.3	0.7	58.8	22	80.8		0.2		100
70th round	Kharif	36.2	35.7	1.7			61.1	0.4	1.1		100
	Rabi	70.8	25.9	2.6			68.9	0.3	2.3		100

Note: For 70th round it also is the proportion of area irrigated by minor surface works, which includes pond, tank, etc.
Source: NSSO, Land and Livestock Holdings Survey 48th, 59th, and 70th round.

A large number of households which have operational holdings lower than 0.4 hectare cultivate their land in the rabi season. Secondly, the households with larger operational holdings had better availability of irrigation than the households with smaller operational holdings. In 2012-13, 14.3 per cent households in the country as whole, which had operational holdings above 3 hectares operated 51.2 per cent of irrigated land in the rabi season and in the case of Rajasthan 11.5 per cent households (with operational holding above 3 hectares) operated 40 per cent of the irrigated land. This scenario has persisted over the years (Table 3A.2 to 3A.7).

Table 3.7: *Proportion of irrigated and unirrigated operational holdings, Rural Rajasthan, 2012-13* in per cent

NSSO regions (Rajasthan)[6]	Kharif		Rabi	
	Proportion of area of operational holdings		Proportion of area of operational holdings	
	Irrigated	Unirrigated	Irrigated	Unirrigated
Western	13.3	86.7	56.6	43.4
North eastern	48.4	51.6	80.4	19.6
Southern	7.4	92.6	93.6	6.4
South eastern	71.3	28.7	95.5	4.5
Northern	42.6	57.4	56.6	43.4

Source: NSSO, Land and Livestock Holdings Survey 70th round.

Further in Rajasthan, there are high intra-state variations in the distribution of irrigation resources, with a very small proportion of area in western and southern regions being irrigated in the kharif season.

Table 3.7 shows that the Southeastern region of the state had the highest proportion of irrigated land as 71.3 per cent was irrigated during the kharif season and 95.5 per cent in

[6] The district included in different regions are following: Western: Bikaner, Jodhpur, Jaisalmer, Barmer, Jalor, Sirohi, Pali; North eastern: Alwar, Bhartpur, Dhaulpur, Karoli, Swai Madhodur, Dausa, Jaipur, Ajmer, Tonk, Bhilwara; Southern: Rajsamand, Dugarpur, Udaipur, Banswara; South eastern: Bundi, Chittaugarh, Baran, Jhalaur, Kota; Northern: Ganganagar, Hanumangarh, Jhunjhunun, Sikar, Churu, Nagaur.

the rabi season. On the other hand, Western and Southern regions had a small proportion of land irrigated—13.3 per cent and 7.4 per cent respectively.

3.4.2 *Disparities in irrigation resources distribution*

A study by Reddy (2004), based on land data from the NSSO decennial rounds between 1960-61 to 1991-92 showed that the Gini coefficient for ownership holdings in India has always remained higher than was true in the case of the operational holdings, i.e., there is more inequality in the distribution of ownership. But lately during the last two rounds of the survey the Gini for operational holdings started increasing and rose to0.641 in 1991-92 as compared with0.583 in 1960-61. On the other hand the Gini for ownership holdings registered a small decrease in 1991-92 (0.710) in comparison to the Gini in 1981-82 (0.712) (Reddy 2004). But the NSSO's 2002-03 survey again shows an increase in the Gini coefficient of ownership holdings to 0.761 (Rawal 2008). Inequality in land distribution has been also been observed in village studies (Rawal and Swaminathan 2011 and Bakshi 2008). The inequalities in the land distribution further lead to the unequal distribution of other resources such as water etc even though they are provided or initiated by the state (Bharadwaj 1985). In 2012-13, The Gini coefficient of irrigated operational holding was 0.713 for All India and for Rajasthan it was as high as 0.740.

Various other studies, particularly village studies have also pointed to the persistent inequalities in the ownership and operational holding of land across size classes and caste groups (Rawal and Swaminathan 2011 and Bakshi 2008). The same can be seen in the NSSO data by analysing the access index, which is a ratio of the proportion of total area irrigated falling in a particular size class of holding to the proportion of total households belonging to that particular class. For irrigated operational holdings at the all India level for rural households, it emerges that 0.29 per cent households which own more than 10 hectares land have 4.61 per cent of the irrigated operational holding and their access index is the highest among all size classes, which is 16.02. On the other hand 46.62 per cent of households which own land below 0.4 hectare have access to 0.23 per cent irrigated land (Table 3.8).

Table 3.8 *Access index of household in different size class of land holdings, All India, 2012-13* in per cent

Size class of operational holding (ha)	Percentage share of		Access index
	Households receiving irrigation	Irrigated operational holding	
	(1)	(2)	3 (2/1)
less than 0.4	46.62	10.76	0.23
0.4 to 1	28.82	22.21	0.77
1 to 2	14.74	23.86	1.62
2 to 3	5.10	14.08	2.76
3 to 5	2.82	12.27	4.35
5 to 10	1.58	12.20	7.74
more than 10	0.29	4.61	16.02

Notes: 1) Access Index is calculated using the method used in Ramachandran (1990).
2) To calculate irrigated land from NSSO land, a plot of land which either received irrigation only in one season or in both seasons is considered as irrigated plot.
Source: NSSO, Land and Livestock Holdings Survey 70th round.

Table 3.9a: *Proportion of household with irrigated operation holdings in different size class of land holdings, Rajasthan, 2012-13* in per cent

Size class of operational holding (ha)	Western	North eastern	Southern	South eastern	Northern	All
less than 0.4	31.78	34.6	71.7	29.46	11.72	36.66
0.4 to 1	20.32	23.39	25.86	29.94	24.97	24.97
1 to 2	15.7	27.68	1.39	23.62	19.33	19.84
2 to 3	9.39	7.39	0.95	6.94	19.66	8.2
3 to 5	17.76	3.13	0.07	6.38	10.41	5.57
5 to 10	2.22	3.81	0.03	3.51	9.43	3.79
more than 10	2.82	0	0	0.15	4.48	0.96

Note: 1) To calculate irrigated land from NSSO land, a plot of land which either received irrigation only in one season or in both seasons is considered as irrigated plot.
Source: NSSO, Land and Livestock Holdings Survey 70th round.

For the households which have irrigated operational holdings lower than 1 hectare their access index is lower than 1. In Rural Rajasthan, the households owning land below 0.4 hectare had an access index of 0.18 per cent, and the households in the higher size classes of holding, also registered increases in their access index. This points to the concentration of irrigated operational holdings in households with larger operational holdings. Tables

3.9a-c also show similar results for intra state variations in Rajasthan. South eastern Rajasthan has the highest variation in the access index. For households which have land holdings of more than 10 hectares the access index is 22.61;on the other hand households with below 0.4 hectare of land recorded an access index of 0.2 as 29.5 per cent of households own only 5.9 per cent of irrigated area. In the northern region, which has around 6.5 per cent of households which own land below 1 hectare, the inter class variations in the access index is smaller than other regions of the state. The reason for the smaller variations in the Northern region of the state is mainly the high level of landlessness in the region (Rawal and Swaminathan 2016).

Table 3.9b: *Proportion of area of irrigated operation holdings in different size class of land holdings, Rajasthan, 2012-13* in per cent

Size class of operational holding (ha)	Western	North eastern	Southern	South eastern	Northern	All
less than 0.4	4.26	7.49	42.25	5.86	0.78	6.53
0.4 to 1	7.33	13.23	45.66	16.53	5.97	12.5
1 to 2	12.76	32.96	5.29	25.39	10.66	20.94
2 to 3	12.31	14.11	5.63	12.93	20.68	15.27
3 to 5	35.55	10.65	0.72	18.54	13.78	15.5
5 to 10	7.27	21.57	0.45	17.4	24.38	18.89
more than 10	20.51	0	0	3.33	23.76	10.37

Note: 1) To calculate irrigated land from NSSO land, a plot of land which either received irrigation only in one season or in both seasons is considered as irrigated plot.
Source: NSSO, Land and Livestock Holdings Survey 70th round.

Table 3.9c: *Access index of households operation holdings in different size class of land holdings, Rajasthan, 2012-13* in per cent

Size class of operational holding (ha)	Western	North eastern	Southern	South eastern	Northern	All
less than 0.4	0.13	0.22	0.59	0.2	0.07	0.18
0.4 to 1	0.36	0.57	1.77	0.55	0.24	0.5
1 to 2	0.81	1.19	3.81	1.08	0.55	1.06
2 to 3	1.31	1.91	5.96	1.86	1.05	1.86
3 to 5	2	3.4	10.06	2.9	1.32	2.78
5 to 10	3.27	5.66	13.74	4.95	2.59	4.98
more than 10	7.27	-	-	22.61	5.31	10.76

Notes: 1) Access Index is calculated using the method used in Ramachandran (1990).
2) To calculate irrigated land from NSSO land, a plot of land which either received irrigation only in one season or in both seasons is considered as irrigated plot.
Source: NSSO, Land and Livestock Holdings Survey 70th round.

Table 3.10: *Proportion of households and proportion of area irrigated by caste group*s, 2012-13 in per cent

Regions	Proportion of households in each caste group				Proportion of irrigated operational holding in each caste group			
	ST	SC	OBC	Others	ST	SC	OBC	Others
All India	13.8	15.8	44.6	25.8	8.3	10.1	47.8	33.8
Rajasthan	18.2	21.3	48.9	11.7	14.4	15.5	51.9	18.2
Western	15.0	10.8	54.1	20.1	1.1	8.3	53.1	37.5
North eastern	13.8	26.8	50.0	9.4	18.6	6.1	52.6	22.7
Southern	44.4	28.0	10.7	16.9	39.1	22.7	22.1	16.0
South eastern	27.7	14.2	50.3	7.7	29.8	11.3	42.8	16.1
Northern	3.4	19.9	70.0	6.6	2.3	30.3	60.6	6.8

Source: NSSO, Land and Livestock Holdings Survey 70th round.

Moreover, the households belonging to the ST and SC caste groups have lower shares in the households operating land as the land is concentrated with the OBCs and Other households. Similarly, their share in operational holdings is very small. The OBCs along with other households in India and Rajasthan have ownership of a majority of the land holdings. By looking at data at a more disaggregated level we find that households belonging to OBC and Others categories have primary control over the top size class of holding. The situation is worst for households belonging to the Scheduled Tribe category (see Table 3.11 and Table 3A.8 in appendix).

Table 3.11: *Proportion of households operating more than 10 hectares of land, by caste group,* in per cent

	ST	SC*	OBC	Others
All India	0	16	62	20
Rajasthan	1	6	50	43

Note: *Data for SC households for all India and Rajasthan level has a sample size of 7 and 6 households respectively.
Source: NSSO, Land and Livestock Holdings Survey 70th round.

The data on the irrigated operational holding collected by NSSO as part of the Land and Livestock Holdings survey (LHS) shows a greater inequality in distribution of irrigated land but the data doesn't provide any information on the adequacy or quality of irrigation. Secondly, the data on irrigation on leased out and current fallows is not collected. Thirdly, the plots which are partly irrigated are not included in the irrigated area because by definition, the NSSO collects information on irrigation on those plots where "the major part of the plot is irrigated" (GOI 2014). Fourthly, neither the information on the uses of multiple sources of irrigation for the same plot or area of land is collected in the 48th and 59th round surveys of the NSSO nor is the definition of criteria being used to include the land under a particular source if it is irrigated by two or more irrigation sources clear. However, irrigating land with multiple sources is an important feature among states which have seen the development of public irrigation at the early stages of planning.[7]

3.4.3 *Impact of irrigation on cropping pattern*

A fact that has been well established in the literature is that as a result of irrigation development, the cropping intensity increases on the irrigated land and the addition of new land to that being cultivated increases the gross cropped area (Dhawan 1994a and Bhalla 2007, and Bhalla S. 1989).Also, as mentioned earlier, the main purpose of launching irrigation projects was to increase food production. Irrigation is an important input in agriculture, and other inputs such as chemical fertilisers, pesticides are useful only when irrigation is available. The use of irrigation also increases production levels, as Bhalla and Singh (2009) in their study point out when explaining why from "1980-83 to 1990-93, the crop output recorded an unprecedented annual growth rate of 3.40% compared with a growth rate of 2.24% during 1962-65 to 1980-83,"Though, it is important to note that the entire increase in production, incomes, etc. is not because of

[7] The data on expenditure on irrigation is collected as part of situation assessment survey but as the data for 60 per cent of sample households which have reported irrigating land is not reported for both the visits, no analysis of the data is done.

irrigation. Dhawan (1988) and Bhalla and Singh (2009) point out that irrigation plays an important role in increasing agricultural output only when used along with other inputs.

Table 3.12: *Irrigated and total area cultivated with food grains and oilseeds, all India* in million hectares

Year	Irrigated foodgrains	Irrigated oilseeds	Total irrigated area under all crops	Total foodgrains	Total oilseeds	Total area under crops
1950-51	18.3	1.7	22.6	101.2	11.0	131.9
1954-55	20.1	0.1	24.9	109.4	12.6	144.1
1959-60	21.8	0.4	27.5	116.4	13.1	152.8
1965-66	24.0	0.5	30.9	114.9	14.2	155.3
1970-71	30.1	1.1	38.2	124.9	14.7	165.8
1975-76	34.1	1.2	43.4	128.5	15.2	171.3
1980-81	37.9	2.3	49.8	127.6	15.7	172.6
1985-86	40.4	3.4	54.3	128.8	19.4	178.5
1994-95	49.9	6.8	70.6	125.9	27.2	188.1
1999-00	55.7	6.6	79.2	124.7	26.2	188.4
2004-05	54.7	8.1	81.1	122.7	29.8	191.1
2009-10 (p)	58.1	7.2	85.1	121.5	27.9	189.2
2014-15 (p)	65.5	7.8	96.5	123.5	28.4	198.4

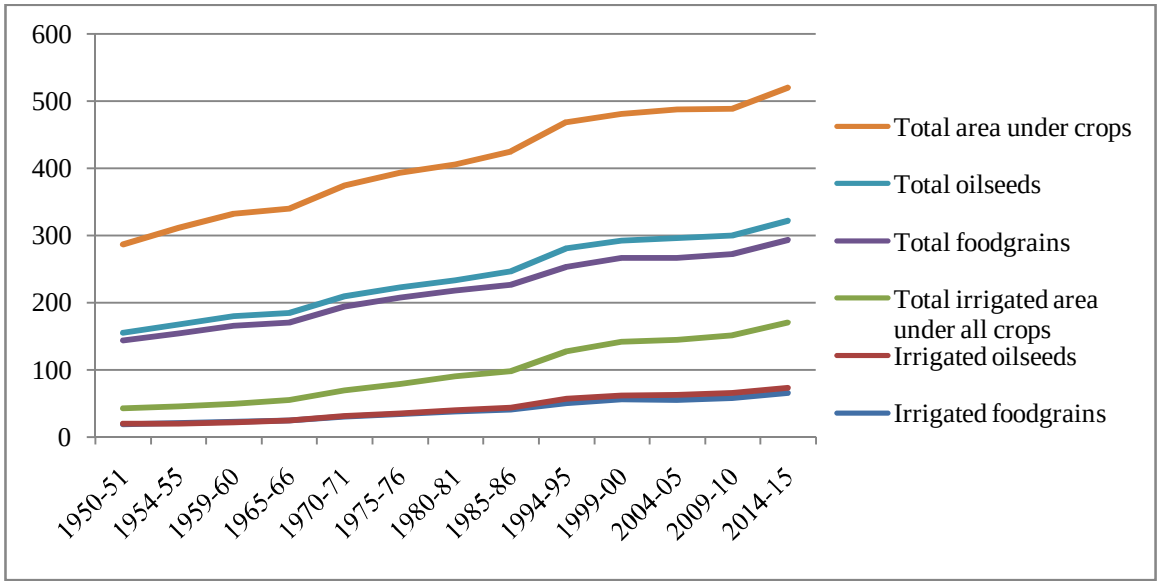
Source: Directorate of Economics and Statistics (DES), Department of Agriculture and Cooperation, Government of India.

The area under foodgrains, oilseeds and other crops has gone up over the years.[8] In 2014-15, the area cultivated with foodgrains and oilseeds was respectively 123.5 million hectares and 28.4 million hectares. In 2014-15, around 47 per cent area under foodgrains was irrigated and for oilseeds the proportion was only 29 per cent. This is contrary to the argument that more non-grain or commercial crops are being cultivated after irrigation was introduced. Although the production of the food crops has increased after the introduction of large scale irrigation and high yielding varieties during the Green Revolution, the entire produce is not consumed by the producers, so more surplus produce is arriving in the market.

[8]The area on which oilseed crop cultivation began in dry states, was the area where coarse cereals were being cultivated earlier and the shift occurred because of the slow growth in the yield (Bhalla and Singh 2009).

Table 3.9 and Chart 3.2 show that the largest share of irrigated area is under foodgrain cultivation, which accounts for almost 67 per cent of the total in recent years. The area under foodgrain cultivation on irrigated land has increased more than three times since 1950. And an FAO study on food and water, points out that in India over 50 per cent of food production derives from the irrigated land.[9]

Chart 3.2: *Irrigated and total area cultivated with food grains and oilseeds, all India* in million hectares



Source: Directorate of Economics and Statistics (DES), Department of Agriculture and Cooperation, Government of India.

The other important change that has occurred in the irrigated tracts is the change in cropping intensity. The *intensity of cropping* which shows the ratio of gross cropped area to net sown area is one of the important measures to assess the use of land resources. The cropping intensity in the area with assured irrigation has witnessed an increase (Dhawan 1998 and Sarkar 2009). The land use statistics indicate that the cropping intensity at the all India level remained stagnant from the mid 1990s to 2004-05,witnessed a small increase in 2004-05, and has once again been stagnant after that.[10] In 2012-13, the

[9] See http://www.fao.org/docrep/x0262e/x0262e01.htm for details.
[10] http://eands.dacnet.nic.in/LUS_2012-13.htm.

cropping intensity in India and Rajasthan was 1.39 and 1.37 respectively.[11] However, NSSO data for 2012-13 (Table 14), shows that the cropping intensity for irrigated land is much higher. That is, the land which receives irrigation is cropped twice in an agricultural year.

Table 3.13: *Area of gross and net for operational holdings and for irrigated operational holding, all India, and Rajasthan, 2012-13* in million hectares

Regions	Area of operational holdings (in million hectare)			Area of irrigated operational holdings (in million hectare)			Proportion of gross operational area to irrigated operational area (%)	Cropping intensity for irrigated land (%)
	Gross	Net	More than once	Gross	Net	More than once		
1	2	3	4 (2-3)	5	6	7 (5-6)	8 (2/5)	9 (5/6)
All India	183.3	93.3	90.1	111.5	56.8	54.7	60.8	1.96
Rajasthan	22.2	11.2	11.0	10.8	5.5	5.3	48.7	1.97
Western	6.6	3.3	3.3	1.3	0.7	0.7	20.2	2.00
North eastern	5.3	2.7	2.6	3.8	1.9	1.8	70.3	1.96
Southern	0.9	0.4	0.4	0.6	0.3	0.3	65.2	2.00
South eastern	2.0	1.0	1.0	1.8	0.9	0.9	93.9	1.96
Northern	7.4	3.7	3.7	3.3	1.7	1.6	44.8	1.97

Note: Cropping intensive is a proportion of gross area irrigated to the net area irrigated.
Source: NSSO, Land and Livestock Holdings Survey, 70th round.

The cropping intensity on irrigated operation holdings of western and southern Rajasthan reveals that the entire irrigated land is sown twice and in other parts of the state a small portion of irrigated land is kept fallow in one of the seasons (Table 3.11).

3.5 *Concluding Remarks*

Our analysis finds that the budgetary expenditure on irrigation has gone down along with the expenditure on the rural economy as whole. The expenditure in Rajasthan state on

[11] http://eands.dacnet.nic.in/LUS_2012-13.htm.

irrigation has only been around 3.8 per cent of its plan and non-plan budget in recent years.

Secondly, NSSO data shows that the irrigated operational holding is highly concentrated in the top size classes of holdings in India. And similar is the situation for the different regions of Rajasthan with small intra-state variations. The data from the different sources have pointed, universally, to an increase in the use of tubewell irrigation particularly in recent years when the area under canal irrigation was fluctuating. On the other hand, tank irrigation has gone down drastically. The decennial surveys of NSSO, from 1991-92 to 2012-13, show that households belonging to the top size classes have not only greater access to tubewell irrigated land but also to the canal irrigated land. This has been persistent over the years for both Rajasthan and India, but the situation is even worse in the former, as a quarter of canal irrigated land in Rajasthan is controlled by a very small proportion of households which have holdings of more than 10 hectares. The caste wise distribution of operational holdings distribution shows that the OBC and Other caste households have primary control, with a small share held by SC and ST households.

The data collected by the agricultural census shows that the spread of irrigation to the dry areas is not occurring and holdings which were partially irrigated in the 1990s have got greater access to irrigation by 2010 then the areas with wholly unirrigated holdings.

However, the data provided by all the sources is inadequate because none of these sources provide any information on the quality of irrigation and on the alternative or combined uses of tubewell and canal irrigation. Also, all the sources collect information on operational holdings and no detailed information on ownership holdings is collected. So, there is further need to look at this at a disaggregated level for both operational and ownership holding.

Appendix Tables

Table 3A.1: *The area irrigated by different sources, all India* in million hectares

Year	Source of irrigation							Net Irrigated Area (col.4 to 8)	Gross Irrigated Area	Area Irrigated More than once (col.10-9)	Cropping intensity
	Government canals	Private canals	Total canals	Tanks	Tube Wells	Other Wells	Other Sources				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1950-51	7.2	1.1	8.3	3.6	(a)	6	3	20.9	22.6	1.7	1.111
1951-52	7.5	1.2	8.7	3.5	(a)	6.5	2.4	21	23.2	2.1	1.116
1952-53	7.5	1.4	8.9	3.3	(a)	6.5	2.4	21.1	23.3	2.2	1.115
1953-54	7.5	1.3	8.9	4.2	(a)	6.7	2.1	21.9	24.4	2.5	1.124
1954-55	7.8	1.2	9.1	4	(a)	6.7	2.3	22.1	24.9	2.9	1.127
1955-56	8	1.4	9.4	4.4	(a)	6.7	2.2	22.8	25.6	2.9	1.141
1956-57	7.9	1.4	9.3	4.5	(a)	6.6	2.2	22.5	25.7	3.2	1.142
1957-58	8.3	1.3	9.7	4.5	(a)	6.8	2.2	23.2	26.6	3.5	1.130
1958-59	8.4	1.3	9.7	4.8	(a)	6.7	2.3	23.4	26.9	3.5	1.150
1959-60	8.8	1.3	10.1	4.6	(a)	7.1	2.2	24	27.5	3.4	1.150
1960-61	9.2	1.2	10.4	4.6	0.1	7.2	2.4	24.7	28	3.3	1.147
1961-62	9.3	1.2	10.5	4.6	0.3	7.1	2.4	24.9	28.5	3.6	1.154
1962-63	9.7	1.1	10.8	4.8	0.9	6.7	2.4	25.7	29.5	3.8	1.150
1963-64	9.9	1.2	11	4.6	1	6.8	2.5	25.9	29.7	3.8	1.150
1964-65	10.1	1.1	11.2	4.8	1.1	7	2.5	26.6	30.7	4.1	1.153
1965-66	9.9	1.1	11	4.3	1.3	7.4	2.5	26.3	30.9	4.6	1.140
1966-67	10.2	1	11.2	4.4	1.7	7.5	2	26.9	32.7	5.8	1.147
1967-68	10.3	0.9	11.2	4.5	2.1	7	2.3	27.2	33.2	6	1.171
1968-69	11	0.9	11.9	3.9	3.1	7.7	2.4	29	35.5	6.5	1.162

1969-70	11.7	0.9	12.6	4.1	3.7	7.4	2.4	30.2	37	6.8	1.170
1970-71	12	0.9	12.8	4.1	4.5	7.4	2.3	31.1	38.2	7.1	1.177
1971-72	12.2	0.9	13.1	3.7	4.7	7.5	2.4	31.5	38.4	6.9	1.182
1972-73	12.1	0.9	13	3.6	5.4	7.6	2.3	31.8	39.1	7.2	1.182
1973-74	12.2	0.9	13.1	3.9	5.6	7.7	2.3	32.5	40.3	7.7	1.193
1974-75	12.7	0.9	13.5	3.5	6.6	7.6	2.4	33.7	41.7	8	1.192
1975-76	12.9	0.9	13.8	4	6.8	7.6	2.4	34.6	43.4	8.8	1.209
1976-77	13	0.8	13.9	3.9	7.4	7.7	2.3	35.1	43.6	8.4	1.200
1977-78	13.7	0.8	14.6	3.9	7.6	7.9	2.5	36.5	46.1	9.5	1.213
1978-79	14.3	0.8	15.1	3.9	8.2	8.3	2.5	38.1	48.3	10.2	1.223
1979-80	13.9	0.8	14.8	3.5	9.3	8.6	2.4	38.5	49.2	10.7	1.221
1980-81	14.5	0.8	15.3	3.2	9.5	8.2	2.6	38.7	49.8	11.1	1.231
1981-82	15.5	0.5	15.9	3.4	10.3	8.4	2.4	40.5	51.4	10.9	1.244
1982-83	15.7	0.5	16.2	2.9	10.8	8.6	2.2	40.7	51.8	11.1	1.227
1983-84	16.3	0.5	16.8	3.5	10.9	8.5	2.3	41.9	53.8	11.9	1.254
1984-85	15.8	0.5	16.3	3	11.6	8.8	2.5	42.1	54.5	12.4	1.251
1985-86	15.7	0.5	16.2	2.8	11.9	8.5	2.5	41.9	54.3	12.4	1.267
1986-87	16	0.5	16.5	2.7	12.3	8.5	2.6	42.6	55.8	13.2	1.264
1987-88	15.3	0.5	15.7	2.5	13.2	8.6	2.8	42.9	56	13.1	1.273
1988-89	16.6	0.5	17.1	3	13.7	9.5	2.8	46.1	61.1	15	1.285
1989-90	16.6	0.5	17.1	2.9	14	9.8	2.8	46.7	61.9	15.2	1.281
1990-91	17	0.5	17.5	2.9	14.3	10.4	2.9	48	63.2	15.2	1.300
1991-92	17.3	0.5	17.8	3	15.2	10.9	3	49.9	65.7	15.8	1.287
1992-93	16.5	0.5	17	3.2	15.8	11.1	3.2	50.3	66.8	16.5	1.301
1993-94	16.7	0.5	17.1	3.2	16.4	11.2	3.4	51.3	68.3	16.9	1.310
1994-95	16.8	0.5	17.3	3.3	17.2	11.7	3.5	53	70.6	17.6	1.315
1995-96	16.6	0.6	17.1	3.1	17.9	11.8	3.5	53.4	71.4	18	1.318
1996-97	16.9	0.2	17.1	2.8	19.3	12.5	3.4	55.1	76	20.9	1.326

1997-98	17.2	0.2	17.4	2.6	19.7	12.4	3.1	55.2	75.7	20.5	1.338
1998-99	17.1	0.2	17.3	2.8	21.4	12.6	3.3	57.4	78.7	21.2	1.343
1999-00	17.2	0.2	17.4	2.5	22	12.6	2.9	57.5	79.2	21.7	1.336
2000-01	15.8	0.2	16	2.5	22.6	11.3	2.9	55.2	76.2	21	1.311
2001-02	15	0.2	15.2	2.2	23.2	12	4.3	56.9	78.4	21.4	1.336
2002-03	13.9	0.2	14.1	1.8	25.6	8.7	3.7	53.9	73.1	19.2	1.318
2003-04	14.3	0.2	14.5	1.9	26.7	9.7	4.3	57.1	78	21	1.348
2004-05	14.6	0.2	14.8	1.7	25.2	10	7.5	59.2	81.1	21.8	1.359
2005-06	16.5	0.2	16.7	2.1	26	10	6	60.8	84.3	23.4	1.365
2006-07	16.8	0.2	17	2.1	26.9	10.7	6	62.7	86.8	24	1.376
2007-08(p)	16.5	0.2	16.7	2	28.5	9.9	6.1	63.2	88.1	24.9	1.384
2008-09(p)	16.7	0.2	16.9	2	28.4	10.4	6	63.6	88.9	25.3	1.377
2009-10(p)	14.8	0.2	15	1.6	28.4	10	7	61.9	85.1	23.1	1.358
2010-11(p)	15.5	0.2	15.7	2	28.6	10.5	6.9	63.6	88.6	25	1.396
2011-12(p)	15.8	0.2	16.0	1.9	29.9	10.6	7.2	65.7	91.8	26.1	1.389
2012-13(p)	15.5	0.2	15.7	1.8	30.5	10.8	7.6	66.3	92.2	26.0	1.388
2013-14(p)	16.1	0.2	16.3	1.8	31.1	11.3	7.6	68.1	95.8	27.7	1.421
2014-15(p)	16.0	0.2	16.2	1.7	31.6	11.4	7.5	68.4	96.5	28.1	1.416

Notes: 1) (a): Included under "Other Wells" as separate figures were not collected during these years.
2) (p): Provisional.
Source: Directorate of Economics and Statistics (DES), Department of Agriculture and Cooperation, Government of India.

Table 3A.2: *Proportion of irrigated operational holdings by source of irrigation and by size class of holding, all India and Rajasthan, rural households, Kharif season, 1991-92* in per cent

Size class of operational holding (ha)	Proportion of households	Proportion of operational area			Percentage distribution of irrigated land with irrigation facilities					
		Unirrigated	Irrigated	N.R.	Canal	Tank	Tubewell	Well	Others	N.R.
All India										
less than 0.4	28.4	3.2	5.2	-	5.5	8.1	5.8	3.0	6.0	2.2
0.4 to 1	30.8	13.0	16.4	-	17.0	24.0	17.0	12.7	19.4	9.9
1 to 2	21.0	20.0	22.7	-	25.6	26.4	22.0	20.7	26.4	10.3
2 to 3	8.9	15.0	15.6	-	16.1	13.0	16.0	15.2	17.1	10.8
3 to 5	6.4	17.9	16.8	-	14.7	14.6	17.7	20.4	13.8	15.6
5 to 10	3.5	18.1	15.2	-	14.5	10.3	14.1	19.0	12.8	21.5
more than 10	1.0	12.7	8.2	-	6.7	3.5	7.3	8.9	4.5	29.8
All India	100.0	100.0	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0
Rajasthan										
less than 0.4	13.4	0.9	1.7	-	0.7	7.3	0.9	3.0	2.8	1.2
0.4 to 1	25.7	5.3	9.4	-	3.6	26.0	8.4	15.0	20.1	2.6
1 to 2	21.2	8.9	16.9	-	10.3	11.6	17.4	22.9	22.6	19.8
2 to 3	12.1	9.8	14.2	-	7.1	33.1	16.8	19.3	23.6	5.5
3 to 5	13.2	18.0	19.9	-	16.5	17.3	30.0	16.4	3.3	44.1
5 to 10	9.9	25.5	25.5	-	39.8	4.7	14.6	19.4	20.0	18.5
more than 10	4.5	31.5	12.3	-	22.0	0.0	12.1	3.9	7.7	8.2
All Rajasthan	100.0	100.0	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0

Source: NSSO, Land and Livestock Holdings Survey, 48th round (kharif).

Table 3A.3: *Proportion of irrigated operational holdings by source of irrigation and by size class of holding, all India and Rajasthan, rural households, rabi season, 1991-92* in per cent

Size class of operational holding (ha)	Proportion of households	Proportion of operational area			Percentage distribution of irrigated land with irrigation facilities					
		Unirrigated	Irrigated	N.R.	Canal	Tank	Tubewell	Well	Others	N.R.
All India										
less than 0.4	36.7	5.6	6.2	-	5.3	12.7	6.4	4.9	9.7	3.0
0.4 to 1	30.5	15.8	17.8	-	16.1	29.9	18.5	16.0	22.2	11.2
1 to 2	17.7	19.5	22.9	-	22.3	28.6	22.4	25.2	24.4	12.3
2 to 3	6.9	14.2	14.4	-	11.9	13.0	15.7	14.6	17.2	9.5
3 to 5	4.9	16.5	16.6	-	16.3	8.2	16.9	18.5	13.9	17.2
5 to 10	2.5	16.9	14.0	-	15.5	5.6	14.0	14.1	9.8	17.3
more than 10	0.7	11.3	8.3	-	12.5	1.9	6.1	6.7	2.7	29.5
All India	100	100	100	-	100	100	100	100	100	100
Rajasthan										
less than 0.4	20.9	1.5	2.3	-	0.9	10.1	1.2	4.4	0.7	1.0
0.4 to 1	27.6	6.2	10.5	-	3.4	34.7	9.3	17.2	27.8	3.9
1 to 2	22.4	12.4	17.7	-	8.5	19.6	16.8	28.9	30.3	7.1
2 to 3	9.8	11.1	12.5	-	4.9	27.4	17.7	16.7	5.3	11.2
3 to 5	9.4	19.3	17.5	-	15.8	2.4	28.6	13.1	24.4	8.3
5 to 10	7.5	24.8	25.0	-	40.9	5.8	17.9	14.5	11.5	28.9
more than 10	2.4	24.7	14.5	-	25.7	0.0	8.5	5.1	0.0	39.6
All Rajasthan	100.0	100.0	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0

Source: NSSO, Land and Livestock Holdings Survey, 48th round (rabi).

Table 3A.4: *Proportion of irrigated operational holdings by source of irrigation and by size class of holding, all India and Rajasthan, rural households, Kharif season, 2002-03* in per cent

Size class of operational holding (ha)	Proportion of households	Proportion of operational area			Percentage distribution of irrigated land with irrigation facilities					
		Unirrigated	Irrigated	N.R.	Canal	Tank	Tubewell	Well	Others	N.R.
All India										
less than 0.4	34.7	5.7	7.5	11.1	7.8	9.5	8.5	3.3	9.9	9.5
0.4 to 1	32.3	17.7	19.2	26.7	20.8	24.3	20.4	11.8	21.6	27.9
1 to 2	18.7	22.4	22.7	29.1	23.0	23.4	22.7	21.6	24.6	31.2
2 to 3	6.2	12.9	12.9	13.7	13.3	15.8	12.3	13.0	14.2	31.4
3 to 5	4.9	17.2	15.2	7.4	14.5	14.7	15.1	17.8	12.1	0.0
5 to 10	2.4	13.1	14.4	11.9	13.5	7.2	14.0	19.9	10.3	0.0
more than 10	0.7	11.0	8.0	0.0	7.1	5.0	7.1	12.7	7.4	0.0
All India	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rajasthan										
less than 0.4	17.3	2.0	1.7	-	0.6	2.2	2.0	2.6	0.0	-
0.4 to 1	32.3	9.8	9.3	-	5.5	56.5	10.0	7.8	47.5	-
1 to 2	19.9	12.5	13.1	-	7.9	26.3	16.7	11.3	28.5	-
2 to 3	9.5	9.5	13.6	-	16.5	0.3	13.7	10.7	24.0	-
3 to 5	10.0	16.4	20.0	-	14.7	0.0	27.4	15.6	0.0	-
5 to 10	7.3	21.2	24.7	-	27.1	14.7	24.8	23.3	0.0	-
more than 10	3.6	28.6	17.7	-	27.7	0.0	5.4	28.8	0.0	-
All Rajasthan	100.0	100.0	100.0	-	100.0	100.0	100.0	100.0	100.0	-

Source: NSSO, Land and Livestock Holdings Survey,59th round (kharif).

Table 3A.5: *Proportion of irrigated operational holdings by source of irrigation and by size class of holding, all India and Rajasthan, rural households, rabi season, 2002-03* in per cent

Size class of operational holding (ha)	Proportion of households	Proportion of operational area			percentage distribution of irrigated land with irrigation facilities					
		Unirrigated	Irrigated	N.R.	Canal	Tank	Tubewell	Well	Others	N.R.
All India										
less than 0.4	40.7	6.4	5.0	8.2	5.2	7.7	4.9	2.9	9.1	13.4
0.4 to 1	31.1	19.0	14.0	27.6	14.8	15.2	13.8	11.0	22.0	18.2
1 to 2	15.8	24.9	21.8	25.6	22.3	23.5	22.3	17.1	26.5	42.2
2 to 3	5.6	12.5	14.5	12.5	15.8	16.6	14.9	13.0	11.6	12.5
3 to 5	4.3	16.9	18.6	9.0	17.8	17.5	18.1	23.5	13.1	0.6
5 to 10	2.0	12.9	17.3	9.4	16.3	14.9	17.7	21.1	6.3	13.0
more than 10	0.5	7.5	8.8	7.8	7.8	4.6	8.3	11.3	11.5	0.0
All India	100	100	100	100	100	100	100	100	100	100
Rajasthan										
less than 0.4	23.3	0.4	-	1.6	0.5	5.8	1.4	2.8	26.5	-
0.4 to 1	32.0	5.8	-	7.4	2.9	16.7	6.3	13.5	35.0	-
1 to 2	15.4	6.2	-	11.9	6.7	0.0	13.1	13.0	38.5	-
2 to 3	12.8	10.6	-	10.3	10.3	21.1	9.6	11.8	0.0	-
3 to 5	7.2	13.6	-	20.9	22.3	0.0	21.9	18.2	0.0	-
5 to 10	6.8	28.3	-	34.1	31.2	56.3	36.6	29.6	0.0	-
more than 10	2.5	35.1	-	13.8	26.1	0.0	11.2	11.1	0.0	-
All Rajasthan	100	100	-	100	100	100	100	100	100	-

Source: NSSO, Land and Livestock Holdings Survey,59th round (rabi).

Table 3A.6: *Proportion of irrigated operational holdings by source of irrigation and by size class of holding, all India and Rajasthan, rural households, kharif season, 2012-13* in per cent

Size class of operational holding (ha)	Proportion of households	Proportion of operational area			Percentage distribution of irrigated land with irrigation facilities				
		Unirrigated	Irrigated	N.R.	Canal	minor surface works (pond, tank, etc)	ground water (tubewell, welletc.)	combination of canal, surface and ground water	Others
All India									
less than 0.4	41.2	7.4	10.2	0.1	10.5	18.6	9.6	5.8	14.1
0.4 to 1	30.4	20.7	21.3	4.9	21.2	20.2	21.7	9.7	31.2
1 to 2	16.4	22.9	23.9	1.6	19.6	27.8	25.0	20.4	27.4
2 to 3	6.2	15.0	15.2	0.6	16.7	16.6	14.0	23.5	17.6
3 to 5	3.3	12.9	12.2	88.6	13.8	7.5	12.3	13.5	5.5
5 to 10	2.0	14.3	11.9	4.2	11.7	7.4	12.1	21.5	3.7
more than 10	0.4	6.8	5.2	0.0	6.5	2.0	5.3	5.6	0.5
All India	100	100	100	100	100	100	100	100	100
Rajasthan									
less than 0.4	25.5	4.5	2.8	-	0.4	0	4	0	2.1
0.4 to 1	29.7	12.7	9.0	-	5.2	10	11	16.2	43.7
1 to 2	21.4	16.9	18.7	-	10.1	30.2	23.4	0	27.7
2 to 3	9.2	11.1	17.7	-	22.2	47.2	14.3	0	18.0
3 to 5	7.5	15.9	18.8	-	16.1	2.2	20.6	83.8	8.4
5 to 10	4.9	19.1	18.2	-	17.5	5.6	19.4	0	0
more than 10	1.9	19.6	14.8	-	28.5	4.8	7.4	0	0
All Rajasthan	100	100	100	-	100	100	100	100	100

Source: NSSO, Land and Livestock Holdings Survey,70th round (kharif).

Table 3A.7: *Proportion of irrigated operational holdings by source of irrigation and by size class of holding, all India and Rajasthan, rural households, rabi season, 2012-13* in per cent

Size class of operational holding (ha)	Proportion of households	Proportion of operational area			percentage distribution of irrigated land with irrigation facilities				
		Unirrigated	Irrigated	N.R.	Canal	minor surface works (pond, tank, etc)	ground water (tubewell, well etc.)	combination of canal, surface and ground water	Others
All India									
less than 0.4	44.4	10.1	9.8	1.6	9.3	9.9	10.8	6.4	12.9
0.4 to 1	28.9	22.8	21.0	38.3	18.4	21.5	22.8	11.4	31.3
1 to 2	16.3	27.3	24.8	55.2	21.6	25.3	28.3	25.5	23.3
2 to 3	5.6	15.6	14.2	4.9	18.7	13.6	9.5	12.7	13.4
3 to 5	2.8	10.8	12.2	0	15.0	11.4	10.7	16.8	11.0
5 to 10	1.5	7.8	12.6	0	9.0	13.0	16.1	21.0	7.9
more than 10	0.3	5.5	5.3	0	8.0	5.2	1.7	6.1	0.3
All India	100	100	100	100	100	100	100	100	100
Rajasthan									
less than 0.4	32.1	2.3	6.6	-	2.8	7.7	16.3	2.1	5.7
0.4 to 1	28.5	12.1	13.1	-	4.4	15.6	33.6	0	15.9
1 to 2	19.7	12.7	20.8	-	8.2	25.5	16.8	0	27.9
2 to 3	8.3	9.2	15.5	-	25.5	12.2	8.6	0	11.7
3 to 5	5.9	17.6	13.3	-	8.4	15.1	5.3	97.9	13.2
5 to 10	3.9	12.6	19.1	-	15.3	20.5	17.8	0	25.6
more than 10	1.7	33.5	11.6	-	35.3	3.4	1.7	0	0
All Rajasthan	100	100	100	-	100	100	100	100	100

Source: NSSO, Land and Livestock Holdings Survey,70th round (rabi).

Table 3A.8: *Proportion of area irrigated by size class and caste group, for all India and Rajasthan,2012-13* in per cent

Size class of operational holding (ha)	All India				Rajasthan			
	ST	SC	OBC	Others	ST	SC	OBC	Others
less than 0.4	6.7	21.9	48.2	23.2	23.6	39.0	29.8	7.6
0.4 to 1	10.7	12.6	50.7	26.0	28.0	9.6	54.4	8.0
1 to 2	10.7	9.6	47.2	32.5	16.4	12.6	59.7	11.4
2 to 3	8.8	12.6	41.7	36.9	13.7	31.1	34.1	21.2
3 to 5	8.3	5.1	49.1	37.5	13.9	10.1	51.9	24.2
5 to 10	4.2	3.4	49.9	42.5	12.4	6.2	49.8	31.6
more than 10	0.9	4.2	46.6	48.3	0.0	16.9	70.8	12.3
For all size classes	8.3	10.1	47.8	33.8	14.4	15.5	51.9	18.2

Source: NSSO, Land and Livestock Holdings Survey, 70th round.

Chapter 4

Nature of Expansion of Irrigation in Gang Canal Region and Description of Study Area

4.1 *Introduction*

The Gang canal region has been referred to as the "greenery of Rajasthan" after the development of canal irrigation. The information on land and production before canal development is available in various settlement reports and Gazetteers of the Bikaner state.[12] The areas through which the Gang canal runs (now in Sri Ganganagar district), were earlier part of Mirzawala tehsil of Bikaner state, and according to Fagon (1893) only 11 per cent of the area in Mirzawala tehsil was cultivated. But after assured irrigation from the Gang canal was delivered to the region, 87.2 per cent of the area in Sri Ganganagar district is being cultivated under different crops (GOR 2016).

This chapter is an attempt to summarise the evolution of canal irrigation and water distribution through canals. It also briefly discusses the settlement and agrarian economy of the region. Gang canal region in this study, refers to the area irrigated by the Gang canal, which falls in the Sri Ganganagar district of Rajasthan. Before the development of the Gang canal, the region was mainly part of Mirzawala tehsil of Suratgarh Nizamat, and some parts of Anupgarh and Sardargarh tehsils of Bikaner state of former Rajputana (Fagon 1893 and Sehagal 1960). In 1927, after the advent of the Gang canal, the boundaries of Sri Ganganagar were demarcated (Sehagal 1960). In 1948,[13]on the formation of Rajasthan state, Hanumangarh district was merged with Sri Ganganagar district. But in 1994, Hanumangarh was made a separate district again. While there have been changes in the geographical area of Sri Ganganagar district, the Gang canal falls in the areas constituting the current Sri Ganganagar district. Therefore, the Gang canal region refers to the area irrigated by the canal in the present district of Sri Ganganagar.

[12] The information on land and production is recorded only for *Khalsa* Villages, the nature of which is explained in the next section.
[13] Sehagal 1960.

4.2 *Land and Production Relations in Gang Canal Region*

4.2.1 *The land tenure, settlements and first formation of chaks*

There were three different types of land tenures in Bikaner state, before Independence and these were *Jagir*, *Khalsa* and *Sasan* or *dharmada* (Singh 1937). *Jagir*s were land grants to influential people who were either relatives of the Maharaja or had got *Jagir*s because of their past services to the state (and most often had to pay additional cesses—termed *rekh*—which the relatives did not have to). Jagirdars used to collect the taxes from villages, including the land tax, and hand over a part of it to the state (Singh 1937). On the other hand, in areas where *Khalsa* prevailed, the villages were under the direct control of the state,and were areas which had the best agricultural land. According to Ram and Chouhan (2016), "In 1884 it was decided to undertake summary settlement of *khalsa* villages. Regular survey was conducted only for *khalsa* area. This was completed and enforced in 1886". *Khalsa* villages were divided in two categories. One was called *Khatwar*, and covered areas where the land titles, i.e., *patta*s were given to individuals and they were made responsible for paying the revenue and tax to the state. The other, known as joint villages, covered areas in which lumpsum assessments with joint responsibility for taxes were made (Munshi and Lal 1895). Thirty two per cent of the area of the Bikaner state was under *Khalsa* villages (Ram and Chouhan 2016). The revenues and taxes were not fixed for *Khalsa* villages in Suratgarh Nizamat which had the highest number of *Khalsa* villages (Fagon 1893). Mirzawala had 125 *Khalsa* villages, out of which 51 were joint villages and 74 were *Khatwar* (Munshi and Lal 1895). At the time of formation of Rajasthan State, Ganganagar Nizamat had 45 per cent of the total of 458 *Khalsa* villages (Sharma 1993).[14] Finally, in areas under *Sasan* the land was given by the state for religious purposes and no tax was charged on that land (Singh 1937).

[14]The number of villages, both Khalsa and other villages, increased after the introduction of the canal. The formation and settlement of these villages is discussed in a later section of this chapter.

As Fagon (1893) wrote, a large proportion of the land, particularly in Suratgarh Nizamat (constituted mainly by three tehsils — Suratgarh, Mirzawala, and Hanumangarh) was fallow waste land and the main reason for this was the insufficient rainfall. Also, these uncultivated lands were with *thikanedars* (subinfeudatories) of the state (*ibid.*). In order to increase the state's revenue, these areas, scattered plots in many cases and with some cultivated fields, were formed into *chaks* or blocks (Fagon1893). The Bikaner state planned to settle people from neighbouring states in these areas (Fagon 1893). These *chaks* were given on lease for a certain number of years with land *patta*s or lease contracts and generally the rate of lease was lower than in the other villages (*ibid.*). Also in order to profit from these *chaks*, the farmers needed to bring every year some additional land under cultivation (*ibid.*). As there was larger demand for the *chaks* close to Sirsa (earlier part of Punjab now in Haryana) and Firozpur (Punjab),[15] the land in the Western areas of the Nizamat was cultivated by people from the neighbouring villages (*ibid.*). The lessees of land in the *chak* area did not initially settle in the *chak* area and returned to their native places after the harvest of kharif crops and sometimes after rabi crops (*ibid.*). In the years of deficient rainfall and drought, the lessees neither cultivated land nor paid the state its revenues (*ibid.*). And these defaulting *chaks* were again leased out to the people who were willing to pay the defaulted revenue (partly or wholly) to the state, and these lands were taken by people as there were no grazing areas in the neighbouring district of Firozpur. Therefore, the land was never used entirely for cultivation (*ibid.*).

4.2.2 *Cropping pattern*

As mentioned earlier, the information on land and production is available only for *Khalsa* villages in settlement reports and Gazetteers as these areas were directly under the control of the State. Fagon (1893) pointed out based on a settlement survey that 11 per cent of the area of Mirzawala tehsil was cultivated, and in the southern parts of the tehsil the proportion of cultivated area was even lower (6 per cent). Whereas for Suratgarh

[15] Sirsa and Firozpur were part of the adjoining states and had irrigation facilities for cultivation. People from these region used to leased in land of Bikaner state for grazing animals.

Nizamatas a whole, the area under cultivation went down to 10 per cent since settlement, partly because of deficiency of rainfall in the region (*ibid.*). In the central parts of Bikaner state including Suratgarh Nizamat, generally only one crop, i.e., the kharif crop, was cultivated. The rabi crop was cultivated only in years of good rainfall (*ibid.*). Crops under cultivation in much of the area were pearl millet (bajra) and bengal gram (moth). Apart from these a small part of land was devoted to sorghum (jawar) (*ibid.*). Rabi crops were cultivated in small parts of Mirzawala and Hanumangarh tehsils, and the major crops were barley and rocket salad (Taramira), and sometimes gram was mixed with the barley crop (*ibid.*). Wheat was cultivated in Hanumangarh tehsil. A similar cropping pattern is revealed in the agricultural statistics of India for the period from 1900-01 to 1904-05, according to which Suratgarh Nizamat had the highest cropped area of 48.27 per cent in the Bikaner state, followed by Reni Nizamat (Ram and Chouhan 2016).

After the development of irrigation (discussed in the next section), the agricultural statistics for 1936-37 to 1937-38 show a drastic change in the land use in Sri Ganganagar district. Whereas earlier a large part of the land area was kept fallow, during these two years on an average 17 per cent of area was under gram cultivation, 13 per cent under cotton, to be followed by sorghum (jawar), pearl millet (bajra), wheat, barley, rocket salad, mustard, fodder crops, and so on. A small proportion of the area was under sugarcane, maize, linseed, fruits, sesame, etc. Also 0.1 per cent of the total area was double cropped (DCIS 1940 and 1941). In other words, after introduction of canal irrigation, on the one hand, the area under cultivation increased, and on the other hand, there was a rise in the share of area under food grain crops. Also, cultivation of commercial crops began in the region as well. The access to irrigation not only increased area under food crops, but production levels also increased in the region.

During the colonial period, when the agriculture and allied sectors did not receive investment for their development and the profits from agriculture were taken either by Zamindars or by the state, agriculture remained stagnant. In the post-colonial period, with the abolition of Zamindari and with investment by the state in the development of agriculture the production relations in the region changed. The ownership of means of

production such as land was given to the cultivator. As prior to introduction of canal irrigation, the households from neighbouring states were tenant cultivator in the state but after the introduction of canal irrigation the households from neighbouring states purchased land which was directly under state control and settled in the Gang canal region.

Singh (1960) points out that in the post-colonial period, pearl millet (bajra) was an important food grain crop in Sri Ganganagar district, with around 24.5 per cent of the area devoted to it. Wheat was cultivated in about half of the area planted with pearl millet, though wheat delivered 7 times higher production than pearl millet. The reason why area under pearl millet cultivation remained large was that only around 50 per cent of agricultural land of Sri Ganganagar district was irrigated with water from the Gang canal. The remaining land of the district was unirrigated till the 1960s. To irrigate the remaining 50 per cent of agricultural land of the district, the construction of the Indira Gandhi Nahar and Bhakhra canals began in 1960s. Fodder crops, cotton, gram, sugarcane, etc were the other main crops (Singh 1960). The post-colonial period also witnessed major changes in the production conditions and relations in the region. Encouraged by an increase in the prices of cash crops, cultivation of cash crops also began. The impact of changes in technology, mechanisation in particular, varied across farm sizes, leading to differentiation. Also, land ownership was concentrated in the hands of few caste groups in the region, particularly, Jats, with an increase in inequality of land ownership in some parts.

4.2.3 *Emigration from neighbouring states*

As mentioned earlier, people migrated from the neighbouring states to take up cultivation in Bikaner state, particularly in the *chaks* (Fagon1893). But before the arrival of canal irrigation these people did not settle in Bikaner and would return to their native places after the harvest (*ibid.*). But after the introduction of canal irrigation, these emigrants were given certain concessions on taxes by the Bikaner state (GOB 1940). These concessions were mainly on household materials brought from their native place, and

later on taxes on land purchase as well (GOB 1940). As a result, unusual changes in the population can be observed across the various censuses conducted during the period from 1901 to 1961.

Table 4.1: *Percentage change in the population in Sri Ganganagar district, from 1901 to 2011*

Census year	Population of Sri Ganganagar District (in numbers)	Percentage change (in per cent)
1901	143,442	-
1911	206,068	43.7
1921	170,593	-17.2
1931	345,436	102.5
1941	533,974	54.6
1951	630,130	18.0
1961	1,037,423	64.6
1971	1,394,011	34.4
1981	2,029,968	45.6
1991	2,622,777	29.2
2001*	1,788,487	-31.8
2011	1,969,168	10.1

Note: * In 1994, Sri Ganganagar district was divided into two districts Sri Ganganagar and Hanumangarh. In 1991, the share of these two districts in total population of Sri Ganganagar was 53.3 per cent and 46.5 per cent respectively.
Sources: Upto 1961, the data is taken from Sehagal (1960), and for further years, from various census reports.

The highest change in population in the area occurred after the introduction of canal irrigation. Between 1921 and1931 the population of the state doubled. And people who came after the development of the canal settled permanently in the region. Also, at the time of partition in 1947, the Muslim population of the state migrated to the neighbouring areas of Pakistan and Hindus and Sikhs from those areas also moved to various parts of India including Sri Ganganagar district. So the introduction of canal irrigation not only brought changes in the production relations but also in the demography of the region with the settlement of people from Punjab in the region.

The entire land in the Gang canal region was not sold, particularly land in the tail end area. The households from neighbouring states preferred to purchase the land with better

irrigation access. The households belonging to the Bawari (Dalit) caste, that were residents of Bahawalpur region (now in Pakistan), had a small share in land ownership in Bahawalpur. As the land in the tail end villages was comparatively cheaper than land in the head and middle reaches, few households belonging to the Bawari caste purchased some land towards the tail end of the gang canal. After the partition, *Lambardars* (landlords) and *Zaildars* (officers-in-charge) and also households belonging to Bawari caste migrated from Tarowari and other villages of Bahawalpur to the tail end of the Gang canal. *Lambardars* and *Zaildars* of Tariwari and neighbouring villages were allotted compensation land of 31.2 acres per household, in the tail end villages. But as the Bawari households were not able to produce their land documents, they were not allotted any compensation agricultural land. After settling down in tail end villages, these households from the Bawari caste reported their attendance daily to the *Lambardars* and *Zaildars* of their ancestral villages. After the 1951 census, these Bawari households registered themselves in the voter list and then in 1953-54, each member of these displaced households was given agricultural land of 3.125 acres at Rs. 2240 per acre, subject to maximum of 15.625 acres per household. Each household had to pay the purchase price in 15-20 instalments to the state. The majority of them paid the amount in 30-35 instalments.[16]

4.3 *Development of Irrigation in the Region*

4.3.1 *Evolution of canal irrigation in the region and reformation of the chaks*

Prior to the opening of the Gang canal only a small proportion of land in Bikaner state was irrigated with water from the Ghaggar river, which is a seasonal river and provided irrigation only in the rainy season (Sehgal 1960). During the period 1898-99 to 1906-07, about 0.2 per cent of the total area for which returns are available was irrigated by canal in the Bikaner state and also the use of wells was negligible (Erskine 1992). In 1899-1900, the Bikaner state suffered a great famine (*ibid.*). After being advised by the chief engineer of Bikaner state and also by the First Irrigation Commission, in 1903, the then Maharaja agreed to the canal building project (Misra 1980). In 1920, an agreement was

[16] This information is collected from land record officer (patwari) and from households as well.

signed by the governments of Bikaner, Punjab, and Bhawalpur (now in Pakistan) to build the canal in Bikaner state as part of the Sutlej valley project (Misra 1980). The canal building project was finished by 1927 and water distribution started on October 26, 1927. Before building the Gang canal a survey was conducted between 1921 and 1924 (*ibid.*) and a map drawn for the canal project with the objective of irrigating the maximum area of the region (*ibid.*). The land in the area was divided into squares of 825 bighas (where 1 bigha was equal to 0.625 acre) with a length of 825 feet on each side of a square (Misra 1980). The area was then divided into 913 *chaks*, of which the land in 495 *chaks* was given to the people who were tenants of the state, at lower rates (later, waived in some cases as well) (Misra 1980).[17] In order to bear the expenditure incurred on the canal building project, the area in the remaining *chaks*, was sold (starting in 1923) before the completion of the canal project (Rathore 2007). Of these *chaks* some were sold by auction, but for most of these *chaks* fixed rates were charged with a payment of one-fourth of the value at the time of purchase (Rathore 2007). "Each *chak* was sold to persons bound together by ties of relationship or neighbourhood and there were no mixed *chaks* either amongst the old or new settlers, with a view to avoid possible future frictions and feuds and generate homogeneity" (*ibid.*) The initial plan for the gang canal was to irrigate 910,000 acres but due to shortage of water supply only a 620,000 acre-area benefited from irrigation (Rathore 2007). The area of the *chaks* was on an average 50 squares (Misra 1980 and Rathore 2007).

The principal objectives of building the canal, as mentioned in the reports and Gazattes, was to increase the area under cultivation, production and employment. But another important objective was to increase the revenue accruing to the state. This is clear from the fact that the Gang canal was built in the areas where there were a larger number of *Khalsa* villages, i.e., the villages from which the state collected taxes directly. The water allocation to the Gang canal was 1.11 MAF (million acre foot).Till 1947 the canal received water from the Hussainiwala headworks at Ferozpur of the Sultej river, and afterwards it started receiving water from the Harke headworks of the Ferozpur feeder. In 1965, the Gang canal was given an additional allocation of 0.33 MAF which was

[17] See Singh (1980) for details.

Rajasthan's share of the Ravi and Beas waters.[18] The length of the Gang canal is 1342.48 kilometres and through its 21 distributaries 1213 *chaks* are irrigated.[19]

4.3.2 *Modernisation of the Gang canal*

The modernisation project of the Gang canal started during 1982-83 to address the underutilisation of the potential that had been created, partly because of the high water seepage as the canal was lined with lime and concrete.[20] With the purpose of improving water utilisation, in 2000, a modernisation budget of Rs. 445.76 crore was approved under the Accelerated Irrigation Benefits Programme *(*AIBP). That budget was revised to Rs. 621.42 crore in 2008.[21] Till March, 2016 Rs. 662.42 crore had been spent on the construction of distributaries, minors and outlets of concrete and cement.[22]

During the period from 1927 to 1935 the culturable command area (CCA) was 5,44,519 acres which increased to 7,76,000 acres during the period from 1935 to 1986.[23] After modernisation the total command area stands at 7,76,600 acre, the area initially planned to be irrigated by the Gang canal.[24] The other factor accounting for the increase in area is the construction of two new distributaries, Bhompura minor and Lakha Hakam minor.[25] But Since 1994, there has not been much change in the command area of the canal.[26]

Apart from receiving water from the Gang canal, the district also receives water from the Bhakhra and Indira Gandhi Nahar projects, which were started in 1952 and 1960 respectively by the Government of India to bring water for cultivation to adjacent areas. At present, 83.6 per cent of the agricultural land in Sri Ganganagar is irrigated.[27] The area

[18] Information collected from the irrigation department, Sri Ganganagar
[19] *Ibid.*
[20] *Ibid.*
[21] *Ibid.*
[22] *Ibid.*
[23] *Ibid.*
[24] *Ibid.*
[25] *Ibid.*
[26] *Ibid.*
[27] *Ibid.*

of Sri Ganganagar district irrigated by different irrigation projects is provided in Table 4.2.

Table 4.2: *Area covered by different projects in Sri Ganganagar district, in 2008* in hectors

Irrigation project	Command area	Un-command area
1. Gang canal	3,14,228	1,25,000
2. Bhakhra canal	87,825	8,681
3. Indira Gandhi Nahar (stage I) (Suratgarh and Anupgarh branch)	2,64,135	2,73,116
Total	6,66,188	4,06,797

Source: Information collected from district canal irrigation department, Sri Ganganagar.

The Bhakhra canal receives water from the Bhakra dam on river Sutlej and the Indira Gandhi Nahar (first and second stage) receives water from the Ravi, Beas and Sutlej rivers via the Harike Barrage. The Indira Gandhi Nahar project is the largest canal project in the state of Rajasthan and irrigates areas under the Hanumangarh, Sri Ganganagar, Bikaner and Jaisalmer districts of the state. The water in both the Bhakra canal and Indira Gandhi Nahar is distributed through the *warabandi* system.

4.3.3 *Water distribution through Gang canal*

A canal system is a method of taking the water from the source (river) to the field. And the flow of the water depends upon the gravitational pull of the water. So to take water to the fields from the main canal it is further divided into distributaries and distributaries are further divided into minors and so on. The length and size of these distributaries and minors depend upon the level of the land, but a lengthy watercourse is avoided in order to reduce water loss. In other words, the length of the distributaries varies according to the landscape of a particular area. To take water from these distributaries or minors to the fields, outlets (known as *moga*) are provided, from which the water is taken to the fields via field channels. These field channels have *nakkas* for different fields. The location of these *nakkas* on field channels also affects the water supply. In Gang canal, an outlet has

a water discharge in the range of 1 cusec to 3 cusecs (flow rate of water of 1 cubic foot per second). There is generally one village settled on each outlet, but for some outlets the number of villages can be two or more. The names of these villages in the *chaks* are also based on the names of the distributary or minor by which water for irrigation is provided. Water for different plots is divided according to the *warabandi* method, under which the plots get canal water in time-bound turns. "In *warabandi* operation canals are run only at full supply levels, or they are closed" (Leaf 1992). The *warbandi* is either kutcha, in which the turn of the particular land is not fixed and is decided as per the different crop seasons or annually by the individuals; or pucca, in which the water turns of each plot of land are allotted and officially recorded (*ibid.*). The Gang canal operates with the pucca *warabandi* system. Therefore, for water distribution, the 168 hours of a week are divided into the total command area of a *chak*. And for water supply of 7 days via distributary or minor, the water for 7 days and half of reach time is provided. In *warabandi*, the water turn is fixed for a year and every year it is rotated, i.e., the plots which are irrigated during the day during one year receive water in the night in the following year and *vice versa*. The plots which are cultivated with sugarcane are given extra water time, which was earlier the case for orchard lands as well. However, there is no provision for compensation for a cultivator who does not get water for irrigation because of non-availability of water in the distributory/minor at the allocated time.

The flow of the canal affects the water supply and so does the size of the outlet affect the flow of water and its supply to the fields. As per the canal building plan, the sizes of the distributaries and outlets were designed such that the peasants at the head and tail reaches would receive equal water. For example, the height of an outlet was kept higher than the distributory/minor level in the head and middle reaches and towards the tail end the level was as per the level of distributory/minor or lower in some cases. But in recent times the water distribution has become highly unequal between head reaches and tail ends and the reason for this is the change in the level and size of various outlets in the head and middle reaches. Changes in the size of outlets could occur because of the effects of the modernisation process involving construction of *Pucca* canals, or due to changes in the command area, resulting from its shift from one outlet to another, or due to changes in the

full supply level (FSL). But another important reason for change in the size of the outlet is the use of political influence to get higher supplies of water. The impact of the changes in the size of outlets can be assessed by analysing the cropping pattern and by analysing the proportion of area irrigated and cultivated in a year.

4.3.4 *Other sources of irrigation in the region*

Apart from canals, in the areas where the water supply from canals is irregular, tubewells are also used to supplement the availability of water. According to Jairath's (1986) study on Punjab, in the case of districts with large land holdings, "irrigation from private sources (i.e., tubewell) is more efficient relative to that from the public source (i.e., canal)" and in case of districts with small sized land holdings, the size of the holding "constrains the utilisation of the given private source of irrigation". The reason for increased efficiency is the control over timing and quantity of water supply for irrigation, which helps in ensuring higher levels of productivity.

There are 8300 tubewells in 2014-15 in the region which are supplementing canal irrigation, particularly in the rabi season.[28] According to the ground water department of Sri Ganganagar district, the ground water in the area is available at the depth of 4 to 16 meters. It is almost brackish, except in the close vicinity of canals. The level of the water table has gone up from 30 meters to 16 meters because of water seepage that takes place not only from the canal but from fields as well. In fact major seepage is from the fields and this contributes to a rise in the ground water level. The use of well and tank irrigation is, however, negligible. The length, location and infrastructure of the canal, affects the quality of irrigation in terms of quantity of water supplied. This quality of irrigation water varies a lot, across the irrigated areas of Gang canal.

[28] Information collected from the Ground water department, Sri Ganganagar.

4.4 *Introduction of Study Villages*

For the purposes of this study, a village level detailed survey of two villages of the Gang canal region was conducted. Two villages from F distributory, were selected. One of the villages, 25 F (Gulabewala),[29] falls in the middle reaches and the second village, 63 F, is at the end of a distributory. 25 F (Gulabewala) receives water from N minor and 63 F gets water from F desh minor of F distributory. Earlier, 25 F used to receive water from a minor which used to take off from Mirzewala head of the F distributary and from the main distributary of Gang canal, which provided irrigation to the low areas near the head. The important reason for this was to limit the number of outlets in the beginning of the main distributary so that tail end outlet peasants also receive their share of water. Later, with continuous demands from 24 F and 25 F *chaks*, the outlets for these villages were shifted to the extended N minor. Currently, there are four villages which receive irrigation from N minor and these are 24 F (791 acre), 25 F (Gulabewala) (659 acre), 1 N (710 acre) and 2 N (777 acre). On the other hand, F desh minor provides irrigation to two villages, 62 F (679 acre) and 63 F (826 acre). The census survey in these villages was done in two rounds. In the first round, May-June 2015, information on household members, land ownership and operational holding, and irrigation details including information on exchanges of irrigation water turns with other households, was collected. In the second round, from September to November 2015, a detailed survey was conducted to obtain information on copping pattern in kharif and rabi seasons, water use, production, expenditure on inputs including labour, employment, assets including means of production, and loans taken, for the agricultural year July 1, 2014 to June 30, 2015.

4.4.1 *25 F (Gulabewala)*

25 F (Gulabewala) is a village in Sri Karanpur tehsil of Sri Ganganagar district. The nearest town to the village is Kesarisinghpur, which is at a distance of 12 kilometers. There is a primary health centre and a branch of State Bank of Bikaner and Jaipur in the

[29] The village was earlier surveyed by the Foundation of Agrarian Studies (FAS) in 2007 as part of Project on Agrarian Relations in India (PARI). For details, see http://fas.org.in/rajasthan-round-may-june-2007-may-2010/.

village. The village has an all-weather road connecting it to the tehsil and district towns. The village had 293 households at the time of survey in 2015.[30]

Table 4.3: *Number of households and population in 25 F (Gulabewala)*

	Number of households	Population			Share of Dalit population in total population (per cent)
		Persons (number)	Male (number)	Female (number)	
Census 2011	318	1465	750	715	60.3
Survey data 2015	293	1464	740	724	65.5

Table 4.4: *Number and proportion of households by caste and caste group, 25 F (Gulabewala), 2015*

Caste and caste groups	Number of households	Proportion of household (in per cent)
Schedule caste households	192	65.5
Majhabi	104	35.5
Nayak	76	25.9
Meghwal	11	3.8
Bawaria	1	0.3
Other backward caste households	98	33.4
Jat Sikh	85	29.0
Kumhar	5	1.7
Nai	3	1.0
Mehra	2	0.7
Labana Sikh	1	0.3
Tarkhan	1	0.3
Saini	1	0.3
Other caste households	3	1.0
Brahmin	2	0.7
Aggarwal	1	0.3
All households	293	100.0

Source: Survey data 2015.

[30] A household is demarcated by using the Census of India 1971 definition, which identifies a householdas "a group of persons who commonly live together and would take their meals from a common kitchen unless the exigencies of work prevented any of them from doing so" (for details: http://censusindia.gov.in/Data_Products/Library/Indian_perceptive_link/Census_Terms_link/censusterms.html). Therefore, a person who did not live with the household during the survey period, i.e., between July 1, 2014 to June 30, 2015, was not considered a part of the household. The LHS of NSSO also uses the census definition of a household.

In the village, among Dalits, the largest proportion of households were Majhabis (104 households) and Nayaks (76 households). Other dailts castes in the village were Meghwal (11 households) and Bawaria (1 households). Among other backward castes (OBCs), Jat Sikhs (85 households) dominated, with the other OBC castes being Kumhar (5 households), Nai (3 households) and Mehra (1 household), followed by Labana Sikh, Tarkhan, and Saini, with one household each. Other castes in the village were Brahmins (2 households) and Aggrawals (1 household). The settlement of the village is very segregated according to caste, with the households belonging to the Scheduled caste Majhabi living on one side of the village in a small cluster and the Nayaks (SC) living in another small cluster on other side of the village.

Jat Sikhs dominate the village both socially and economically. The members of Dalit households work as manual workers in non-agricultural and agricultural activities. Some of the workers from these Dalit households are attached workers in Jat Sikh households.

The village has one Anganwadi, one government primary school, and one government senior secondary school. The literacy rates for Dalit households, for both males and females, are lower than the average for the village and only 45.5 per cent of the females above the age of 6 years are literate.

Table 4.5: *Literacy rate among the population of age 7 years and above, in 25 F (Gulabewala), 2015*

Caste group	Person (number)			Literacy rate (per cent)		
	Male	Female	All	Male	Female	All
SC	192	171	363	51.3	45.5	48.4
OBC	224	183	407	88.5	72.6	80.6
Others	9	4	13	100	66.7	86.7
All	425	358	783	66.8	56.5	61.7

Source: Survey data 2015.

Except for a small portion of land owned by four Majhabi (SC) households, Jat Sikhs held a majority of the land. Out of the total agricultural land, 98.1 per cent is owned by Jat Sikh households. Except for one household among the Jat Sikh households, which did

not own any land, all other households owned land in the village or in neighbouring villages.

4.4.2 *63 F*

63 F is a village at the tail end of the F distributory and receives water via F desh distributory. The village is also in the Sri Karanpur tehsil of Sri Ganganagar district. The village is connected to the nearest town, Gajsinghpur, with an all-weather road. The caste composition of this village is very different from the one in the middle reaches (25 F Gulabewala). The village had 106 households at the time of survey in 2015. Of them,86 households were Dalit households and belonged to Bawaria (76 households) and Meghwal (10 households) castes. Among other households, 10 households were of Jat Sikhs and 10 households belonged to the Tarkhan (OBC) caste. The village is settled in two segments, which are known as 63 F (A) and 63 F (B), with households in 63 F (A) belonging to all castes, while 63 F (B), had a majority of Bawaria (Scheduled caste) and Tarkhan (OBC) households.

Table 4.6: *Number of households and population in 63 F*

	Number of households	Population			Share of Dalit population in total population (per cent)
		Persons (number)	Male (number)	Female (number)	
Census 2011	99	514	262	252	77.2
Survey data 2015	106	501	264	237	81.1

The share of Dalit households in all households was 81 per cent at the time of survey in 2015, as compared with 77.2 per cent recorded at the time of the survey done by Census of India in 2011.

The share of the Dalit population in the total was 81.1 per cent in village (63 F), with a dominant share of Bawaria households. This is one of the common features of the tail end villages of the F distributory in particular, i.e., the villages at the tail end of the canal have a higher proportion of Dalit households as compared to the head or middle reaches

villages. And secondly, the total number of households also starts decreasing towards the tail end.

Table 4.7: *Number and proportion of households by caste and caste group, 63 F, 2015*

Caste/caste group	Number of households	Proportion of household (per cent)
Schedule caste households	86	81.1
Bawaria	76	71.7
Meghwal	10	9.4
Other backward caste households	20	18.9
Jat Sikh	10	9.4
Tarkhan	10	9.4
All households	106	100

Source: Survey data 2015.

Table 4.8: *Literacy rate among the population of age 7 years and above, in 63 F, 2015*

Caste group	Person (number)			Literacy rate (per cent)		
	Male	Female	All	Male	Female	All
Scheduled caste	137	82	219	75.3	47.4	61.7
Other backward caste	52	28	80	89.7	66.7	80.0
All households	189	110	299	78.8	51.2	65.7

Source: Survey data 2015.

The village has one primary and one middle government school. For secondary and senior secondary schooling, students go to neighbouring villages or Gajsinghpur town. The literacy rate among males and females (in particular) from scheduled caste households is lower than the average literacy of the village. However, the literacy rate among the men from scheduled castes is higher than in 25 F. There are only 51.1 per cent men from scheduled caste households in 25 F who could read and write, while that proportion was 75.3 in 63 F. Women lag behind in education in both the villages.

Most of the Dalit households excepting for 9, had agricultural land at the time of survey. The members from Dalit households were also engaged as manual workers in agricultural and non-agricultural activities. The occupation among Jats who settled in the village between 1955 to 1975 (excepting for one household in 1998) is cultivation. Also, a part

of the irrigated land falls close to the zero line (border line of India-Pakistan), which has been left fallow for years.

Though a small proportion of Jat and Tarkhan households (20.6 percent of all households) own 36 per cent of agricultural land, unlike the other village surveyed, Dalit households have ownership holdings of agricultural land. All the households in the village owned homestead land and houses as well.

4.5 Land Distribution in Gang Canal Region

As discussed above, both the surveyed villages were settled after the development of the infrastructure to reach canal water to the region. The structure of agricultural land distribution in terms of both ownership and operational holdings is very different in the surveyed villages.[31] 25 F (Gulabewala) (25 F hereafter) has high inequality in land ownership, with 69.3 per cent (203) of households not owning any agricultural land in 2015 and 15 per cent of households (large peasants) owning 80 per cent (2283.8 acres) of agricultural land (refer Table 4.9).

The concentration was in the higher size class of ownership holding in 25 F. The variation between the smallest and largest ownership holding was stark as the smallest holding in 25 F was 0.781 of an acre and the largest holding was 121.9 acres in 2015 and the size difference between the average holding of a small peasant and large (with 50 and above acres land) peasant was 74 acres.

The distribution of agricultural operational holdings reflected even higher levels of inequalities than the ownership holdings as 75 per cent (219) of households did not cultivate any land in 2014-15 in 25 F. The large peasants cultivated 88.8 per cent of area

[31] For the classification of farm size groups the definition of agricultural census has been used in the analysis, and the households are classified as marginal (less than 2.5 acres), small (2.5-5 acres), semi-medium (5-10 acres), medium (10-25 acres) and large (greater than 25 acres) peasant households based on their operational holdings. However, since there is large variation the households in belonging to the large category, these households are subdivided further into two categories: large 1 (25-50 acres) and large 2 (greater than 50 acres).

under operational holdings during 2014-15. Marginal, small and semi-medium peasants cultivated only 1.8 per cent of operational holding. In other words, land ownership was concentrated in the large land holding classes and land was primarily cultivated by these households. The marginal, small and semi-medium peasants not only own a negligible share of the land but also their share in land cultivated is small.

Table 4.9: *Distribution of households and land extent of ownership holding, by size class of ownership holding, in 2015, 25 F* in acre and per cent

Size class (in acres)	Number of households	Proportion of households (per cent)	Extent (acres)	Proportion of extent (per cent)	Average ownership holding (acre)
Landless	203	69.3	0	0	0
Less than 2.5	4	1.4	6.9	0.2	1.7
2.5 to 5	2	0.7	6.6	0.2	3.3
5 to 10	15	5.1	123.3	4.3	8.2
10 to 25	25	8.5	434.2	15.2	17.4
25 to 50	27	9.2	1002.2	35.1	37.1
50 and above	17	5.8	1281.6	44.9	75.4
All	293	100	2854.8	100	9.7

Source: Survey data 2015.

Table 4.10: *Distribution of households and land extent of operational holding, by size class of operational holding, in 2015, 25 F*

Size class (in acres)	Number of households	Proportion of households (per cent)	Extent (acres)	Proportion of extent (per cent)	Average operational holding (acres)
Landless	219	74.7	0	0	0
Less than 2.5	5	1.7	5.6	0.2	1.1
2.5 to 5	1	0.3	3.8	0.1	3.8
5 to 10	6	2	44.4	1.5	7.4
10 to 25	17	5.8	269.5	8.9	15.9
25 to 50	22	7.5	877.3	28.8	39.9
50 and above	23	7.8	1842.4	60.5	80.1
All	293	100	3042.9	100	10.4

Source: Survey data 2015.

The large peasants in 25 F belonged to Jat Sikh Households. The Jat Sikhs owned and operated 98 per cent of the agricultural land. Among Dalit households, only four Majhabi Sikh households owned a small area of land (below 2.5 acre for each household).

Table 4.11: *Distribution of households and land extent of ownership and operational holding, by caste group, 2015, 25 F*

Caste group	Number of households	Ownership holdings		Operational holding	
		Area (acres)	As proportion to total ownership holdings (per cent)	Area (acres)	As proportion to total operational holdings (per cent)
SC	*192*	*6.9*	*0.2*	*4.8*	*0.2*
Bawaria	1	0	0	0	0
Majhabi	104	6.9	0.2	4.8	0.2
Meghwal	11	0	0	0	0
Nayak	76	0	0	0	0
OBC	*98*	*2802.8*	*98.2*	*2993.1*	*98.4*
Jat Sikh	85	2799.4	98.1	2989.4	98.2
Kumhar	5	0	0	3.8	0.1
Labana Sikh	1	0	0	0	0
Mehra	2	0	0	0	0
Mistri/Tarkhan	1	3.4	0.1	0	0
Nai	3	0	0	0	0
Saini	1	0	0	0	0
Others	*3*	*45*	*1.6*	*45*	*1.5*
Aggarwal	1	0	0	0	0
Brahmin	2	45	1.6	45	1.5
All	293	2854.8	100	3042.9	100

Source: Survey data 2015

Given the structure of land distribution, the large peasants were not only the biggest land owners and owned the highest proportion of land, but they were also the households which had the highest proportion of land operated with hired manual workers. Though the family members of the households operating land in the size class of 25 to 50 acres

did work on the land, the members of households from the size class of 50 acres and above did not undertake manual work on agricultural land.

The structure of land holdings in 63 F was starkly different when compared with 25 F, as barring 9 households (8.5 per cent), all other households had ownership of agricultural land. In other words, the level of landlessness was lower in 63 F as compared to 25 F. The largest proportion of land (45.9 per cent) was owned by land size category of 10 to 25 acres. Only 4 households (3.7 per cent) in 63 F owned more than 25 acres of land. The proportion of households with agricultural land below 2.5 acres was 30 per cent of all households.

Table 4.12: *Distribution of households and land extent of ownership holding, by size class of ownership holding, in 2015, 63 F*

Size class (in acres)	Number of households	Proportion of households (per cent)	Extent (acres)	Proportion of extent (per cent)	Average ownership holding (acres)
Landless	9	8.5	0	0	0
Less than 2.5	32	30.2	47.8	6.6	1.5
2.5 to 5	29	27.4	113.6	15.6	3.9
5 to 10	10	9.4	74.5	10.2	7.5
10 to 25	22	20.8	334.0	45.9	15.2
25 to 50	3	2.8	96.0	13.2	32.0
50 and above	1	0.9	62.5	8.6	62.5
All	106	100	728.5	100	6.9

Source: Survey data 2015.

Cases of reverse tenancy existed in 63 F, where marginal and small peasants leased out land to semi-medium and large peasant households. In 63 F, 17.9 per cent of households didn't operate any agricultural land in 2015. Medium and large peasant households had the largest share of acreage in terms of operational holdings, accounting for 39.1 and 36.6 per cent of the total respectively.

Table 4.13: *Distribution of households and land extent of operational holding, by size class of operational holding, in 2015, 63 F*

Size class (in acres)	Number of households	Proportion of households (per cent)	Extent (acres)	Proportion of extent (per cent)	Average operational holding (acres)
Landless	19	17.9	0	0	0
Less than 2.5	20	18.9	28.9	3	1.4
2.5 to 5	13	12.3	53.6	5.7	4.1
5 to 10	20	18.9	148.1	15.6	7.4
10 to 25	24	22.6	370.7	39.1	15.4
25 to 50	9	8.5	284.1	30	31.6
50 and above	1	0.9	62.5	6.6	62.5
All	106	100	947.9	100	8.9

Source: Survey data 2015.

Table 4.14: *Distribution of households and extent of land ownership and operational holding, by caste group, 2015, 63 F*

Caste group	Number of households	Ownership holdings		Operational holding	
		Area (in acres)	As proportion to total ownership holdings (per cent)	Area (in acres)	As proportion to total operational holdings (per cent)
SC	*86*	*466.3*	*64.0*	*599.3*	*63.2*
Bawaria	76	420.4	57.7	541.2	57.1
Meghwal	10	45.9	6.3	58.1	6.1
OBC	*20*	*262.2*	*36.0*	*348.6*	*36.8*
Jat Sikh	10	188.0	25.8	220.0	23.2
Tarkhan/Mistri	10	74.2	10.2	128.6	13.6
All	106	728.5	100.0	947.9	100.0

Source: Survey data 2015

The land distribution across the caste groups shows that households belonging to scheduled castes owned (64 per cent) and operated (63.2 per cent) the highest proportion of land in 63 F. The Bawaria (SC) households not only have the largest share in population but also have the largest share in land ownership and operational holding. Five

Bawaria households had operational holdings of size above 25 acres. And Jat Sikhs, who constitute the largest land owning caste in 25 F, own 25.8 per cent of agricultural land in 63 F. Tarkhan households, operated around 13.6 per cent of agricultural land.

It is clear that in the village in the middle reaches, land distribution is highly unequal with 74.7 per cent household (mostly Dalits) landless and much of the land was owned and operated by Jat Sikhs in the village. The land distribution in 63 F was also unequal but the inequality was higher in terms of the size class of holding as opposed to the caste wise distribution.[32] While in 25 F the operational holdings were concentrated with large peasant households, in 63 F a large proportion of land in terms of operational holding were with marginal, small and semi-medium peasant households.

[32] The Rai Sikh and Bawaria households (Dalit households, which have also migrated from Punjab and neighbouring states) bought land in the tail end villages after the canal building as the price of the land was lower in these areas as compared to the land price in the head and middle reaches villages.

Chapter 5

Linkages between Irrigation and Cropping Pattern

5.1 *Introduction*

The previous chapter discussed the land distribution and cropping pattern in the Gang canal region of Bikaner state before the development of canal irrigation. It also examined the immediate impact of canal irrigation on cropping pattern and land ownership. Land, which is a fundamental means of production, is not only a determinant of economic outcomes in rural India but the ownership of land also determines the social position of the household in the village. Similarly, the access to irrigation, both surface and ground water has never been equitable. With the increase in private investment in water resources, the control of individual households has increased over these resources, particularly over ground water resources (Janakarajan and Moench 2006). The overall impact of water resources depends on the access to these resources across households.

Existing studies in India that have examined the impact of irrigation have mostly analysed the consequent changes in cropping pattern and production levels. Dhawan (1995) has shown that there is positive association between groundwater development and yield. But inequality in the access to ground water along with excessive draft on the water tables remains a problem.[33] Singh and Singh (1962) studied 15 irrigated and 7 dry villages and pointed out that stable production conditions due to improved irrigation have led to changes in the cropping pattern. Dhawan (1988) and Bhalla and Singh (2009) pointed out that irrigation also plays an important role in the increase of agricultural output along with other inputs. In sum, access to irrigation resources reduces the instability in land productivity and production levels (Ray 1971 and Dhwan 1988).

[33] Moench (2001 and 2002) as cited in Janakarajan and Moench (2006).

There have been various studies which find that the area under cultivation has increased due to increase in area under irrigation. However, some recent studies find that the income levels have declined in some parts of India and in Rajasthan as well (see Dhawan 1994a, Sarkar 2009, Swaminathan and Rawal 2011). Further, Sarkar 2009 and Gandhi 1997 argued that the expenditure on farm inputs and on mechanisation is growing steadily which results in a decline of net crop incomes.

Nonetheless, the relationship between irrigation and cropping pattern is not a simple one as other factors such quality of land, availability of fertilisers and pesticides along with the market prices of commodities play an important role in determining the cropping pattern of a region.

The evidence shows that the access to irrigation is more unequal among different sections of peasantry within a village than is water access across the villages in the middle reaches and tail end. Per acre water access at the tail end village is around 2/3 of the middle reaches village. The inadequacy of irrigation water, on one hand, and the rise in prices of guar and higher cost of cultivation of cotton crop on other, has changed the cropping pattern of the region. Area earlier left uncultivated during the kharif season has been devoted to cultivation of a guar crop. Also from 2006-07 to 2014-15, the area under cotton crop has witnessed a decline. The increase in the cropping intensity has led to the increase of crop incomes of peasant households in 25 F between 2006-07 to 2014-15. Even with the higher per acre income from cotton than from guar in the survey year, a larger proportion of area is under guar cultivation as it is a less water intensive crop and also increases cropping intensity. So, with the additional use of irrigation the net incomes in both villages rose enormously.

For the classification of farm size groups the definition of agricultural census has been used in the analysis, and the households are classified as marginal (less than 2.5 acres), small (2.5-5 acres), semi-medium (5-10 acres), medium (10-25 acres) and large (greater than 25 acres) peasant households based on their operational holdings. However, since there is large variation the households in belonging to the large category, these

households are subdivided further into two categories: large 1 (25-50 acres) and large 2 (greater than 50 acres).

Section one of the chapter examines the issue of equity in the distribution of irrigation resources by analysing access to irrigation across size classes Section two discusses the differences in the cropping pattern in the region. It also examines the changes in the cropping pattern and cropping intensity in a surveyed village and the impact of irrigation, guar prices, and cost of cultivation on the cropping pattern.This section also discusses productivity differences across the middle reach and tail end villages, by analysing crop yields. The third section explores the economic impact of irrigation across the villages and operational holdings by examining the net incomes across irrigation intensity groups. The last section summarises the findings of the chapter.

5.2 *Access to Irrigation*

A canal irrigation system appropriates valuable water resources and allocates them in specified quantities during allotted time spans. Every irrigation system has its own usefulness and limitations. Both surface (canal) and ground water (tubewell) irrigation systems have constraints imposed by limiting factors. Canal irrigation lacks in flexibility and reliability. Also the inadequate supply in terms of timing and quantity of canal water leads to the exploitation of ground water (Dhawan 1993).Individual households who own tubewells have greater control over their irrigation resources. But problems like recharging of ground water, higher installation and operational cost (such as electricity or diesel costs and maintenance costs) reduce the flexibility and accessibility of ground water resources. Shah (1991) argues that conjunctive use of ground water and canal water is not only sustainable but also cost efficient, as it provides more equity to the peasants by providing alternative resources for irrigation, particularly to the peasant who cannot afford to install the tubewell/borewell. Further, Shah (1991) recommended the installation of public tubewells so that peasant households have equitable access to water resources.

In order to understand the access to irrigation in surveyed villages, firstly the area irrigated by different sources is identified across size class of holding and the ratio of gross irrigated area to operational holding is analysed. Gross irrigated area, takes into account the number of times an area received irrigation, over a year. The entire agricultural operational holdings area including the land cultivated outside the village, fall in the command area of the Gang canal. Since the water distributed via the canal is inadequate, ground water irrigation is used to augment canal irrigation particularly during the rabi season. The use of ground water is negligible in the kharif season as the main crop during the kharif season in the region, guar, is less water intensive. But due to the salinity in ground water, the use of groundwater is very limited.

In 2015, 98.7 per cent of agricultural land was irrigated with canal water, whereas 57.1 per cent also received irrigation from tubewells/borewells. The households in 25 F, combined tubewell and canal water in order to avoid the impact of salinity on agricultural land. Tubewell water is extracted using electric pumps in 25 F and due to the uncertainty in irrigation availability, the water is stored in tanks.

Table 5.1: *Area irrigated by different sources of irrigation as proportion to the total operational holding, 25 F, 2015*

Source of irrigation	Area irrigated by different sources	
	In acres	Proportion to total operational holding (per cent)
Canal	3002.9	98.7
Tubewell*	1739.0	57.1
Unirrigated	14.4	0.5
Total	3042.9	100

Note: *The area irrigated with tubewell is mainly the land which receives canal irrigation as well.
Source: Survey data 2015.

The peasants from medium and large size classes, who use tubewells on their operational holdings have built water storage tanks on their land to store the water. However, the area which is irrigated with a combination of both canal and tubewell water in 25 F is not irrigated more than once with tubewell water. The combination of these is primarily used for irrigating land prior to sowing, i.e., for the first irrigation of rabi crops, as canal water

falls short of that needed to irrigate the land within the stipulated time before sowing. In other words, tubewell water is mixed with canal water in the rabi season in order to avoid delays in the rabi season sowing. Table 5.1 also shows that out of the total 3043 acres of operational holdings in 25 F, 99 per cent is irrigated with canal water (3003 acres).

The utilisation of a combination of both canal and tubewell irrigation is higher among the medium and large peasants in 25 F. The proportion of operational holdings on which tubewell water is used along with canal water ranged between41 and66 per cent across holding of different size classes in2014-15, except for marginal and small cultivator households that are solely dependent on canal irrigation. Only 19 per cent of area owned by semi medium peasants is irrigated by tubewells. Since the tubewell water is used along with canal water, it is very difficult to identify the exact area irrigated by tubewells. Other than households from the semi-medium category, all other households which have used tubewell water in 25 F had ownership of tubewells.

Table 5.2: *Area irrigated by different sources of irrigation as proportion to the total operational holding, by size class of operational holding, 25 F, 2015*

Size class (in acres)	Number of households	Area irrigated by different sources as proportion to the total operational holding (per cent)	
		Canal	Tubewell*
Less than 2.5	5	100	0
2.5 to 5	1	0	0
5 to 10	6	100	19.0
10 to 25	17	97.2	54.3
25 to 50	22	96.7	41.4
50 and above	23	100.0	66.3
All	74	98.7	57.1

Note: *The area irrigated with tubewell is mainly the land which receives canal irrigation as well.
Source: Survey data 2015.

In 63 F diesel pumps or tractors are used for extracting irrigation water, instead of electric pumps, because of the higher running cost (fixed electricity bill even during the lean season) associated with the latter during the lean season. Since the largest proportion of households (50 per cent) are marginal, small and semi-medium sized farm households, it

is economically not viable for these households to pay the running cost of electric pumps particularly during the lean season. Secondly, a significant proportion of land falls in the zero line, which has not been cultivated over the last 15 years.[34] But as the land falls in the command area of F desh distributory, the water allocation of that land is used by the households to irrigate other operational holdings held by them or the water is sold to other households, though the former is the general pattern among households in 63 F.

Table 5.3: *Area irrigated by different sources of irrigation as proportion to the total operational holding, 63 F, 2015*

Source of irrigation	Area irrigated by different sources	
	In acres	As proportion to total operational holding (per cent)
Canal	778.458	82.12
Tubewell*	176.12	18.58
Unirrigated	170.376	17.97
Total	947.898	100

Note: *The area irrigated with tubewell is mainly the land which receives canal irrigation as well.
Source: Survey data 2015.

In 63 F, 82.12 per cent of land is irrigated using canal water, while 18 per cent also receives tubewell irrigation. Only in 0.5 per cent of unirrigated land on which canal water is not accessible, is tubewell water used for irrigation. In order words, the use of tubewell water is predominant on the land with access to canal irrigation instead of unirrigated land. And the highest use of tubewell water in 2015 was among the semi-medium (26.1 per cent) and medium (24 per cent) cultivator households. Though there is no wide spread market for ground water in 63 F, the tubewell owners charge Rs. 100/hour as rent for tubewell use and, in addition to this, the user has to bear the cost of diesel used for extracting the ground water.

[34]The land which is not cultivated is not included in the ownership and operational holdings. As by the definition of agricultural census only current fallows are included in the ownership and operational holdings not the long term fallow land.

Table 5.4: *Area irrigated by different sources of irrigation as proportion to the total operational holding, by size class of operational holding, 63 F, 2015*

Size class (in acres)	Number of households	Area irrigated by different sources as proportion to the total operational holding (per cent)	
		Canal	Tubewell*
Less than 2.5	20	78.7	16.9
2.5 to 5	13	85.4	19.8
5 to 10	20	74.3	26.1
10 to 25	24	85.8	24.0
25 to 50	9	78.4	11.6
50 and above	1	94	0
All	87	82.1	18.6

Note: *The area irrigated with tubewell is mainly the land which receives canal irrigation as well.
Source: Survey data 2015.

In irrigation systems where tubewell water is used along with canal water, the pressure on the ground water reduces as ground water gets recharged with the seepage from canal. But with the increase in the division of land through inheritance, the ownership of the tubewells also changes. In 25 F, land is primarily owned by the large landholding classes, therefore the ownership of the tubewells is also with individual households. Only 23 per cent (18 tubewells) of the tubewells were shared. However, in 63 F, 17 out of 33 tubewells were owned jointly; these tubewells were shared with the division of inherited land.

Table 5.5: *Ownership of tubewells in surveyed villages, by size class of operational holding, 25 F and 63 F, 2015*

Size class of operational holding (in acres)	Ownership of tubewell in 25 F (numbers)			Ownership of tubewell in 63 F (numbers)		
	Personal	Joint	Average number of tubewell	Personal	Joint	Average number of tubewell
Less than 2.5	1	0	0.2	0	7	0.4
2.5 to 5	0	0	0	1	0	0.1
5 to 10	0	0	0	2	3	0.3
10 to 25	3	12	0.9	8	3	0.5
25 to 50	13	4	0.8	5	4	1
50 and above	44	2	2	0	0	0
All	61	18	1.1	16	17	0.4

Source: Survey data 2015.

The average number of tubewells owned by each size class of operational holding increases with the increase in land size in both the villages. Only the largest landowner (one house) in 63 F didn't own any tubewell. There are cases where tubewells were jointly owned and operated by the households who have common inheritance of land and are of the same caste. There is no case of inter-caste use and ownership of tubewells in the surveyed villages. In 25 F, the canal water is mixed with tubewell water, whereas in 63 F it is used alternatively. However, the uses of tubewell water is very limited in both the villages and the agriculture in the surveyed villages depends primarily on canal irrigation.

In order to understand the access to irrigation across households in surveyed villages, ratio of gross irrigated area to operational holding is analysed. The ratio of gross irrigated area to the operational holding, provides information on the number of times irrigation is received by each plot of land in an agricultural year. On an average, in 25 F each plot received irrigation 5.3 times. The households belonging to the large size class of holdings had higher access than the village average; on the other hand households from the marginal size class of holding received irrigation only 2.7 times for each acre. Similarly, in the case of 63 F, each acre received 3.9 times irrigation and the cultivators with marginal operational holdings lagged behind the village average. And medium, large 1 and large 2 households have higher access to canal irrigation then the village average.

Table 5.6: *Access to Irrigation, by size class of holding, 25 F*

Size class of operational holding (in acres)	Operational holding (acre)	Gross Irrigated area (acre)	Ratio of gross irrigated area to operational holding
	(a)	(b)	(b/a)
Less than 2.5	5.2	14.3	2.7
2.5 to 5	3.8	0.0	0.0
5 to 10	44.4	156.4	3.5
10 to 25	269.5	1261.0	4.7
25 to 50	877.3	4550.1	5.2
50 and above	1842.4	10117.4	5.5
All	3042.6	16099.1	5.3

Source: Survey data 2015.

Table 5.7: *Access to Irrigation, by size class of holding, 63 F*

Size class of operational holding (in acres)	Operational holding (acre) (a)	Gross Irrigated area (acre) (b)	Ratio of gross irrigated area to operational holding (b/a)
Less than 2.5	27.7	75.9	2.7
2.5 to 5	53.6	175.1	3.3
5 to 10	148.1	479.4	3.2
10 to 25	370.7	1518.4	4.1
25 to 50	284.1	1215.9	4.3
50 and above	62.5	279.4	4.5
All	946.6	3744.0	3.9

Source: Survey data 2015.

The access to irrigation increases with the increase in the operational holdings in both villages. The reasons for higher irrigation intensity, is the location of land relative to the outlet and the fragmentation of agricultural land. There exists larger inequalities in water access across the households within a village as compared to inter-village inequalities. Other than the reasons mentioned earlier, the large difference in the access to irrigation within a village occurs because of control over the socio-economic spheres of the village by the households from large size classes. Secondly in case of households from small, marginal and semi medium size holdings, the small share in the operational holdings, on one hand, and fragmentation of land on the other results in a significant loss of time in *bharai* (filling time). *Bharai* or filling time, is the time required for filling water in watercourse before it reaches the agricultural plot.[35] In *warabandi* system, water turns are fixed taking into account of *bharai* (filing) and *nikai* (emptying) timings of the watercourse.[36] Other then allotting water for each plot, additional timing is allotted for filling (*bharai*) the watercourse to field at the time of allocating water from an outlet. In

[35] The expenditure on the maintenance of canal outlays upto the water outlet are borne by the irrigation department of the government and the maintenance from outlets to field is a joint responsibility of the land owners owning land in each outlet.

[36] In *warabandi* system the water turns are fixed by the total number of minutes of water supply in a week by dividing it to the total number of acres to be irrigated by the outlet. That is, irrigation turns for a plot are fixed on the basis of area under the CCA of an outlet.

Gang canal region, 50 per cent of the filling (*bharai*) time of watercourse is allotted along with water turns.[37]

Table 5.8: *Difference in the irrigation access in 25 F and 63 F*

Size class of operational holding (in acres)	Ratio of gross irrigated area to operational holding (25 F)	Ratio of gross irrigated area to operational holding (63 F)	Difference in the access to Irrigation (per cent)
	(a)	(b)	(a-b/b)
Less than 2.5	2.7	2.7	0
2.5 to 5*	0.0	3.3	-
5 to 10	3.5	3.2	8.9
10 to 25	4.7	4.1	14.2
25 to 50	5.2	4.3	21.2
50 and above	5.5	4.5	22.9
All	5.3	3.9	35.7

Note: *only one household in 25 F falls in this category and has cultivated unirrigated land in the neighbouring village.
Source: Survey data 2015.

A comparison across the villages indicates that the land in 25 F receives 35.7 per cent more irrigation than 63 F, overall. Secondly, the difference in access to irrigation rises with the size class of holdings in both the villages. In case of households with operational holding of 50 acres and above, the difference in the access to irrigation in the middle reaches and tail end villages is 23 per cent. The difference in the distribution of irrigation across villages is dependent on the location of the village on the distributory, size of outlet, and on the length of the minor and distributory.

5.3 *Impact of irrigation on Cropping Intensity and Cropping Pattern*

5.3.1 *Cropping intensity and cropping pattern across the villages in the region*

The irrigation availability also affects the cropping intensity and cropping pattern in a region. The *intensity of cropping* which shows the ratio of gross cropped area to net sown

[37] Similar was the case in Pujnab. See Jairath (1984).

area is a measure of the use of land resources. In 25 F, the cropping intensity rises with the increase in the size of land holding, with the exception of a semi-medium peasant household (only one household falls in that category). In 63 F, the cropping intensity across the different size classes of households is more or less the same, except for the highest size class. But there is not much difference in the average cropping intensity in the two surveyed villages.

Table 5.9: *Cropping intensity by size class of holding, 25 F and 63 F, 2014-15*

Size class of operational holding (in acres)	Cropping Intensity	
	25 F	63 F
Less than 2.5	0.787	1.555
2.5 to 5	2.000	1.612
5 to 10	1.535	1.523
10 to 25	1.744	1.572
25 to 50	1.766	1.545
50 and above	1.790	1.860
All	1.774	1.577

Source: Survey data 2015.

The cropping intensity at the all India level and in Rajasthan, in 2012-13 was 1.38 and 1.25 respectively (GOI 2016). The cropping intensity in both the surveyed villages is higher than the averages for all of India and Rajasthan, partly because of significant changes in the cropping pattern. Prior to the changes in the cropping pattern, in 2006-07, the cropping intensity in 25 F was 1.24 (Rawal 2013).

In 2014-15, 68.3 per cent of operational holdings in 25 F was cultivated with guar in the kharif season and only a small share of land was under cotton and moong cultivation. In the rabi season, barley and wheat are the major crops followed by rapeseed. Six per cent of the operational holding is devoted to perennial crops, sugarcane and kinnu cultivation.

Table 5.10: *Area under different crops as proportion of total operational holding and gross cropped area, 25 F, 2014-15*

Season	Crop	Gross cropped area (acres)	Share in gross cropped area (per cent)	Share in total operated land (per cent)
Kharif	Cotton	158.8	2.9	5.2
Kharif	Gwar	2077.5	38.5	68.3
Kharif	Kapas	4.4	0.1	0.1
Kharif	Moong	47.2	0.9	1.6
Kharif	Kharif fodder crops	111.8	2.1	3.7
Late kharif fodder	late kharif fodder	20.8	0.4	0.7
Rabi	Barley	1139.1	21.1	37.4
Rabi	Chick pea	77.7	1.4	2.6
Rabi	Rapeseed	548.3	10.2	18.0
Rabi	Wheat	887.2	16.4	29.2
Rabi	Rabi fodder crop	127.3	2.4	4.2
Rabi	Other rabi crops	13.1	0.2	0.4
Annual	Sugarcane	127.5	2.4	4.2
Annual	Orchard	64.4	1.2	2.1
All	All crops	5397.4	100.0	3042.9 (177.4)

Source: Survey data 2015.

The cropping intensity in 63 F was similar to 25 F.In the kharif season both villages had the largest proportion of area cultivated under guar (61.8 per cent of operational holding in 63 F and 68.3 per cent in 25 F). But in the rabi season, the largest proportion of area in 63 F is cultivated with wheat (26.2 per cent of operational holding), followed by chick pea (19.6 per cent), barley (16.5 per cent), rapeseed (14.3 per cent) and Moong (1.4 per cent of operational holding). The proportion of area which was cultivated with fodder crops in the kharif and rabi season was 3.1 per cent and 3.3 per cent respectively.

The extent of cultivation of different crops in the middle reaches village indicate that the intensity of cropping of barley and chick pea in the rabi season as a proportion of total operational holding was 34.6 per cent and 2.6 per cent respectively. The figures for the tail end villageare16.5 per cent and 19.6 per cent respectively. This indicates that the

extent of cultivation of crops (barley) which require higher levels of irrigation, is double that at the tail end in the middle reaches villages.

Table 5.11: *Area under different crops as proportion of total operational holding and gross cropped area, 63 F, 2014-15* in acre and per cent

Season	Crop	Gross cropped area (acres)	Share in gross cropped area (per cent)	Share in total operated land (per cent)
Kharif	Cotton	96.2	6.4	10.2
Kharif	Gwar	585.5	39.2	61.8
Kharif	Kapas	5.2	0.3	0.5
Kharif	Moong	13.3	0.9	1.4
Kharif	Kharif fodder crops	29.4	2.0	3.1
Late kharif fodder	Late kharif fodder	2.7	0.2	0.3
Rabi	Barley	156.8	10.5	16.5
Rabi	Chick pea	185.5	12.4	19.6
Rabi	Rapeseed	135.7	9.1	14.3
Rabi	Wheat	248.1	16.6	26.2
Rabi	Rabi fodder crop	30.9	2.1	3.3
Rabi	Other rabi crops	3.5	0.2	0.4
All	All crops	1494.8	1494.8 (100)	947.9 (157.7)

Source: Survey data 2015.

The extent of cultivation of crops (chick pea), which require lower levels of irrigation, is 7.5 times higher in the tail end village. Also, crops like sugarcane and kinnu orchard which require high levels of irrigation are cultivated only in the middle reaches village.

5.3.2 *Changes in cropping intensity and cropping pattern within the village*

An earlier study in 25 F by the Foundation for Agrarian Studies (FAS) in 2007 had found that the crops cultivated in the kharif season were cotton (27 per cent of operational holding) and guar (6 percent of operational holding) (Rawal 2013). During the rabi season the major crops cultivated were rapeseed (42 per cent of operational holding), wheat (32 per cent of operational holding), and barley (7 per cent of operational holding) in 2007 (*ibid.*). A small proportion of land was also being cultivated with fodder crops in

both seasons and perennial crops like sugarcane. A small area was devoted to Kinnu orchards (*ibid.*).

In the rabi season, in which the largest proportion of area was cultivated with rapeseed in 2007, barley became the major rabi crop in 2014-15 (37.4 per cent of operational holding), followed by wheat (29.2 per cent of operational holding) and rapeseed (18 per cent of operational holding) (Table 7.10). The guar stubbles, which remain on land after harvesting, are generally ploughed back into the land and used as manure for rabi season crops (wheat and barley). The guar crop, which is a leguminous crop, helps in fixing the essential fertilizers, particularly nitrogen, in the soil, improves resistance to drought and can be easily grown in the semi-arid regions. In 2014-15, the area under sugarcane also increased as a government sugar mill was being constructed near the village.

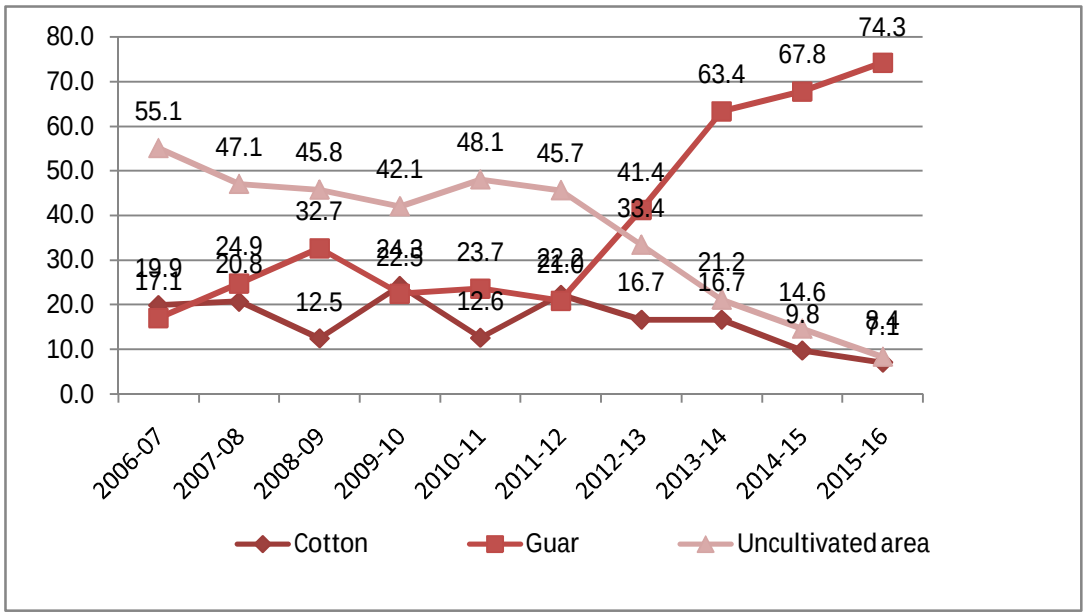
From 2006-07 to 2014-15 the area under cultivation of guar crop in Sri Ganganagar district increased from 17.1 per cent of net cropped area to 67.8 per cent (Chart 5.1). On the other hand, the area under cotton cultivation went down from 19.9 per cent in 2006-07 to 9.8 per cent of operational holding in 2014-15 (*ibid.* and Table 5.13). The cultivation of a guar crop brought a large amount of uncultivated area under cultivation in Sri Ganaganagar district. The share of uncultivated area in the kharif season went down from 55.1 per cent to 8.4 per cent. As a result the cropping intensity in the region increased sharply.

Besides the larger amount of water used for a cotton crop, the cost of cultivation was also very high and amounted to almost double of the cost of cultivation of the guar crop in 2014-15 (discussed in a later section). The lower cost of cultivation of guar crop also played an important role in changing the cropping pattern from cotton to guar.

In the agricultural year 2011-12, the market price of guar crop increased, due to high demand in the international market stemming from its use in the fracking process for extraction of shale oil and gas that had been proliferating since 2009. Fracking technology, which turned competitive during the years of high oil prices, increased shale

gas production in the United States by almost nine times between 2005 and 2013 to reach 11.3 trillion cubic ft in 2013 (Sharma 2016).

Chart 5.1: *Percentage distribution of cultivated area under cotton and guar and uncultivated area as share in the total area in kharif season, Sri Ganganagar district, agricultural year 2006-07 to 2015-16*



Note: Form 2006-07 to 2014-15, revised final estimates of area under different cropsare used and for 2015-16 final estimates are used.
Source: Rajasthan agriculture statistics of various years.

With the increased use of guar gum in the extraction process, the US became the largest importer of guar gum in the global market (Sharma 2016). India became the leading exporter of guar with a 90 per cent share in world's export of guar (Agricultural and Processed Food Products Export Development Authority (APEDA, hereafter).[38].

5.3.2.1 *Guar production, use, and prices*

5.3.2.1.1 *Uses of Guar:* The share of guar in total agricultural exports was 3.96 per cent in 2014-15 (Table 5.2) of which the largest share was of guar gum (Appendix 5A.3). Guar gum (galactomannam) is derived from the endosperm of the guar seed. After

[38]See http://apeda.gov.in/apedawebsite/SubHead_Products/Guargum.htm.

harvesting, the seed coats are dried in the sun light and then threshed mechanically. As mentioned earlier, the largest share of guar gum is used in the fracking process for extraction of gas and shale oil. Other than that, guar gum is used for stabilizing and thickening, and as a disintegrant, binder and gelling agent in various industries such as gas, oil, explosives, mining, paper, food etc. The byproduct of guar gum (guar meal) is also exported and used as a food supplement like oil cake.

5.3.2.1.2 *Production of Guar:* Guar or cluster bean which is a drought tolerant multi-purpose legume kharif crop, is mainly cultivated in the dry environment for nitrogen fixation and humus producing effects. According to APEDA, India produces 90 per cent of world's total guar, followed by Pakistan.[39] Some other countries such as Australia, South Africa, southwestern USA, China, Bangladesh, Brazil, Myanmar, and Sri Lanka also produce guar on a small scale.[40] In India, Rajasthan is leading the producer of guar with a 72 per cent share in the total guar production. Other than Rajasthan, a small amount of guar is also produced in Haryana, Gujarat, Punjab, Uttar Pradesh, Madhya Pradesh, Tamil Nadu, Maharashtra, Karnataka and Andhra Pradesh.

Traditionally, guar was used either as a fodder or vegetable crop or as green manure for soil improvement. But with the increase in the price of guar on one hand and persistent drought in Rajasthan on the other, guar cultivation has been taken up as a cash crop for export. Simultaneously, other kharif crops such as cotton, moong and soyabean have witnessed a decline in area under cultivation (Chart 5.1). Guar seed production in India fluctuated considerably, ranging from 11 lakh tones to 385 lakh tones during 2006-07 to 2013-14, except for a low of 5 lakh tones in 2009-10, when production was affected because of very low yield in Rajasthan due to bad weather conditions. Except for the year 2009-10 guar seed production has been increasing over the years. Production of guar in India increased by almost 46 percent in 2013-14. In the agricultural year, 2013-14 Rajasthan produced 79 per cent of the total guar seed in India (Table 5.12). Sri Ganganagar produced 19 per cent of all guar gum produced in Rajasthan.

[39] *Ibid.*
[40] *Ibid.*

Table 5.12: *Area, production and yield of guar in India, Rajasthan and Sri Ganganagar district, agricultural year 2006-07 to 2013-14*

Year	India			Rajasthan			Sri Ganganagar		
	Area (000 Hectare)	Production (000 Tones)	Yield (Kg/ Hectare)	Area (000 Hectare)	Production (000 Tones)	Yield (Kg/ Hectare)	Area (000 Hectare)	Production (000 Tones)	Yield (Kg/ Hectare)
2006-07	3344	1169	350	2808	658	234	120	97	805
2007-08	3473	1789	515	2910	1244	427	180	145	807
2008-09	3863	1936	501	3318	1261	380	247	197	794
2009-10	2995	595	199	2587	203	78	152	11	73
2010-11	3382	1965	581	2981	1541	517	182	164	899
2011-12	3449	2222	644	3096	1848	447	162	197	1210
2012-13	5152	2458	477	4533	2027	447	325	340	1047
2013-14	5963	3588	602	5071	2862	564	498	545	1093
2014-15	5346	3287	615	4730	2747	593	533	622	1167
2015-16	A	a	a	4787	2223	465	584	564	966
Changes in area and production (per cent)									
From 2006-07 to 2010-12	**1**	**68**		**6**	**134**		**51**	**69**	
From 2010-11 to 2013-14	**76**	**83**		**70**	**86**		**173**	**233**	

Notes: 1) a: all India estimates of 2015-16, are not yet available.

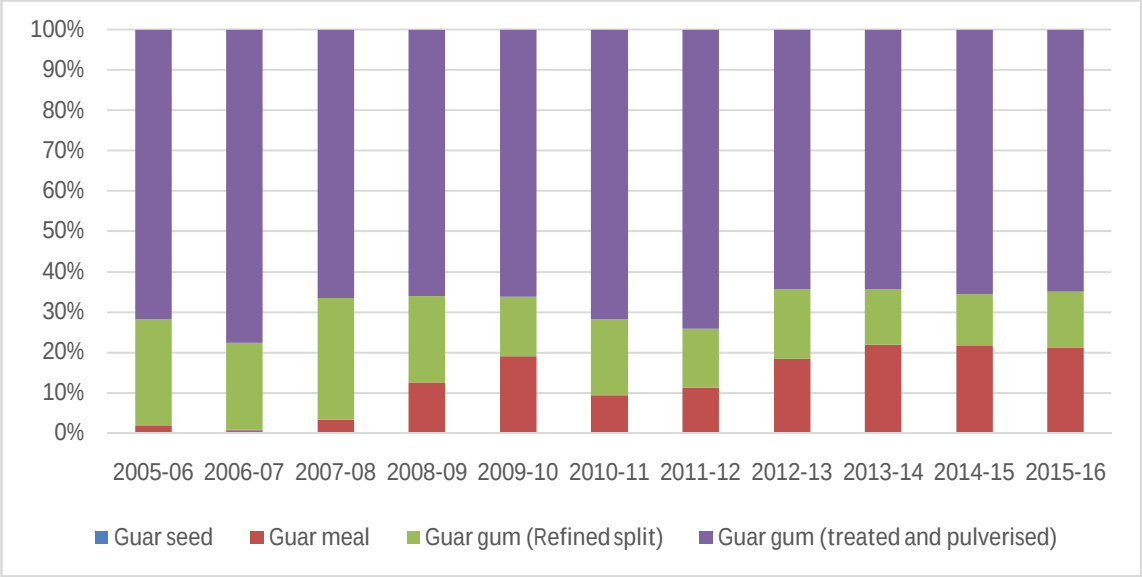
2) For 2014-15 revised final estimates and for 2015-16 final estimates of area and production of guar are used for Rajasthan and Ganganagar.

Source: India and Rajasthan agricultural statistics of various years.

As a result of increases in both area and yield, production has registered a sharp increase over the period 2010-11 to 2013-14. The increase in the area under cultivation during this period was 70 per cent and 76 per cent in Rajasthan and India respectively. However, in Sri Ganganagar district, the increase was as high as 173 per cent. On an average Ganganagar district has shown high levels of yield of guar as well.

5.3.2.1.3 *International trade of guar and its derivatives:* There are major derivative forms in which guar seed is exported to the world. These derivatives are guar seed, guar meal and guar gum. Guar gum is also of two types: refined guar split and treated and pulverized guar. The largest proportion of Indian export of guar consists of guar gum. Guar gum production in India contributes 80 per cent of the world's total. From India, guar gum is exported to the US mostly, besides China, Germany, Italy, Malaysia, Russia, Turkey, Indonesia and Egypt.[41]

Chart 5.2: *Composition of guar derived products in total value of guar export from India, financial year 2005-06 to 2015-16*



Source: Calculated from the export data on provided by Department of Commerce, Ministry of Commerce and Industry, Government of India.

[41] *Ibid.*

Chart 5.2 shows that guar gum is exported predominantly in the form of treated and pulverized guar gum, followed by refined split and guar meal over 2005-06 to 2011-12. From 2012-13 onwards, the share of guar meal export has increased relative to guar gum refined splits. The share of guar seed export has remained negligible over the years. Countries like, USA, Spain, Italy, Germany etc. import guar gum refined split from India and after processing that into treated and pulverized guar gum for industrial use re-export it further. Despite that India's export income from treated and pulverized guar gum has remained much higher than the income from guar gum refined splits (appendix 5A.3).

Table 5.13: *Share of guar and its derivatives in agricultural export and total export from India, financial year 2000-01 to 2015-16*

Year	Export of guar & its derivatives (Crore Rs.)	Export of total agricultural commodities (Crore Rs.)	Total export (Crore Rs.)	Share of Guar in agricultural export (per cent)	Share of guar in total export (per cent)
2000-01	603.4	28657.4	201356.5	2.1	0.3
2001-02	403.2	29728.6	209018.0	1.4	0.2
2002-03	486.8	34653.9	255137.3	1.4	0.2
2003-04	508.4	36415.5	293366.8	1.4	0.2
2004-05	690.0	41602.7	375339.5	1.7	0.2
2005-06	1050.1	45711.0	456417.9	2.3	0.2
2006-07	1131.4	57767.9	571779.3	2.0	0.2
2007-08	1125.8	74673.5	655863.5	1.5	0.2
2008-09	1339.0	81064.5	840755.1	1.7	0.2
2009-10	1133.3	84444.0	845533.6	1.3	0.1
2010-11	2938.7	111019.0	1142921.9	2.7	0.3
2011-12	16523.9	180528.6	1465959.4	9.2	1.1
2012-13	21287.0	223618.2	1634318.8	9.5	1.3
2013-14	11735.4	262779.0	1905011.1	4.5	0.6
2014-15	9478.3	239453.2*	1891644.7*	4.0	0.5

Note: *Provisional
Source: Agriculture Statistics at a glance, 2015 and calculated from the export data provided by Department of Commerce, Ministry of Commerce and Industry, Government of India.

The share of gaur and its derivatives in total agricultural export has shown variations from year to year. In years 2010-11 and 2011-12, the value of guar exports increased by

more than 150 per cent and 450 per cent respectively because of the very high industrial demand for guar gum. With this large increase in guar export, its share in agriculture commodity exports touched a high of9.52 per cent in 2012-13, making it a major agricultural export. In that year India exported guar valued at Rs. 21,287 crore. Even though the share of guar exports has since declined, particularly during financial year 2013-14, the quantity of guar and its derivatives exported has remained almost the same till 2015-16. On the other hand, the price of guar declined substantially between 2012-13 and 2013-14 and further in 2014-15.

The primary reason for the decline in prices and in the share of guar in value of Indian exports was the oversupply of guar, following increases in the area under guar cultivation during earlier periods triggered by the increase in the prices (discussed in the next section). But in the period after 2014-15, the quantity of guar export declined as well due to the fall in the prices of crude oil in international markets that affected fracking adversely and also with the emergence of substitutes for guar. The price of crude oil was $118.6/barrel in April 2011 and during the period from 2011 to 2014 the price registered small fluctuations.[42] But in February 2016, prices went down to $30.5/barrel (Chart 5.4).[43]

5.3.2.1.4 *Impact of international trade on guar prices and cropping pattern*: With the increase in the global demand for guar gum, mainly because of its use in fracking, which involves deep drilling for natural gas, prices rose sharply during the financial years of 2011-12 and 2012-13.Increased demand for guar and its different products in international markets raised prices of guar seed in the Indian national market. And better prices induced increased production of guar in the country.

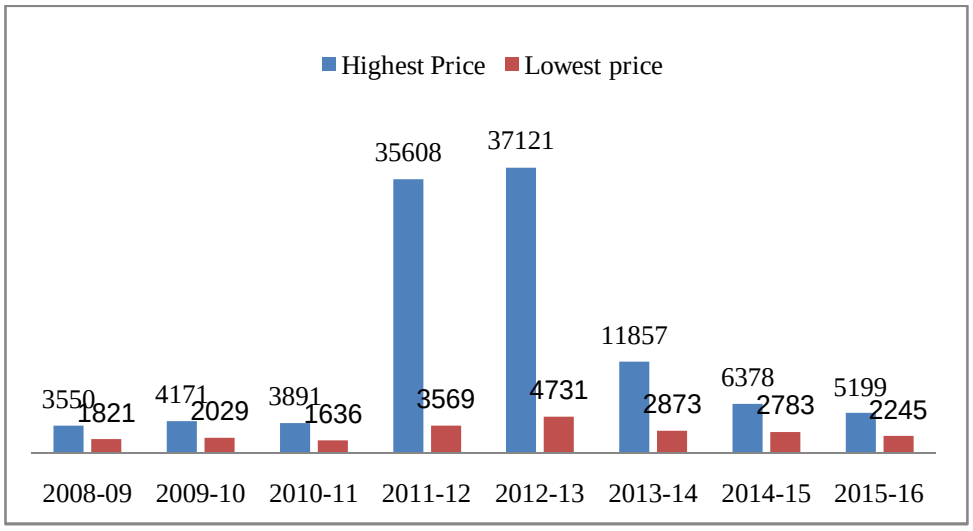
Because of these developments in the international trade of guar seed, Sri Ganganagar district emerged as a big market for guar seed. And as data collected from one mandi, Gajsinghpur of the Sri Ganganagar district shows, prices of guar seed had varied from Rs.

[42] http://www.ppac.org.in/content/149_1_PricesPetroleum.aspx.
[43] *Ibid.*

1000 per quintal in 2008-09 to Rs.31,000 per quintal in May 2011. With the increase in the prices of guar seed in the agricultural year of 2011-12 the area under cultivation of guar increased sharply in the agricultural year of 2012-13.

As discussed earlier in the chapter, guar is a drought tolerant crop and it also does not need much pesticides and chemicals like other many crops (such as cotton, wheat etc.). The lower cost of cultivation and higher prices of guar seed induced the production of guar on a large scale and the area under cultivation went up in all guar cultivating regions across India.

Chart 5.3: *Per quintal price of guar in Gajsinghpur mandi of Sri Ganganagar district, Rajasthan, financial year 2008-09 to 2015-16* Rs.



Note: Prices are converted to 2015-16 prices by using CPI (AL).
Source: Based on data collected from Krishi Upaj Smiti, Gajsinghpur.

As a result of this increase in the area under cultivation, two important changes occurred. Firstly, with the doubling of the area under cultivation between 2011-12 in 2012-13 in Sri Ganganagar district, the total production of guar increased. Combined with the decline in crude oil prices, this led to a decline in the demand for guar in international market resulting in an oversupply of guar in the markets led to decline in prices of guar in both international and domestic markets. Though the decline in the guar prices has still remained higher than the prices prior to the period when the export of guar began. Secondly, the net area under cultivation in the kharif season increased as guar is a less

water intensive crop and the land which was earlier kept fallow due to inadequate availability of irrigation, was used for guar cultivation.

5.3.2.2 *Relative cost and benefits of different crops*

This section of the chapter explores the relative costs and benefits of changes in the cropping pattern in the region by analysing the gross value of output of different crops and the expenditure on different inputs. The section also discusses the impact of cropping pattern changes on incomes of the households in 25 F. Net incomes from the agricultural land for the households with different irrigation access, are calculated after deducting the paid out cost. For calculating paid out cost, the cost A2 methodology of the Commission on Agricultural Cost and Prices (CACP) is adopted. The paid out cost on various inputs such as manure, seeds, chemical fertlisers, irrigation, plant protection, hired manual labour and machine labour are calculated.[44] Since cost A2 accounts for paid out costs only, therefore cost or expenditure of family labour and rent on owned land are not included in the calculation.

A study by Chauhan and Agarwal (1970) in three village of Sri Ganganagar panchayat simiti (Sri Ganganagar district of Gang canal region) over the period from 1961-62 to 1968-69 shows that owner cultivators on an average had higher average expenditure on cultivation than the tenant cultivators, since owner cultivators incurred higher levels on expenditure on mechanisation and on groundwater irrigation (particularly tubewell installations). As the use of tubewell is very limited in the villages and during the agricultural year 2014-15, no household in the surveyed villages installed any tubewell. However, households with large holdings on an average had higher use of tubewell water. Further, with the increase in mechanisation, the share of expenditure on machines hired and owned has remained one of the important components of expenditure. And a third important component of expenditure, among small peasants in particular, was rent payment for leased in land.

[44] GOI (1991, 1996, and 2000) as cited in Surjit (2008), CACP calculates cost on depreciation and maintenance along with interest on working capital, therefore these costs are calculated as well using CACP methodology.

The important components of cost of cultivation in 25 F were the expenditure on the rent payments of leased in land, machines, hired labour and chemical fertilisers. The share of land rent was higher among the farmers from marginal (39 per cent) and small (80 per cent) size classes. Whereas in case of other classes the expenditure on machinery and land rent along with the expenditure on hired manual workers were the dominant costs of cultivation.

Table 5.14: *Average per acre expenditure on different inputs, by size class of holding, 25 F* in Rs. per acre

Expenditure on various particulars	Less than 2.5	2.5 to 5	5 to 10	10 to 25	25 to 50	50 and above	All
Seeds	1084	227	686	722	439	531	587
Manure	0	0	43	162	65	132	102
Chemical fertilizer	1427	0	810	1225	1003	1169	1101
Plant protection	444	60	325	745	610	744	643
Irrigation	0	0	78	374	312	262	270
Hired manual labour	907	0	1669	2053	2634	2433	2226
Machine	1806	547	2482	2858	2402	2666	2540
Maintenance and depreciation	0	0	260	1653	719	607	814
Rent payment for leased in land	3702	3600	2046	2555	2516	2701	2625
Other expenses	218	92	227	448	422	420	396
Paid out cost (A2)	9588	4526	8626	12796	11121	11667	11304

Source: Survey data 2015.

On an average, per acre expenditure on irrigation was almost double in 63 F compared with 25 F. The expenditure on irrigation was higher among small, marginal, semi-medium and medium peasants, as most of these households have to rent tubewells water from large households. Apart from higher per acre expenditure on machine and hired labour among medium and large peasants in 63 F, rent payments for leased-in land shows that small and marginal peasants have been leasing out land to large farmers as they are not able to bear the increasing cost of cultivation. On the other hand, large farmers, who have access to machinery and other capital intensive technology for cultivation earn

higher profits from leased-in land in 63 F. Even though these households are able to earn profits from the leased in land because of ownership of machinery etc. but still the expenditure on machines and hired labour remain one of the important component of cost across all households.

Table 5.15: *Average per acre expenditure on different inputs, by size class of holding, 63 F* in Rs. per acre

Expenditure on various particulars	Less than 2.5	2.5 to 5	5 to 10	10 to 25	25 to 50	50 and above	All
Seeds	880	641	531	575	446	488	627
Manure	274	118	69	114	37	18	130
Chemical fertiliser	1011	815	712	805	713	551	818
Plant protection	1511	620	447	502	743	509	755
Irrigation	971	307	482	300	323	40	491
Hired manual labour	59	635	731	1326	1717	5568	894
Machine	1937	2817	2588	2617	2253	2030	2445
Maintenance and depreciation	438	169	389	386	344	341	361
Rent payment for leased in land	514	2755	3253	3300	3504	0	2574
Other expenses	179	241	221	247	240	215	224
Paid out cost (A2)	7774	9117	9422	10171	10321	9761	9319

Source: Survey data 2015.

The expenditures on various inputs in agriculture have a positive relation with the size class of holding. That is, households with greater size of operational holding have higher investments on inputs. This is warranted, since these households are able to earn higher per acre income which is generally invested for producing the next season's crop. The technology is also income biased as it gives higher returns to the better endowed households. Various studies have pointed out that accumulation of capital among large peasants is a concomitant phenomenon (Sarkar 2008, Ramachandran, Rawal, and Swaminathan 2009).

The average per acre production in 25 F has remained higher than both the district and state level average production. The average per acre productivity of crops which require

three to four waterings, such as barley, kapas, wheat and cotton, is higher in 25 F than 63 F.

Table 5.16: *Average per acre production of grain, for selected crops, in quintal per acre, 2014-15* in quintal per acre

Crops	Average per acre production (quintal per acre)			
	25 F	63 F	Sri Ganganagar district	Rajasthan
Barley	17.5	12.1	12.4	11.3
Chick pea	3.7	2.8	4.2	2.9
Cotton	7.9	6.8	3.6	2.2
Guar	4.5	3.5	4.7	2.4
Kapas*	8.1	5.2		
Moong	3.5	2.8	3.6	2.1
Rapeseed	5.6	4.4	5.7	4.8
Wheat	15.8	13.2	15.6	12

Note: *Separate production for Kapas is not collected in secondary data.
Source: Survey data for 25 F and 63 F and for district and state level production data of Department of Agriculture, Government of Rajasthan (available at http://agriculture.rajasthan.gov.in/index.php?option=com_content&view=article&id=243&Itemid=961&lang=en) is used.

Apart from orchards and sugarcane in 25 F, the higher net return per acre crops have been moong, cotton, wheat, guar and rapeseed. But average per acre income from crops like cotton and guar increases with the increase in land size class. The reason for variation in net income across different size classes is the use of chemical fertilisers which, when combined with irrigation, helps in increasing production. Unlike other crops, barley had less variation in per acre incomes generated across households from different size classes because the area under barley cultivation have had broadly similar irrigation across classes and therefore results in less variation in production. Expenditure on hired manual workers and machinery are among the major componant of the cost of cultivation for all the crops.. Also the cost on chemchical fertilisers is higher for the crops which are more water intensive as compare to less water intensive crops.

Table 5.17: *Average per acre earning across different size classes of holding, for major crops, 25 F* in Rs. per acre

Crops	Less than 2.5	2.5 to 5	5 to 10	10 to 25	25 to 50	50 and above	All
Barley			6509	5166	7342	8878	7307
Chick pea					627	8795	6344
Cotton	7789		7978	9254	15936	18663	13245
Guar	8830	-3594	4563	9025	13234	13078	11554
Kapas			5257	9568		29547	13485
Moong			3623		16091	13651	13868
Orchard	0	0	0	0	30550	189326	189822
Rapeseed	1945		7681	9743	9505	11877	9814
Sugarcane				27760	28089	52406	39186
Wheat	8657		11225	10771	12270	13352	12054
All crops	5226	-3859	6864	8241	11381	13370	10359

Source: Survey data 2015.

Even though cotton cultivation delivered the highest per acre revenues in 2014-15 in 25 F, the average per acre cost for cultivation of a cotton crop is almost double the cost of cultivation of kharif crops like guar. Guar is not an irrigation intensive and required almost 47 per cent less per acre expenditure on irrigation than a cotton crop. Not only irrigation but the costs of other inputs such as seeds, fertilizer, pesticides, and hired manual labour were respectively 84, 82, 70, and 57 per cent higher for cotton than for guar cultivation in the kharif season. In the case of rabi crops, whereas chick pea has the highest expenditure on seeds, it records the lowest expenditure on irrigation. Also, in the rabi season tubewells were used along with canal irrigation to irrigate rapeseed, wheat and barley, because of inadequacy of surface water. In the rabi season, the wheat crop showed the highest average per acre expenditure on cultivation (Rs. 12, 674/acre) and the largest proportion of this expenditure was on machinery.

In 63 F, cotton and kapas have the highest net per acre income during the kharif season which is in line with the other village. In the case of guar, the highest net profit earners are the households with more than 50 acres of land, because they sell the crop at higher market prices. But the traditional wheat crop has less variation in per acre income across different sections of the peasantry in the rabi season.

Table 5.18: *Average per acre expenditure on different inputs for major crops, 25 F* in Rs. per acre

Expenditure on various particulars	Barley	Chick pea	Cotton	Guar	Moong	Rapeseed	Wheat
Seeds	547	1289	1777	287	495	212	893
Manure	48	0	103	9	0	117	111
Chemical fertiliser	1250	574	1833	323	380	871	1919
Plant protection	325	504	2163	655	1421	144	417
Irrigation	321	106	292	156	322	415	351
Hired manual labour	1284	1786	5679	2449	2704	2020	1874
Machine	2357	1844	4111	2619	1658	2514	2991
Maintenance and depreciation	3067	3113	3182	2651	0	2442	2623
Rent payment for leased in land	706	430	1152	840	556	808	1043
Other expenses	356	316	903	322	209	358	454
Paid out cost (A2)	10261	9962	21194	10312	7746	9902	12674

Source: Survey data 2015.

Table 5.19: *Average per acre earning across different size class of holding, for major crops, 63 F* in Rs. per acre

Crops	Less than 2.5	2.5 to 5	5 to 10	10 to 25	25 to 50	50 and above	All
Barley		1932	3207	4311	4801	6636	3921
Chick pea	3427	3650	4862	4328	7807	13715	4790
Cotton	6643	7031	12011	14221	19247	12345	12045
Guar	5099	6215	7592	7642	9706	13277	7291
Kapas	1486	7749	9486	15236	28454		11141
Moong		16857	-8055	7864	3722	10651	6484
Rapeseed	5429	6649	6666	8475	7341	13703	7239
Wheat	8112	10321	11528	9438	15618	12101	10514
All crops	4317	5659	6424	7577	9899	12220	6595

Source: Survey data 2015.

Though the cost of cultivation is higher for cotton as compared with all other crops in both seasons, the average expenditure on irrigation is very high for cotton in the kharif season and for rapeseed in the rabi season. Since the largest proportion of land is cultivated by small, marginal, semi-medium and medium peasants, the average expenditure on hired manual labour is much lower than in 25 F, i.e, the average per acre

expenditure on labour is around 1/3rd that in 25 F. Apart from expenditure on irrigation, the average expenditure on all other inputs is lower in 63 F as compared with25 F because the use of inputs like fertilisers, pesticides and so on are positively related to irrigation, i.e, with the increase in availability of water for irrigation the application of fertilisers increases.

Table 5.20: *Average per acre expenditure on different inputs for major crops, 63 F* in Rs. per acre

Expenditure on various particulars (in Rs. per acre)	Barley	Chick pea	Cotton	Guar	Moong	Rapeseed	Wheat
Seeds	535	698	1610	219	661	233	905
Manure	46	34	394	17	0	10	115
Chemical fertiliser	1001	57	1682	303	246	912	1574
Plant protection	252	395	2982	579	338	222	300
Irrigation	470	171	941	498	347	607	839
Hired manual labour	584	529	2230	970	1443	1016	905
Machine	2228	1931	2630	2766	2574	2328	3176
Maintenance and depreciation	2611	1753	3360	2844	2229	2924	3292
Rent payment for leased in land	213	281	679	352	295	384	476
Other expenses	208	123	552	189	253	218	300
Paid out cost (A2)	8149	5973	17060	8735	8387	8853	11881

Source: Survey data 2015.

With the changes in cropping pattern, the average incomes in 25 F have increased between 2006-07 and 2014-15, in the kharif season (Table 5.25). In the case of cotton, guar and moong, per acre incomes have increased by Rs. 3201, Rs. 3741, and Rs. 5200 respectively. All the kharif crops also witnessed an increase in the per acre cost of cultivation. In the case of rabi season crops there is a sharp decline in the average per acre incomes, particularly for chick pea, wheat and rapeseed.

Table 5.21: *Changes in the per acre crop incomes and cost from 2006-07 to 2014-15, in 2014-15 prices, 25 F* in Rs. per acre

Crop	Rs. Per acre in 2014-15			Rs. Per acre in 2006-07 (in 2014-15 prices)			Change in various components of households incomes from 2006-07 to 2014-15		
	Gross value of output (Rs.)	Paid out cost (A2) (Rs.)	Net income (Rs.)	Gross value of output (Rs.)	Paid out cost (A2) (Rs.)	Net income (Rs.)	Gross value of output (Rs.)	Paid out cost (A2) (Rs.)	Net income (Rs.)
	A	B	C	D	E	F	(a-d)	(b-e)	(c-f)
Cotton	34439	21194	13245	26081	16037	10044	8358	5157	3201
Guar	21866	10312	11554	14959	7145	7813	6908	3167	3741
Moong	21614	7746	13868	15761	7095	8668	5853	651	5200
Rapeseed	19715	9902	9814	22546	9233	13313	-2831	669	-3500
Wheat	24728	12674	12054	28078	12711	15367	-3350	-36	-3313
Barley	17568	10261	7307	16633	8729	7902	935	1532	-595
Chick pea	16306	9962	6344	22527	10084	12443	-6221	-122	-6099
Sugarcane	73914	34728	39186	61616	40534	21082	12298	-5806	18104
All	21663	11304	10359	27244	13539	13705	-5581	-2235	-3346

Note: Prices for 2006-07 have been converted to 2014-15 prices by using state level CPI (AL).

Source: Survey data 2015 and Rawal (2013).

In the case of chick pea, the decline in the gross value of output and net income occurred because of a decline in production levels. In the case of wheat and rapeseed, however, minimum support prices (MSP, hereafter) declined in real terms, by Rs. 513 per quintal for rapeseed and Rs. 130 per quintal for wheat.

Table 5.22: *Change in the minimum support price of crops, 2006-07 to 2014-15, in 2014-15 prices, Rajasthan state* in Rs. per quintal

Crop	MSP in 2006-07 (in 2014-15 prices)	MSP in 2014-15	Change in MSP from 2006-07 to 2014-15
Cotton (small)	3729	3750	21
Moong	3202	4600	1398
Rapeseed	3613	3100	-513
Wheat	1580	1450	-130
Barley	1190	1150	-40
Chick pea	3044	3175	131

Note: Prices for 2006-07 have been converted to 2014-15 prices by using state level CPI (AL).

Source: Cabinet Committee on Economic Affairs (CCEA), GOI, various years.

The decline in the MSP in real terms between 2006-07 and 2014-15, has affected the incomes derived from the rabi season crop more than the increase in the cost of cultivation. Even with the decline in the per acre incomes in the rabi season , the overall crop incomes of households in 25 F has increased between 2006-07 and 2014-15. The increase in the household crop incomes occurred because of a rise in the cropping intensity from 1.24 of operational holdings in 2006-07 to 1.77 of operational holdings in 2014-15. That is with the increase in the area under cultivation in kharif season the households in 25 F experienced an increase in crop incomes.

5.4 *Economic Impact of Irrigation*

The above discussion reveals that the access to irrigation not only varies across the villages but also across households as well. Therefore, this section seeks to understand the economic impact of irrigation on household earning. The economic impact of the

access to irrigation is analysed by the method provided by Molden *et.al.* (1998) from the International Water Management Institute (IWMI). The method involves assessing irrigation system performance by comparing, the GVO (gross value of output).[45] Further, the GVO of crops, is divided by the net cropped area, gross cropped area and gross irrigated area. All these three indicators are used to understand the impact of irrigation on per acre incomes generated.

Table 5.23: *Impact of irrigation on output, by village* in Rs. per acre

	25 F	63 F
Output per cropped area (Rs. Per acre)	37806	25187
Output per unit gross cropped area (Rs. Per acre)	21663	15914
Output per unit of gross irrigated area (Rs. Per acre)	7242	6016

Note: Output here is taken to be gross value of output.
Source: Survey data 2015.

The data indicates that the GVO per unit of cropped area is 50 per cent lower in 63 F than 25 F. Similarly, the per acre GVO in the case of gross irrigated area is 20 per cent lower in 63 F. In other words, irrigation delivered higher levels of crop GVO in the middle reaches village as compared to the tail end village.

Within this region, tail end villages have lower levels of gross crop income because of inadequate canal water supply, which affects the uses of other inputs as well. The difference in net incomes, which are calculated after deducting paid out cost from the gross value of output by using the CACP method, indicates that with additional water supply per acre, net incomes from land rose enormously. The difference between the net incomes of irrigation intensity groups is not as high across villages as it is within a village. Within a village, increased irrigation use increases the levels of net incomes in both the middle reaches and tail end village. The difference in net per acre incomes at the same level of irrigation intensity results from the absence of timely supply of canal water.

[45] Molden *et.al.* 1998 has used SGVP (standardised gross value of production) which is the value of the produce in the standard market prices for calculating the economic impact of irrigation. Since value of the produce is collected at the household level in the village survey, therefore value of the produce is calculated using the prices which the households have received in 2014-15.

Table 5.24: *Net per acre by irrigation intensity, 25 F and 63 F, 2015* in Rupees

Number of times land irrigated (Irrigation intensity)	Net per acre income (Rs.)	
	25 F	63 F
Less than 3	4408	4443
3 to 4	5932	5207
4 to 5	10607	8479
5 and more	13453	
Grand Total	10359	6595

Source: Survey data 2015

Since the per acre irrigation intensity rises with the rise in the size of operational holdings, the net incomes of households also vary in a similar manner. In 25 F, the highest per acre GVO (gross value of output, GVO hereafter) was earned by households belonging to the large category, with households with holdings of 50 acres and above registering a GVO of Rs. 25,037 and households belonging to 25 to 50 acres category recording Rs. 22,503. On the other hand, the GVO of households with less than 2.5 acre operational holding was almost 69 per cent lower than the 50 and above acres cultivators, and 46 per cent lower than the village average. The GVO of households belonging to the 2.5 to 5 acre size category (1 household), is also lower, since the land operated by these households was in a neighbouring village and did not get any water for irrigation in 2014-15. Also, the household from the small size category in 25 F, experienced crop failure in the rabi season so the net income from crop production was negative.

Table 5.25: *Average gross value of output, cost A2 and net income from crop production by size class of holding, 25 F* in rupees per acre

Size class (in acres)	Gross value of output (Rs.)	Paid out cost (A2) (Rs.)	Net income (Rs.)
Less than 2.5	14814	9588	5226
2.5 to 5	667	4526	-3859
5 to 10	15490	8626	6864
10 to 25	21036	12796	8241
25 to 50	22503	11121	11381
50 and above	25037	11667	13370
All	21663	11304	10359

Source: Survey data 2015.

In 63 F, the highest per acre GVO (gross value of output) was earned by households belonging to the large category, in which households with land of 50 acres and above had a GVO of Rs. 21,981 and households belonging to 25 to 50 acres of land class earned Rs. 20,221. On the other hand, the GVO of households with less than 2.5 acre operational holding was almost 81 per cent lower than the 50 and above acres cultivators, and 31 per cent lower than the village average.

Table 5.26: *Average gross value of output, cost A2 and net income from crop production by size class of holding, 63 F* in rupees per acre

Size class (in acres)	Gross value of output (Rs.)	Paid out cost (A2) (Rs.)	Net income (Rs.)
Less than 2.5	12091	7774	4317
2.5 to 5	14776	9117	5659
5 to 10	15846	9422	6424
10 to 25	17748	10171	7577
25 to 50	20221	10321	9899
50 and above	21981	9761	12220
All	15914	9319	6595

Source: Survey data 2015.

The average per acre GVO and net income is lower in 63 F than 25 F. The average GVO of 25 F, was Rs. 21,663 and in 63 F it was Rs. 15,914.The above discussion shows that on an average, the tail end households received 36 per cent less irrigation then the middle reaches village. Even though officially each plot of land is allotted a similar quantity of water across agricultural holdings in the Gang canal region, within a village, the households with large operational holdings have not only control over land resources but over water resources as well. The income from land is also affected by the access to water for irrigation and water availability has an impact on the use of other inputs. However, irrigation access affects the income levels in both surveyed villages by affecting their cropping intensities and cropping patterns.

5.5 *Summary of Findings and Conclusion*

The concentration of land among the large peasants with holdings of 25 to 50 acres and 50 acres and above, also gives these households greater access to public water resources in villages in the Gang canal region. These households not only own the most land in the village but also the best land because of social and economic influence in the villages. The use of private water resources is very limited and restricted to the rabi season crops in both the villages. The difference in the access to irrigation increases with the increase in the size class of operational holdings. On an average every acre in 63 F receives 36 per cent less irrigation then the middle reaches village of Gang canal because of the size of the disrtibutory and size of the outlet.

Prior to changes in the cropping pattern and cropping intensity in the kharif season the water deficit was greater in the villages. Other than water inadequacy, the higher cost of cultivation for cotton and the rise in the prices of guar during the financial year of 2010-11 resulted in an increase in the area under guar cultivation. Though guar replaced the cotton crop to a significant extent in 25 F, in Sri Ganganagar as a whole the expansion of guar cultivation occurred through the cultivation of hitherto uncultivated areas. With the rise in guar cultivation in the kharif season on seasonal fallow, the cropping intensity in the region also increased.

The changes in the kharif season cropping pattern was accompanied by changes in the rabi season cropping pattern as well. While the area under rapeseed witnessed a decline in 25 F, the share of area under barley cultivation increased. The cropping pattern in the middle reaches and tail end village were different in the rabi season. The cropping intensity of cultivating a crop (such as barley) which requires more irrigation is higher in the middle reaches, whereas the cropping intensity of less irrigated (chick pea) is higher in the tail end village. The area under chick pea cultivation in the tail end village was 7.5 times higher than that in the middle reaches village.

The prices of guar crop increased because of demand for guar in the international market for use in fracking. But in recent years the price of guar has witnessed a decline due to increased supply of guar and lower demand for it because of a fall in fracking technology use following a decline in crude oil prices. Alternative methods of fracking process have also affected the prices of guar.

The gross value and cost of cultivation of various crops indicate that on an average per acre revenues from cotton cultivation are higher than that for guar. But the cost of cultivation of guar is 50 per cent lower than that of cotton. The cotton crop is also water intensive, while guar is less water intensive. Therefore, guar cultivation is more economically viable for peasant households.

The overall crop revenues in the kharif season witnessed an increase in 25 F between 2006-07 and 2014-15, but revenues in the rabi season have gone down sharply. The primary reason for decline in per acre revenues of rabi season crops is a decline in MSP in real terms in this period. Though with the rise in the area under cultivation overall crop incomes of cultivators have increased in real terms in 25 F.

The economic impact of irrigation is assessed by analyzing per acre incomes across households with differing irrigation intensity. The data shows that with additional watering of each acre, net income levels rise immensely. However, this is not because income levels increase with additional watering *per se*, but additional watering contributes to an increase in the use of other inputs, mainly chemical fertilisers. As the crops which are more water intensive have higher per acre expenditure on fertiliers as compare to less water intensive crops (Tables 5.18 and 5.20). The difference in the incomes across the middle reaches and tail end village is due to the timely supply of water in the middle reaches as compared with the tail end.

The access to irrigation varies both across the households in a village and across the villages, even though households in a village receive water from the same minors and water across villages is distributed via the same distributory. The water access is affected

by the size of the minor, size of outlet, location of land in a particular village and region, distance of land from the outlet and size of land and fragmentation of land. Secondly, with the availability of irrigation, the cropping pattern within the region varies, with the middles reaches village cultivating more of the water intensive crops and the tail end village cultivating the less water intensive crops. Other than guar (the less water intensive crop), the cropping pattern of the region is influenced by the availability of and access to irrigation rather than by crop prices and net incomes from crops, though access to irrigation also affects crop incomes signifcantly. Thirdly, the changes in guar price were very volatile and cultivation of the crop increased due to a rise in international market prices and as a result of prices in the domestic market. But with the decline in the demand for guar in the international market after agricultural year 2012-13, the prices of guar witnessed a sharp decline. The cost of cultivation of guar is lower than other kharif season crops in the region and cultivators are still able to earn profits from guar cultivation. But as there is no government support price for guar, the cultivator households of the area are exposed to larger market risks.

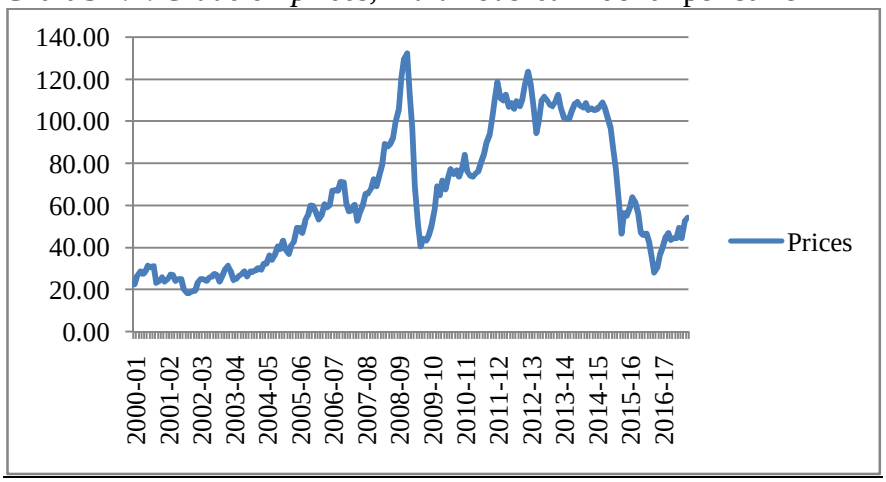
Appendix Tables

Table 5A.1: *Import and Export of India in Guar and related commodities, financial year 200-01 to 2015-16*

Year	Import		Export	
	Value (Lakh Rs.)	Quantity (Thousands kg)	Value (Lakh Rs.)	Quantity (Thousands kg)
2000-01	124	516	60336	129674
2001-02	2380	14479	40316	117886
2002-03	422	2502	48682	111994
2003-04	294	2368	50841	120779
2004-05	19	5	69003	131525
2005-06	154	281	105009	187078
2006-07	150	70	113142	190591
2007-08	351	135	112577	211175
2008-09	245	203	133903	258582
2009-10	243	83	113331	218480
2010-11	266	88	293870	441607
2011-12	990	299	1652387	707326
2012-13	4642	7023	2128702	406312
2013-14	2325	871	1173544	601963
2014-15	595	248	947827	665098
2015-16	1407	683	323436	325293

Source: Calculated from the export data provided by Department of Commerce, Ministry of Commerce and Industry, Government of India.

Chart 5A.1: *Crude oil prices, Indian basket* in dollar per barrel



Source: Petroleum Planning & Analysis Cell (PPAC), Ministry of Petroleum & Natural Gas, Government of India, available at http://www.ppac.org.in/content/149_1_PricesPetroleum.aspx.

Table 5A.2: *Import of guar seed and its derivatives to India, financial year 2001-02 to 2015-16*

Year	Guar seed		Guar meal		Guar gum (Refined split)		Guar gum (Treated and pulverised)	
	Quantity (Thousands kg)	Value (Lakh Rs.)	Quantity (Thousands kg)	Value (Lakh Rs.)	Quantity (Thousands kg)	Value (Lakh Rs.)	Quantity (Thousands kg)	Value (Lakh Rs.)
2000-01	513	111.9	3.3	12.1				
2001-02	14472	2356.6	6.8	23.2				
2002-03	2496.1	395.8	6.4	26.0				
2003-04	1895.0	240.6			473.0	52.1	0.3	1.7
2004-05			4.6	17.0	0.3	0.1	0.3	1.4
2005-06	180.0	26.9	15.7	63.0	16.2	22.7	69.6	41.6
2006-07			29.4	123.5			40.9	26.5
2007-08			71.4	255.9	10.0	17.3	53.4	78.0
2008-09	105.9	17.1	54.8	184.5			42.6	43.5
2009-10	11.0	1.9	70.7	230.6			1.7	10.4
2010-11			87.7	265.7				
2011-12			118.3	453.5	139.9	469.5	40.5	66.7
2012-13	6455.7	1281.3	107.3	787.0	311.0	1955.6	149.4	618.1
2013-14	495.9	140.6	61.5	411.0	164.2	1171.5	150.0	602.2
2014-15	120.2	23.5	2.4	20.2	65.2	296.5	60.4	255.0
2015-16	48	13.7	1.5	9.4	32.9	206.1	600.2	1177.4

Source: Calculated from the export data provided by Department of Commerce, Ministry of Commerce and Industry, Government of India.

Table 5A.3: *Export of guar seed and its derivatives from India, financial year 2001-02 to 2015-16*

Year	Guar seed		Guar meal		Guar gum (Refined split)		Guar gum (Treated and pulverised)	
	Quantity (Thousands kg)	Value (Lakh Rs.)	Quantity (Thousands kg)	Value (Lakh Rs.)	Quantity (Thousands kg)	Value (Lakh Rs.)	Quantity (Thousands kg)	Value (Lakh Rs.)
2000-01	143.2	41.1	1720.2	923.5	43954.9	20597.6	83855.7	38773.9
2001-02	3.4	7.0	756.0	334.7	32961.4	10131.2	84165.7	29843.2
2002-03	45.3	8.6	1097.5	459.1	41337.0	18051.3	69513.9	30163.4
2003-04	218.0	51.3	4691.4	1868.6	38072.3	15317.0	77797.6	33603.9
2004-05	225.2	55.0	4706.0	2256.7	49801.4	22166.0	76792.5	44525.0
2005-06	359.5	85.8	3146.5	1078.0	49381.3	23797.7	134190.6	80047.6
2006-07	1286.2	562.5	192.5	85.9	41266.8	19328.3	147845.1	93165.0
2007-08	8.4	2.8	7025.1	1329.4	63711.4	30206.8	140430.1	81038.4
2008-09	14.5	4.8	32268.2	4243.0	55433.1	24999.2	170866.3	104656.3
2009-10			41574.6	6381.0	32137.1	15656.1	144768.0	91293.4
2010-11	0.3	0.1	41424.9	6548.5	83011.5	50767.9	317170.7	236553.5
2011-12			80151.9	11682.5	102423.7	192330.0	524750.8	1448374.2
2012-13	0.4	1.5	74814.1	14027.9	70515.2	339053.8	260982.4	1775618.6
2013-14	1.5	4.8	132110.9	28993.7	82689.1	148408.8	387161.6	996136.7
2014-15	0.3	0.4	143921.8	32551.2	84744.3	116171.4	436431.7	799103.5
2015-16	42.6	48.6	68573.5	22234.1	45667.7	40311.5	211009.6	260841.9

Source: Calculated from the export data provided by Department of Commerce, Ministry of Commerce and Industry, Government of India.

Chapter 6

Inter-Linkages between Irrigation, Agricultural Technology and Employment: Insights from Survey Villages

6.1 *Introduction*

The analysis in the previous chapter tries to understand the reasons behind a shift in cropping pattern as well cropping intensity in the surveyed villages. It has been found that the most convincing reasons for these changes are uncertainties regarding access to irrigation and movements in crop prices. The analysis also argues that the location of and infrastructure available in a village influence it's cropping pattern.The intensity of cropping varies across the middle reaches and tail-end villages because of limited irrigation availability in the latter. With the limited area under cultivation, increases in agricultural production through the adoption of hybrid seeds, fertilisers and pesticides depends largely upon the expansion of irrigation. In the present chapter, an attempt has been made to examine the inter-linkages between irrigation, cropping pattern and rural employment.

The central argument of this chapter is that the changes in the cropping pattern have brought down the level of wage employment, particularly wage employment in the farm sector. In the absence of regular employment in agriculture, the available non-farm casual employment in both private and public works is inadequate to provide similar levels of employment to female wage workers as was the case prior to the cropping pattern change. To put it differently, the change in cropping pattern has resulted in the creation of a large labour reserves of female workers. The level of employment in both farm and non-farm sector declines towards the tail end due to the changes in the cropping intensity, and also because of connectivity and access to alternative employment opportunities in neighbouring villages and urban areas. The chapter tries to support this argument with

evidence on micro-processes at the village level based on empirical material and existing studies.

The introduction of irrigation induced technologies increases employment in the farm sector through a) an increase the cropping intensity; b) an increase in production levels, by cultivating multiple crops per season and by bringing more area under cultivation; and c) the reduction of risk of crop failure in case of rainfed crops (Ahmed and Sampath 1992). The other factors which affect labour use in agriculture are farm size and alternative technologies and techniques used for cultivation (Basant 1987).[46] Techniques such as use of bio-chemical inputs in cultivation affect labour use positively, while mechanisation has a negative impact on labour use, particularly for some individual crops such as rice and wheat. And with the expansion in irrigated area the use of machinery increases as well. That is the use of irrigation stabilise and improves the production levels and results in higher per acre earnings as compare to unirrigated land, and the rise in crop incomes increases the access to other agricultural means of production among cultivator households. However, the increase in capital investment in terms of new technology (such as irrigation, machinery and other bio-chemical fertilisers) has not only increased agricultural productivity but labour productivity as well. It has resulted in the growth of non-farm employment rather than farm employment (Himanshu *et.al.* 2016), because irrigation and other technologies have both forward and backward linkages with non-farm employment.Through backward linkages, with the increase in the demand for chemical fertiliser, pesticides and other bio-chemical inputs, there will be a rise in employment in manufacturing industry. Whereas the uses of irrigation induced technology results in higher production levels and provides higher employment in transport, procurement, distribution, trade and so on (Basant 1987).

The agrarian structure of the country has been changing over the last two decades, with implications for employment. The size of land holding is becoming smaller, and wage

[46] By alternative technology and techniques, Basant (1987) referred to any innovation, whether bio-chemical or mechanical which affects labour use per unit of output.

employment in agriculture is declining (Rawal 2013.).[47] The studies based on secondary data also point out that there is larger dependency on non-farm casual employment and the work force in the rural labour market is not solely dependent on agriculture (Himanshu *et.al.* 2016 and Jatav and Sen 2013). But it is also difficult to separate non-farm wage workers from agricultural manual workers as workers in rural India are involved in miscellaneous farm and non-farm wage work (Ramachandran 2011).[48]

Between 2004-05 and 2009-10, there has been a shift from regular and self-employment to casual employment in the non-farm sector for both male and female workers (Jatav and Sen 2013). With this background, in which employment opportunities have gone down in the agricultural sector and the casualisation of employment has increased in recent years, the chapter mainly focuses on the impact of changes in cropping pattern and irrigation on employment structure in the Gang canal region, besides exploring the access to non-farm employment opportunities in the region.

The chapter is divided into five sections. The first section discusses the occupational structure of the workers by analysing their primary occupation status. The second section is an analysis of the impact of cropping pattern changes on casual wage employment in the farm sector in 25 F along with a brief analysis of non-farm sector employment as well. For this, reports based on an earlier survey of conducted in 25 F in 2006-07, by the Foundation for Agrarian Studies is used as a comparative benchmark. The chapter also explores whether the non-farm sector is able to provide employment to the displaced workers from agriculture. To understand employment intensity, the labour days of paid work performed outside household units have been analysed. Further, these labour days are calculated in 8 hour work days. The third section looks at the relation of irrigation and wage employment by analysing the labour days in the farm and non-farm sector in the middle reaches and tail end village. The fourth section examines the pattern of and

[47] The few other studies which discuss labour use in agriculture, are Bhalla (1981), Bharadwaj (1974), Binswanger (1978), Ishikawa (1981), Laxminarayan (1981) and so on.
[48] Classification of manual workers was done on the basis of incomes and labour ratio by Ramachandran (2011). A detailed discussion on these classes is given in Ramachandran, Swaminathan and Rawal (2010).

changes in wage rates, by analysing the average wage in the farm and non-farm sectors. And the last section summarises the major findings of the chapter.

6.2 *Occupational Structure in the Villages*

The occupational structure of the rural work force is determined by the agrarian structure and the development of agriculture in the particular region or village, especially the use of irrigation and machinery.[49] Apart from this, other factors such as educational levels, expansion of non-farm sector, access to market and demographic structure also play an important role in the determination of the occupational structure of a village. The declining share of agriculture in GDP (with small fluctuations) and the growing non-farm casual employment because of unavailability of regular employment, have led to a diversified occupational structure in rural India (Himanshu *et.al.* 2016, Thomas 2014 and 2012).

The categories of occupation in the surveyed villages have been defined based on the self-identified primary occupation of household members. The analysis is only for the working population of age group 15-59 years. In 25 F, 64 per cent of population of this age group was part of the work force in 2015 (Table 1).[50] The share of males and females in the relevant age group in the work force was 87 per cent and 40 per cent respectively. Out of the remaining 60 per cent of the female population, a large proportion was performing unpaid household work which by definition is not included in economic activity.

Of the total work force, 63 per cent male workers were either cultivating land or were working as farm labourers.[51] The proportion of female workers in the non-farm casual

[49] See Dhawan 1994a and 1984, Bhalla 2007, Rawal 2001b and 2013, Bhalla S. 1989, Stone 2004, Krishna Rao 1993, Jairath 1984 and 1986, Jaglan 1990, Shah and Kumar 2008 for details.
[50] The work force and labour force are identified using NSSO definitions. The population which is economically active, i.e., employed and unemployed who are seeking for work, is included in the labour force (NSSO 2014). And work force is a proportion of employed population (*ibid.*)
[51] NSSO uses three broad categories to identify workers: self-employed, casual worker, regular employees (NSSO 2014. The worker who works in household enterprises as own-account worker, or as an employer or as helper, are included in the category of self-employed; the worker who does not have a secure job or

work force is higher than that for male workers because of the larger participation of female workers in the Mahatma Gandhi National Rural Employment Guarantee Scheme, (MGNREGS hereafter). The share of farm workers and cultivators in 25 F, according to Census of India 2011was 64 per cent and 19 percent respectively (Appendix 6A.1). Both the Census and village surveys point to two features of employment in 25 F: a) a small proportion of working population are engaged in cultivation as the land is highly concentrated among few households in the village, and b) female workers are primarily wage workers in the farm or non-farm sector.

Table 6.1: *Occupational structure of population in 15-59 years age group in 25 F, by gender, 2015*

Occupation category	Male		Female		All	
	Number	Share (per cent)	Number	Share (per cent)	Number	Share (per cent)
Cultivation and animal husbandry	107	27	11	6	118	21
Farmworkers (casual)	143	36	64	36	207	36
Non-farm worker (casual)	68	17	82	47	150	26
Regular/salaried work	31	8	10	6	41	7
Self-employment/ business	44	11	9	5	53	9
Total	393	100	176	100	569	100

Note: For the classification, the primary occupation reported by the household members is used. Domestic work and students are not included in the classification by using NSSO definition for work force participation which is a proportion of employed population to the total population (NSSO 2014).
Source: Survey data 2015.

The proportion of workers with regular employment along with self-employment, remained low in case of both male and female workers (Table 6.1). The study by Jatav and Sen (2013) on NSSO data has shown that the proportion of self employed workers

employment, and whose occupation, wages etc are also not fixed, is generally included in the casual work force; and the worker who is employed either on regular wages or salaries are considered as regular employees by NSSO (GOI 2014). The casual workforce here is further divided into farm and non-farm workers and self employment in agriculture and non-farm activity is also analysed separately.

and workers employed on regular basis has gone down in rural India and that there is a higher level of casualisation in the non-farm sector. In village 25 F also, only 7 per cent of working people have employment on regular basis and a very high proportion (62 per cent) of workers is working on casual basis.

The work force participation in the tail end village (63 F) was 65 per cent in 2015 which is almost similar to the middle reaches village (25 F). The work force participation rate for men and women is 77 per cent and 52 per cent respectively. Agriculture still plays an important role in the economy of 63 F, with a significant proportion of male workers (49 per cent) reporting their main occupation to be cultivation. As discussed in the previous chapter, 82 per cent of the total households in the village have operational holdings, of which 31 per cent are marginal and small cultivator households. The workers from these households have reported casual employment in the farm or non-farm sector to be their primary occupation rather than cultivation. In 63 F, 26 per cent of male workers, reported that the non-farm sector was their primary source of employment. In the case of women workers, a significant proportion (73 per cent) of the work force was employed on a casual basis in both the farm and non-farm sectors.

In short, agriculture remains the primary source of employment among male workers in both surveyed villages. In 25 F, 63 per cent of male workers are either cultivators or casual wage workers and the proportion of cultivators and agricultural wage workers in 63 F is 74 per cent (Tables 6.1 and 6.2). However, in the case of female workers, non-farm wage employment (for 47 per cent) is the primary source of employment in 25 F but in 63 F a higher proportion of female workers are wage workers in farm sector (43 per cent).

Wage workers in both the surveyed villages worked as long-term workers in farm and related work. These contract workers were paid either a fixed amount or where given a share of the produce(generally 1/6 share of produce). In the agricultural year 2014-15, there were 69 male workers who worked as long-term workers in farm and related

activities in 25 F. Apart from these, another 27 workers (4 males and 23 females) had worked as long-term workers in non-farm activities such as cleaning houses etc.

Table 6.2: *Occupation structure for the population in 15-59 years age group in 63 F, by gender, 2015* in number and per cent

Occupation category	Male		Female		All	
	Number	Share (per cent)	Number	Share (per cent)	Number	Share (per cent)
Cultivation and animal husbandry	64	49	15	19	79	37
Farm workers (casual)	33	25	34	43	67	32
Non-farm worker (casual)	21	16	24	30	45	21
Regular/salaried work	5	4	4	5	9	4
Self-employment/ business	8	6	3	4	11	5
Total	131	100	80	100	211	100

Note: For the classification, the primary occupation reported by the household members is used. Domestic work and students are not included in the classification by using NSSO definition for work force participation which is a proportion of employed population to the total population (NSSO 2014).
Source: Survey data 2015.

Of the total households, workers from 25 households had worked as share contract long-term workers (*siri*) in 25 F. These workers had to bear the labour cost for the hired workers needed to cultivate the land of the employer and in return they were paid a share of the crop. The households which received a share of produce as wage payment mostly employed family members to cultivate the land. All other costs of cultivation, such as cost of seeds, manure, fertiliser, machinery, irrigation, etc. are borne by the employer household. The decision on cropping pattern and other decision relating to cultivation are taken by the employer households. The primary reason to work on share contract is the decline in casual wage employment in agriculture.

There were 8 long-term workers (all male) in 63 F employed on fixed wages during 2014-15. Out of these 8 workers, 7 workers were employed exclusively for irrigation work and in return were paid a fixed amount annually. Also, workers from 9 households

in 63 F had worked as share contract long-term workers. The share wage contracts in 63 F were similar to 25 F. All other wage workers in agriculture were employed on casual basis (daily or piece-rated contracts).

The above discussion reveals that while agriculture is providing employment opportunities to a majority of households in the region, the workers in rural areas are dependent on the non-farm sector as well, in order to earn a subsistence wage. Therefore, to understand the employment opportunities in the non-farm sector, the days of work performed outside farm activities are classified into various categories (Tables 6.3 and 6.4).

Tables 6.3 and 6.4 point out that out of total employment provided by the non-farm sector, the proportion of regular employment which has relatively stable income and job security, is very low (12.6 per cent in 25 F and 6.3 per cent in 63 F).The workers who are regularly employed for limited time periods, as anganwadi workers, mid-day meal cooks and so on, and have also worked under MGNREGS because their earning from regular work is not able to provide adequate income for a living. Workers who were self-employed in the non-farm sector or had small businesses such as petty-shopkeepers, tailors etc (19 per cent in 25 F and 10 per cent in 63 F) also worked under the MGNREGS. The income generated from these small investment businesses accounts for a significant share of the earnings of poor rural households. But as these businesses and petty production activities involve low investment and since the income earned from them is insufficient to make both ends meet,[52] the workers from these households work on casual wages as well, though the number of days of employment reported by these workers varied across households. The high income group households have investments in large scale businesses in both surveyed villages. The largest share of employment provided in the non-farm sector is on a casual basis. The proportion of workers employed on casual contracts is 68.2 per cent in 25 F and in case of 63 F, the share is extremely

[52]The type of employment for workers who are working as self-employed along with casual manual work has been identified using the number of days of work performed in either classification.

high (84 per cent).The availability of such casual work is also dependent on the varying demands of agricultural households (Tables 6.3 and 6.4).

Table 6.3: *Composition of non-farm workers by type of employment, 25 F, 2014-15*

Type of employment	Number	Share (per cent)
Casual manual employment	255	68.2
Regular/salaried	47	12.6
Self-employment/business	72	19.3
All	374	100

Note: The days of work performed outside farm activity are included in classification.
Source: Survey data 2015.

Table 6.4: *Composition of non-farm workers by type of employment, 63 F, 2014-15*

Type of employment	Number	Share (per cent)
Casual manual employment	134	83.8
Regular/salaried	10	6.3
Self-employment/business	16	10.0
All	160	100

Note: The days of work performed outside farm activity are included in classification.
Source: Survey data 2015.

Studies (Thomas 2012, Jatav and Sen 2013 and Himanshu *et.al.* 2016) based on NSSO data and also some village studies (Dhar and Kaur 2013 and Himanshu *et.al.* 2016) have found evidence of growing rural non-farm employment with an increase in casualisation. The highest growth in the last decade has been in the construction sector. However, the quality and stability of employment has declined over the years (Chandrasekhar and Ghosh 2006).

Engagement in low investment businesses or self-employment including unskilled non-farm labour, which also accounts for a significant share of incomes for rural households, is generally reported by rural poor households rather than the households with high income levels (Haggblade and Hazell 1989).

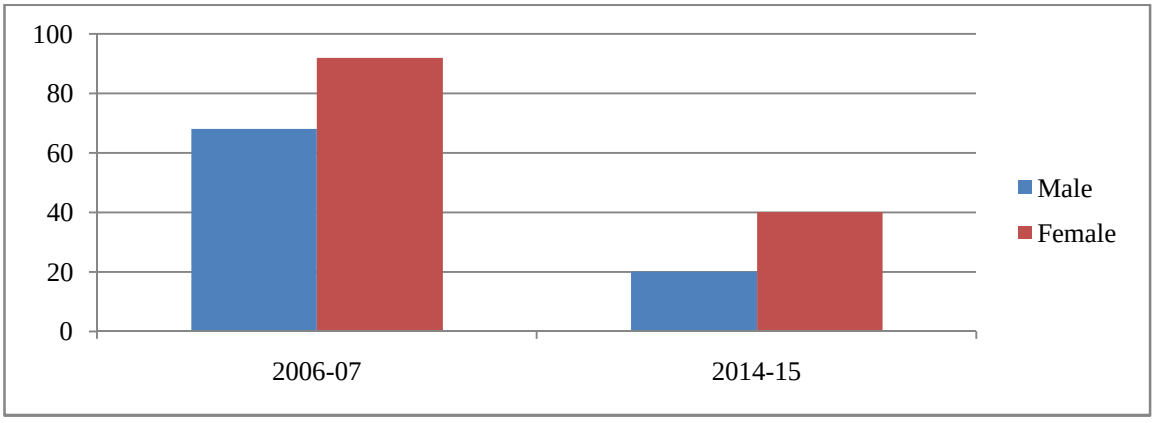
To sum up, the work force in both the surveyed villages levels have high levels of dependence on agriculture for employment whether as cultivators or as casual workers in

agriculture. The share of the work force in regular and self-employment remains minimal in both villages. Because of larger dependency on agriculture for employment, it is important to understand the changes in the wage employment in the farm sector over the period from 2006-07 to 2014-15 due to changes in the cropping pattern. The analysis across the middle reaches and tail end villages is important also because of the differences in the water accessibility which not only affects the cropping pattern and intensity but also the socio economic structure of the village.

6.3 *Changes in the Employment Structure*

As mentioned earlier, with the changes in production conditions in the agricultural sector, the structure and composition of the work force has also changed. Between 2006-07 and 2014-15 the cropping pattern of village 25 F saw a huge increase in the area under guar cultivation in the kharif season. A significant proportion of land under cotton cultivation had been taken over by guar, because of a sudden increase in guar prices and lower availability of irrigation (as mentioned in the previous chapter). The cotton crop which is a labour intensive crop, particularly in harvesting and post-harvesting operations, has been substantially replaced with guar, a machine intensive crop. Also over this particular period, other crops such as wheat and rapeseed also witnessed a rise in the use of machinery for various agricultural operations. So, with more mechanisation production relations have changed in the village.

Chart 6.1: *Share of workers working exclusively in farm sector in 25 F*, per cent



Source: Survey data and Rawal (2013).

Table 6.5: *Share of casual workers, by sector, in 25 F, 2014-15,* in number and per cent

Sector	Male		Female		All	
	Number	Share (per cent)	Number	Share (per cent)	Number	Share (per cent)
Farm	40	20	70	40	110	29
Non-farm	56	27	39	23	95	25
Both	109	53	65	37	174	46
Total	205	100	174	100	379	100

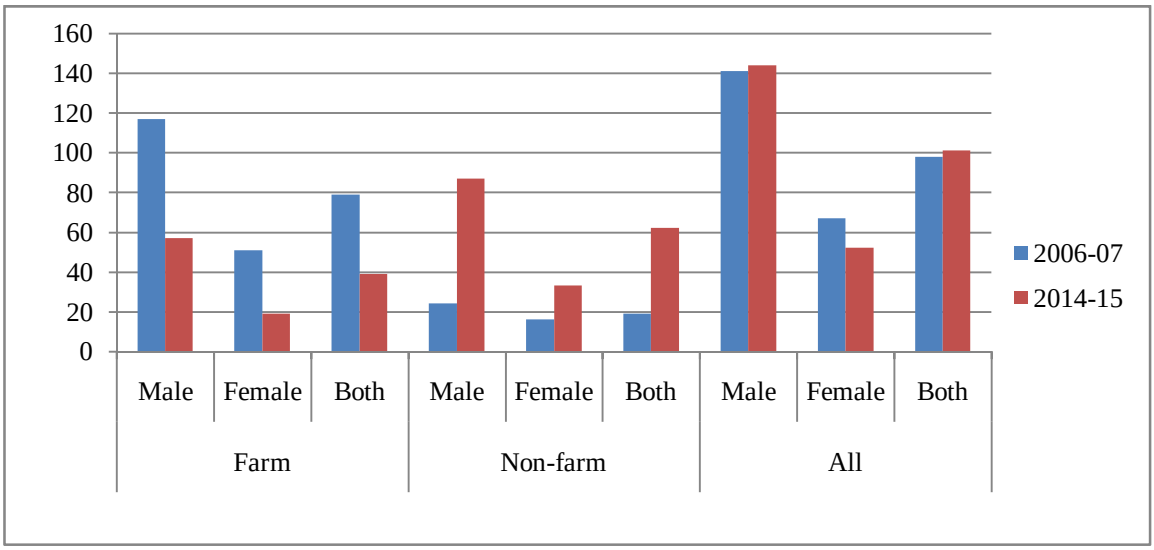
Source: Survey data 2015.

According to the report based on the earlier survey of the village in 2007, a significant proportion of casual workers, both male and female, were exclusively wage workers in agriculture, amounting to 68 per cent and 92 per cent respectively (Rawal 2013 and Chart 6.1). The period between 2006-07 and 2014-15 has seen an increase in the share of workers in the non-farm sector and the proportion of workers working exclusively as casual workers in agriculture witnessed a decline because the high level of mechanisation has pushed workers out of agriculture. As a result of this, 27 per cent of male workers are working exclusively in the non-farm sector on casual wages and a majority of the male workers (53 per cent) are engaged in both the agricultural and non-agricultural sectors (Table 6.5). In the case of female workers, 40 per cent are still exclusively wage workers in agriculture and 37 per cent work in both agriculture and non-agriculture.

Since the mobility towards the cities and towns is lower among female workers as compared with male workers, a large proportion of female workers are working exclusively in the farm sector. For the same reason, the major source of employment in the non-farm sector for female workers is under the MGNERGS. The studies by Abraham (2009) and Chandrasekhar and Ghosh (2007) based on NSSO data for the period between 1999-2000 and 2004-05, which found an increase in female labour participation in agriculture, explained that trend as a distress driven response. And the later decline in the female work force in agriculture from 2004-05 to 2009-10 was attributed to the improvement in the economic conditions of households (Thomas 2012

and Abraham 2013).But female workers in 25 F have been displaced from agriculture between 2006-07 and 2014-15, due to the contraction of wage employment in agriculture.

Chart 6.2: *Average days of casual work in farm and non-farm sector, 25 F* in number



Source: Survey data and Rawal (2013).

Table 6.6: *Average days of casual work by gender in 25 F, 2014-15* in number

Gender	Farm	Non-farm	All
Male	57	87	144
Female	19	33	52
Both	39	62	101

Source: Survey data 2015.

The other important indicator of employment structure is days of employment, which has also shown a decline in agricultural wage work for both male and female wage workers. In the earlier study of 25 F, Rawal (2013) had found that the average days of farm employment among casual workers was 117 days and 51 days respectively for male and female workers. With the introduction of a more mechanised crop in the kharif season and the intensive use of machines in cultivation, the average number of days wage employment in agriculture for female workers has gone down drastically from 51 days to 19 days, or by around 69 per cent. Thus, changes in the production process in rural areas

has affected wage employment in agriculture in two ways: first, by displacing workers in agriculture with machines; and, secondly, by reducing the average days of wage work.

However, wage employment in the non-farm sector has witnessed an increase as the average days of employment for manual workers has increased by 226 per cent. In 2007, male workers obtained wage employment in the non-farm sector for an average of 24 labour days in a year and average days of employment for female workers was even lower (16 labour days in a year) (Rawal 2013). In 2014-15, the average number days of non-farm employment had risen to 87 days for male wage workers and 33 days for female wage worker. This sharp increase in non-farm employment is mainly because of the introduction of MGNREGS in the year 2007. During 2006-07 there was no government scheme for employment in the region. The increase in non-farm employment did, however, not amount to increased overall employment for female workers. The average days of total employment (farm and non-farm combined) for female workers was lower in 2014-15 as compared with 2006-07. This was because female workers have been traditionally involved in wage employment only in the agricultural sector, and such employment has declined significantly. Rather than better opportunities for employment the trends point to displacement of workers from agricultural wage employment, which has pushed them to work in the non-agricultural sector, particularly in the case of female workers.

The data provided in Table 6.7 reveal how mechanisation and change in cropping pattern have affected the average wage days of employment of manual workers in specific crops. Guar, cotton, wheat and rapeseed are four major crops in 25F which provide most of the farm employment opportunities in both rabi and kharif seasons. The average days of casual employment has increased only in the cultivation of the guar crop, because of the increase in the area under guar cultivation. In the period between 2006-07 and 2014-15, the share of guar crop in the gross cropped area has increased by 33.5 per cent (previous chapter).

Table 6.7: *Average days of casual employment, crop and year wise, 25 F* in number

Crop	2006-07	2014-15
Guar	1	13
Cotton	46	11
Wheat	18	4
Rapeseed	13	6
All crops	81	39

Source: For 2006-07 data Swaminathan and Rawal (2016) and for 2014-15 survey data.

The area under cotton, which is also a kharif season crop, as a proportion of gross cropped area has fallen by 18.1 percentage points, resulting in a decline in the number of days of wage employment in cotton cultivation. The rise in the area under guar cultivation as a proportion of gross cropped area was much higher than the decline in the area under cotton cultivation. But the average days of casual employment in cotton crops have declined more than the increase in the average days of wage employment in guar. This is because cotton is a labour intensive crop in which all harvesting and post harvesting operationssuch as picking, uprooting bushes and transporting are labour intensive, while guar is a capital intensive crop in which harvesting and threshing is done by combine harvester. The land preparation and sowing were mainly mechanised operations even in 2006-07 in the case of both crops.

The average days of casual work in wheat and rapeseed has also declined because of more machine-centric cultivation. Harvesting and threshing of both wheat and rapeseed are also highly mechanised operations. In 2006-07 harvesting and weeding of wheat and rapeseed was mainly undertaken by casual wage workers, while now it has also become more mechanised. In other words, use of technology has increased the productivity of labour and affected employment opportunities in agriculture negatively. While cotton cultivation predominantly provided employment during the picking season, the cultivation of highly mechanised crops restricted manual employment to few specific operations.

Table 6.8: *Agricultural employment in different crop operations, by gender, 25 F, 2014-15*

Crop operations	Male		Female		All	
	Average days (number)	Share in total days (per cent)	Average days (number)	Share in total days (per cent)	Average days (number)	Share in total days (per cent)
Land preparation and Sowing	7	12.4	0	0.1	4	9.6
Weeding	9	16.2	1	4.4	5	13.6
Irrigation	7	12.0	NA	NA	4	9.3
Other intercultural operations	4	6.9	NA	NA	2	5.4
Miscellaneous	6	10.9	0	0.9	3	8.7
Harvesting and post-harvesting operations	23	41.6	18	94.5	21	53.5
All	56	100	19	100	39	100

Source: Survey data 2015.

As a result of these trends the major share of employment in the farm sector is in harvesting and post-harvest operations for both male and female workers in 25 F. The gender division for different agricultural operations is very prominent, as wage employment in land preparation, sowing and irrigation operations is available only to male workers. The intercultural operations including weeding is also dominated by male workers. Female workers on an average received wage employment in weeding for only one day. Harvest and post-harvest operations were open to female workers, but the average days of wage employment was higher for male workers.

Over the years, the changes in the agrarian economy have not only brought out changes in the structure of farm wage employment in the surveyed villages but led to a transformation involving the following

a) The gross cropped area of the villages increased, with the increase in guar cultivation. But, this was accompanied by a decline in the area under cultivation of the cotton crop,

which had higher per acre expenditure on various agricultural inputs, including labour. The average per acre expenditure on a cotton crop was almost twice the expenditure on guar cultivation. The increased area under cultivation of guar could not provide employment to the displaced workers from the cotton crop, as most of the agricultural operations for guar were machine based.

b) The average days of employment for female workers have declined, despite the rise in non-farm employment, as their access to wage employment in the non-farm sector was and is limited.

6.4 *Difference in the Employment Opportunities within the Region*

Production conditions vary within a region because of the control over land, means of production and water resources. As pointed out earlier, 69 per cent households are landless in 25 F and depend upon wage labour for their livelihood (previous chapter). On the other hand, 91 per cent of households in 63 F have ownership of land, though the majority of these are small and marginal cultivators (previous chapter). But with the decline in per acre irrigation towards the tail end, the cropping pattern and productivity were affected. The earning from agricultural land was not adequate and therefore workers from these households took up wage work in both the farm and non-farm sector.

In 25 F, of all wage workers, 75 per cent are working in the farm sector, but in the case of 63 F, the share of wage workers employed in agriculture is 58 per cent. The small scale of cultivation, lower access to irrigation and greater use of machinery for cultivation in 63 F results in lower expenditure on hired manual workers. In the case of 25 F, because of the higher gross cropped area, better access to irrigation and land concentration, households still depend upon hired wage workers for specific agricultural tasks. The limited wage work in agriculture requires workers to depend upon the non-agricultural sector for wage work in 63 F. Therefore, 42 per cent workers are exclusively working in the non-farm sector in 63 F. The important source of non-farm employment is work under MGNREGS in 2014-15 for both male and female workers.

Table 6.9: *Share of casual workers, by sector, in 63 F. 2014-15* number and per cent

Sector	Male		Female		All	
	Number	Share (per cent)	Number	Share (per cent)	Number	Share (per cent)
Farm	29	26	32	37	61	31
Non-farm	52	46	32	37	84	42
Both	31	28	23	26	54	27
Total	112	100	87	100	199	100

Source: Survey data 2015.

The category of casual workers in the farm and non-farm sector has a concentration of workers from Dalit households. In the case of 63 F, the workers from all castes worked on a casual basis. But in 25 F, it is mainly individuals from Dalit households who are working as casual workers. The workers from Jat Sikh and other OBC castes are engaged either in cultivating land or are employed on a regular basis in the government or private sector in 25 F. A majority of Dalit households in 25 F are dependent on wage incomes from agriculture and non-agriculture. In the case of Dalit households in 63 F, which constitute 81 per cent of households in the village and have small or marginal operational holdings, wage employment is one among the important sources of earning.

Table 6.10: *Share of casual workers by caste group and gender, in 25 F and 63 F, 2015* in per cent

Village	Gender	Caste group		
		OBC	SC	All
25 F	Male	3	97	100
	Female	4	96	100
	All	3	97	100
63 F	Male	17	83	100
	Female	7	93	100
	All	13	87	100

Source: Survey data 2015.

The structure of wage employment in both the villages is also different. The employment intensity is higher in 25 F, with a causal worker obtaining on average employment for

101 days in a year (Table 6.7). But 63 F lags far behind because a casual worker gets employment for only an average of 43 days in a year. A similar pattern is visible in the employment structure of male workers of both the surveyed villages. However, employment intensity among female workers in both the villages is much lower.

The average number of labour days provided by farm and non-farm employment are an important indicators of access to employment in the different sectors. The scale of casual employment in farm and non-farm sectors is lower in 63 F for both male and female workers as compare to 25 F. In the case of 63 F, male workers were employed for only 62 days in 2014-15, while female workers were employed for 42 days. The ratio of male to female casual wage employment in 25 F was 114:52 (Table 6.7). The reason for lower days of employment for both male and female workers in 63 F was the limited presence and diversification of the non-farm sector in the village.[53]

Table 6.11: *Average days of casual work, by gender, in 63 F, 2014-15* in days

Gender	Farm	Non-farm	All
Male	21	41	62
Female	21	21	42
Both	21	32	53

Source: Survey data 2015.

Within agriculture in 63 F, the highest number of days of employment are in harvest and post-harvest operations for both male and female workers. As in 25 F, male workers obtained a higher average number of days of employment not only in land preparation, sowing operations and irrigation, but also weeding, and other intercultural operations (Table 6.8). In 63 F, the average days of wage employment in harvest and post-harvest operations are higher by 6 days for female workers as compared to male. Other than these agricultural operations, female workers are working only in weeding. In both the villages harvesting and post-harvesting work, such as loading-unloading, cleaning fields etc are the main source of agricultural employment for both male and female workers.

[53] Detailed discussion on this is in the next section.

Table 6.12: *Agricultural employment in different crop operations, by gender, 63 F, 2014-15* in days and per cent

Crop operations	Male		Female		All	
	Average days (days)	Share in total days (per cent)	Average days (days)	Share in total days (per cent)	Average days (days)	Share in total days (per cent)
Land preparation and Sowing	1	6.3	NA	NA	1	3.5
Weeding	2	10.2	1	4.7	2	7.8
Irrigation	1	2.8	NA	NA	0	1.6
Other intercultural operations	0	0.8	NA	NA	0	0.4
Miscellaneous	3	13.0	NA	NA	2	7.3
Harvesting and post-harvesting operations	14	67.0	20	95.3	17	79.4
All	21	100	21	100	21	100

Source: Survey data 2015.

6.5 *Diversification of Non-farm Employment and Mobility*

While employment opportunities in agriculture were shrinking, the non-farm linkages created by irrigation induced technology not only increased employment opportunities but also the integration process of rural and urban areas (Himanshu *et.al.* 2016 and Hagglade and Hazell 1989). .

In the village (25 F) which is close to a town (Kesarisinghpur, at a distance of 12 kilometers), the proportion of male workers who are engaged in both farm and non-farm work was 53 per cent.[54]

MGNREGS and construction related work are two major sources of non-farm employment in 25 F. In 2014-15, the work of cleaning and maintaining irrigation channels was under MGNREGS in both the survey villages. Female wage workers in 25

[54] Days of employment of long term workers are not included in the analysis.

F, however, do not have the same access to diversified non-farm wage employment. Because of socially discriminatory norms they have much less mobility as compared with their male counterparts. Therefore 68.8 per cent of the days of non-farm employment they obtained were in the public works under MGNREGS within the village. Apart from this, the remaining 30.4 per cent of days of wage employment were in domestic work (16.2 per cent) and construction work (14.2 per cent). Wage employment in casual work was more diversified for male workers, with the largest number of days of employment being in construction and related activities (66.9 per cent). Other than construction, transport related work, loading and unloading, MGNREGS employment, work as carpenters and blacksmiths, and wage employment in domestic work were the main types of non-agricultural work in the village. There were very few opportunities for technical or skilled work in repairing, welding, plumbing etc for male workers in 25 F.

Table 6.13: *Distribution of number of days of non-farm employment, by type of work and gender, 25 F, 2014-15*

Occupation categories	Male		Female		Both	
	Average days (number)	Share of labour days (per cent)	Average days (number)	Share of labour days (per cent)	Average days (number)	Share of labour days (per cent)
MGNREGS	7	8.3	23	68.8	14	22.9
Construction work	59	66.9	5	14.2	34	54.2
Transport related work	8	9.5	0	NA	4	7.2
Loading and unloading	6	7.2	0	NA	3	5.4
Domestic work	1	1.7	5	16.2	3	5.1
Carpenters and blacksmiths	2	1.7	0	NA	1	1.3
Technical jobs (motor mechanic, welding, plumbing)	0.3	0.3	0	NA	0.2	0.3
Other work	4	4.5	0.3	0.8	2	3.6
Grand Total	87	100	33	100	62	100

Note: NA: not applicable.

Source: Survey data 2015.

An important feature of non-farm employment that needs to be noted is that employment generated in construction is also very temporary in nature. The sudden rise in construction sector employment was because of the spike in area under guar. As noted, because of the decline in the quality of irrigation over the years and the rise in the market price of guar, the cropping pattern has changed. With the introduction of guar crop, the gross cropped area increased and this resulted in an increase in crop incomes during the kharif season. The sudden increase in farm incomes among cultivator households led to enhanced expenditures on house construction. To put it differently, the casual non-farm employment generated in the private sector is also related to the agricultural transformation of the region.

In 63 F, casual employment in unskilled work, particularly construction (55.8 per cent of labour days) and MGNREGS employment for male workers, were major sources of non-farm employment for male workers. However, for female wage workers in 63 F the only source of non-farm employment was the MGNREGS.

Table 6.14: *Distribution of number of days of non-farm employment, by type of work and gender, 63 F, 2014-15*

Occupation categories	Male		Female		Both	
	Average days (number)	Share of labour days (per cent)	Average days (number)	Share of labour days (per cent)	Average days (number)	Share of labour days (per cent)
MGNREGS	16	38.2	21	100	18	55.9
Construction work	23	55.8	0	NA	13	39.8
Transport related work	1	1.3	0	NA	0.3	0.9
Carpenters and blacksmiths	2	3.9	0	NA	1	2.8
Technical jobs (motor mechanic, welding, plumbing)	0.3	0.8	0	NA	0.2	0.6
All	41	100	21	100	32	100

Note: NA: not applicable.
Source: Survey data 2015.

Therefore, wage employment among workers in 63 F was less diverse as compared with the workers in 25 F, particularly in the case of female workers. The diversification of the non-farm sector in both the villages is the outcome of changes in the agricultural production process of the region or village, as non-farm activities depend not only on the pattern of farm input use but also on the consumption demand of farmer households (Haggblade and Hazell 1989).

Male workers in 25 F, had higher mobility for work, as they had access to non-farm employment in neighbouring villages and towns. Out of the total days of non-farm employment, 63 days (73 per cent) work in wage employment were performed outside the village. In the case of female wage workers access to non-farm employment was mainly within the village primarily as wage workers in MGNREGS. Male workers worked outside the village in construction work, transport related works, and in loading and unloading tasks.

Table 6.15: *Non-agricultural employment by category of place of work, by gender, 25 F, 2014-15*

Place of work	Male		Female		All	
	Average days (number)	Share in total days (per cent)	Average days (number)	Share in total days (per cent)	Average days (number)	Share in total days (per cent)
Within village	21	24	29	89	25	40
In neighbouring villages and towns	63	73	4	11	36	58
All over Country	2	3	NA	NA	1	2
All	87	100	33	100	62	100

Source: Survey data 2015.

63 F is the village at the tail end which is a peripheral area. So the workers of 63 F have very limited access to non-farm employment in the urban areas. The mobility for

employment among male workers in 63 F was much less than for their counterparts in 25 F. Female workers also did not get any opportunity for wage work outside the village. Out of the total 32 days of wage employment for both male and female workers, 20 (63 per cent) were performed within the village. Construction work was a major source of mobility towards neighbouring villages and towns. Other studies on employment have pointed to an increase in the diversification of non-farm employment (Himanshu *et.al.* 2016, Harriss and Jeyaranjan 2014). These studies also indicated that the mobility towards urban areas for non-farm employment is higher among poor and marginalised households (*ibid.*).

Other than lower access to urban areas, the reason for limited availability of employment is the low level of government expenditure on employment creation. Thus, the average number of days of work provided by the MGNREGS is lower than the days of work promised under the scheme.

Table 6.16: *Non-agricultural employment by category of place of work, by gender, 63 F, 2014-15*

Place of work	Male		Female		All	
	Average days (days)	Share in total days (per cent)	Average days (days)	Share in total days (per cent)	Average days (days)	Share in total days (per cent)
Within village	20	49	21	100	20	63
In neighbouring villages and towns	21	51	NA	NA	12	37
All	41	100	21	100	32	100

Source: Survey data 2015.

In sum, employment in the farm and non-farm sectors combined is lower in the tail end village as compared with the middle reaches village, not only because of differences in cropping pattern and intensity, but also because of the lower mobility to the neighbouring urban economy, and unavailability of alternative sources of employment.

6.6 *Wage Pattern and Growth*

The structure of wage employment changed in the region after the introduction of MGNREGS and later with the changes in the cropping pattern from cotton to guar. Both these changes brought not only changes in the employment structure of the village but also in the wage rates among casual workers. As pointed out in Dhar and Kaur (2013), the average wage in 25 F was Rs. 97 per day in 2006-07 (in 2014-15 prices).[55] The wage rates among casual workers increased around 2.5 times between 2006-07 and 2014-15. In 2014-15, the average daily wage of causal workers was Rs. 242, with a small difference in farm and non-farm wages. Studies based on NSSO data have pointed out that an increase in the average daily wage occurred after the introduction of MGNREGS in 2007 (see Thomas 2012 and Usami 2012). The implementation of MGNREGS empowered the workers to negotiate wages, particularly in rural areas. Secondary data on wage rates has shown an increase of 7.4 per cent in wages in the agricultural sector between 2004-05 and 2011-12, while the increase in wages in the non-agricultural sector was 4.5 per cent (Mahendra Dev undated). The increase in agricultural wages much higher between 2004-05 and 2011-12, than between 1993-94 and 2004-05 (2.24 per cent) (*ibid.*). Similarly, the wage trends in Rajasthan have shown an increase (compound annual growth of 1.22 per cent) between 2004-05 and 2011-12, in average daily wages (Kaur 2016).

The average daily wage of casual workers in Rajasthan in 2011-12 was Rs. 299 (in 2014-15) as reported in the NSSO survey, which is higher than the prevalent wage rate in the surveyed villages in 2014-15, though the introduction of the MGNREGS increased wage rates. However, given limitations of the available data and the unavailability of village data for 2011-12, it is difficult to reflect on the changes in the wage rate after the changes in cropping pattern towards a mechanised crop in the region.

[55]The average was in 2006-07 prices was Rs. 47/day, the wage is converted to 2014-15 prices by using CPI RL (consumer price index - agricultural labourer).

Table 6.17: *Average daily wage of casual workers in agriculture and non-agricultural sector, 2014-15* in Rs.

Sector	Average daily wage	
	25 F	63 F
Agriculture	239	260
Non-agriculture	245	240
All	242	248

Source: Survey data 2015.

The average daily wage of farm workers is higher in 63 F as compared to 25 F. Contrary to 25 F which has large scale landlessness and dependence on wage employment for livelihood, 81 per cent of households in 63 F have operational holdings, and the household members from these households work on their own operational holdings. As wage employment in agriculture is available in the peak season of harvesting, which provides the workers from these households with smaller plots a higher wage rate on an average, the majority of work performed in agriculture by the wage workers in the surveyed villages is in piece-rated contracts.

Table 6.18: *Average daily wages of casual workers, by gender in 25 F, 2014-15* in Rs.

Gender	Agricultural	Non-agricultural	Both
Male	256	280	271
Female	177	131	148
Both	239	245	242

Source: Survey data 2015.

Table 6.19: *Average daily wages of casual workers, by gender in 63 F* in Rs.

Gender	Agricultural	Non-agricultural	Both
Male	278	293	288
Female	237	110	174
Both	260	240	248

Source: Survey data 2015.

The difference in the average wage of workers between the two surveyed villages was because of higher wage levels among the female workers. The use of machines in the harvesting of wheat and barley is lower in case of 63 F, whereas in 25 F both harvesting

and threshing operations are primarily mechanised. This results in provision of piece-rated harvesting contracts to both male and female workers. As a result the average wage of female workers is higher in 63 F.

The average wage in the non-agricultural sector does not show much difference in the middle reaches and tail end village. The average wage in construction work is higher in the tail end village, as 40 per cent of the workers in the construction sector are masons (skilled workers) and receive higher wages than un-skilled construction workers. The share of workers working as masons was only 5 per cent of the total construction sector workers in 25 F and the remaining 95 per cent were labourer or helper in the construction work. As a result of the higher proportion of skilled workers in the construction sector and also carpenters and those in transport related work, the average wages of workers are higher in the tail end village as compare to middle reaches village.

Table 6.20: *Average wages in different non-agricultural casual work, by villages, in 2014-15* in Rs.

Occupation categories	Average wages	
	25 F	63 F
MGNREGA	112	107
Construction work	278	406
Transport related work	313	478
Carpenters and blacksmiths	300	450
Domestic work	161	NA
Loading and unloading	421	NA
Other work	271	NA
Technical jobs (motor mechanic, welding, plumbing)	388	350
All	245	240

Source: Survey data 2015.

The average wage in MGNREGS work in both the villages is much lower than the average wage in non-agricultural work. The MGNREGS wages are also piece-rated. Since female workers in both the surveyed villages work mainly in MGNREGS projects, their non-agricultural wages were much lower than their male counterparts.

6.7 *Summary of Findings*

This chapter is an analysis of the impact of irrigation induced technology and cropping pattern changes on farm and non-farm employment, based on an examination of the structure of the work force and employment intensity in the surveyed villages. Further, the diversification to and mobility to areas of non-farm employment is also examined. The data on employment highlights the following results:

The recent secondary statistics and survey data (of 25 F) indicate that the area under cultivation of guar has gone up. With the increase in cultivation of the less water intensive and more mechanised guar crop in 2009-10, the average number of days of employment in the surveyed villages has gone down. The harvest and post harvest operations in the guar crop are mechanised whereas cotton provided wage employment during the picking season. Even though with the introduction of guar the cropping intensity has increased in the kharif season, this did not have a positive impact on overall farm employment.

Secondly, in 25 F, there is a high level of landlessness (discussed in previous chapter) and a larger share of population in the village is employed in casual wage work (Table 6.1). An earlier study by the Foundation for Agrarian Studies (see Rawal 2013) in the village had noted the higher dependence on agriculture for wage employment, as the dominant proportion of casual workers were involved in wage employment in agriculture. But with the change in employment structure a larger proportion of casual workers are not dependent only on agriculture but have been working in the non-agricultural sector in neighbouring villages and towns, on casual basis in order to earn a livelihood.

Thirdly, in the tail end village, 63 F, the average days of wage employment are much lower than in the middle reaches village, because of decline in cropping intensity and also because of smaller size of operational holdings.

Fourthly, the displaced workers from agriculture are working on casual basis in the non-agricultural sector. But the non-agricultural sector has not been able to provide employment to the same extent as earlier, because of the low level of access to regular employment and diversification. The structure of non-farm employment was diversified for male workers in the village with higher availability of work in the construction sector or in public works (MGNREGS). But wage work in construction sector is also very temporary in its nature. However, in 63 F the scale of non-farm employment was not as wide spread as in the middle reaches village.

Fifthly, casual wage employment for female workers has declined drastically in the surveyed villages (both 25 F and 63 F). The only source of non-farm employment among female workers in the surveyed villages was work under MGNREGS. The two major reasons behind this contraction in casual employment for female workers are a) larger dependency on agriculture for wage employment; and b) no access to non-farm employment other than MGNREGS due to lack of mobility and education.

Sixthly, self-employment as petty shopkeepers, tailors and so on, was not sufficient for economic survival of households belonging to poor or marginalized backgrounds, as these businesses have very low levels of investment and earning (Haggblade and Hazell 1989). Therefore, these self-employed workers also worked in the non-farm sector as casual wage workers (particularly in work under MGNREGS) to meet their livelihood requirements.

Lastly, the average wage rate of casual workers has increased between 2006-07 and 2014-15. In 2014-15, there was not much difference in the average agricultural and non-agricultural wage in the middle reaches villages. The average wage in the MGNREGA is almost 50 per cent lower than the average casual wage in the non-farm sector.

To sum up, the chapter brings out two important trends in employment. Firstly, the cropping pattern change from a labour intensive crop to mechanised crop reduced the level of employment relative to the earlier period. Even with the new opportunities, such

as employment in public works or in the construction sector, the employment intensity of wage workers still remained below levels that prevailed before the changes in the cropping pattern. The female wage workers, who were dependent on agriculture for wage work, are going out of the work force or obtained less than two months of work in a year on an average. As a result of these transitions, large labour reserves are created.

Secondly, the level of employment in both farm and non-farm sectors is substantially lower in the tail end village as compare to the middle reaches village. This is because of the cropping intensity differences and lower access and connectivity to the urban economy. As discussed earlier, the access to irrigation determines the socio-economic structure of the village but its location and infrastructure also affect employment in the non-agricultural sector. Therefore, an important policy conclusion that emerges from the chapter is that both in villages with higher levels of irrigation and relatively advanced agriculture and in villages with less connectivity to the urban economy, public sector employment generation schemes providing productive employment in the farm and non-farm sectors are needed.

Appendix Tables

Table 6A.1: *Proportion of workers involved in cultivation and farm labour in surveyed villages, by gender, 2011* in per cent

Village	Gender	Proportion of workers by occupation category	
		Cultivators	Farm labour
25 F	Male	29.3	51.9
	Female	0.4	85.0
	Person	18.5	64.4
63 F	Male	73.2	8.5
	Female	8.5	87.2
	Person	57.1	28.0

Source: Census of India, 2011

Table 6A.2: *Caste composition of casual workers, by gender, in 25 F, 2014-15*

Caste	Male		Female		All	
	Number	Share in total worker (per cent)	Number	Share in total worker (per cent)	Number	Share in total worker (per cent)
OBC	**6**	**2.9**	**7**	**4.0**	**13**	**3.4**
Jat Sikh	0	0	0	0	0	0
Kumhar	4	2.0	4	2.3	8	2.1
Mehra	1	0.5	2	1.1	3	0.8
Nai	1	0.5	1	0.6	2	0.5
Tarkhan	NA	NA	NA	NA	NA	NA
SC	**198**	**96.6**	**167**	**96.0**	**366**	**96.6**
Bawaria	1	0.5	1	0.6	2	0.5
Majhabi	118	57.6	86	49.4	204	53.8
Meghwal	12	5.9	10	5.7	22	5.8
Nayak	68	33.2	70	40.2	138	36.4
All	205	100	174	100	379	100

Source: Survey data 2015.

Table 6A.3: *Caste composition of casual workers, by gender, in 63 F, 2014-15*

Caste	Male		Female		All	
	Number	Share in total worker (per cent)	Number	Share in total worker (per cent)	Number	Share in total worker (per cent)
OBC	**19**	**17.0**	**6**	**6.9**	**25**	**12.6**
Jat Sikh	4	3.6	1	1.1	5	2.5
Tarkhan	15	13.4	5	5.7	20	10.1
SC	**93**	**83.0**	**81**	**93.1**	**174**	**87.4**
Bawaria	81	72.3	73	83.9	154	77.4
Meghwal	12	10.7	8	9.2	20	10.1
All	112	100	87	100	199	100

Source: Survey data 2015.

Chapter 7

Asset Ownership and Distribution

7.1 *Introduction*

The earlier chapters discussed how the distribution of water resources across the Gang canal has affected the social and economic structure of the region. This chapter focuses on land concentration in the hands of richer peasants, and how it affords these households larger access to irrigation resources. The access to irrigation, determines the intensity of cropping. As a result of differential access to land and water resources the inequality among households further increases. Households from the same landholding class have a larger share of wealth concentration in the middle reaches village as compared with tail end village. In order to understand the impact of the unequal distribution of land and irrigation resources on the economic condition of households across different classes and caste groups, the pattern of accumulation of assets is discussed in what follows.

The ownership of assets, productive assets in particular, is an important indicator of the wellbeing of a household and also of the economic status of a household. In rural India, land remains the most important asset and accounted for 73 per cent of the value of all assets in 2012 (NSSO 2016). Access to irrigation, not only augments the production and cropping intensity, but also increases the price of land. The resulting concentration of land, water resources and other assets are the basis of class power in the rural areas (Ramachandran, Rawal and Swaminathan 2010).

Jayadev, Motiram, and Vakulabharanam (2007) point out that there has been an increase in absolute wealth levels in the period after liberalization, which has contributed to increased inequality of wealth across the groups categorized by size of holdings and caste. The manner in which this is realized will vary according to local circumstances. It would, therefore, be useful to analyse, keeping in mind the role of irrigation in asset accumulation, how the level and pattern of assets ownership among the different class and caste groups in the two villages studied here varies, since one village is characterized

by high levels of land concentration and the other by low levels of landlessness (detail discussion in chapter 4).

For the analysis in this chapter, the households are classified into different classes[56] based on:1) ownership and operational holdings of agricultural land; 2) value of productive means of production and all assets; 3) household income from different sources and per capita income; 4) the labour ratio, or the ratio of work performed by members of a household to that performed by hired labour. By using these criteria, households are identified as peasants, manual workers, salaried workers, pension/remittance/handout receivers, rent receivers and non-agricultural self-employed. The peasant households are further categorised into six broad categories based on their size of ownership holdings, identifying them as marginal (less than 2.5 acres), small (2.5-5 acres), semi-medium (5-10 acres), medium (10-25 acres), large 1 (25-50 acres) and large 2 (greater than 50 acres) peasant households. The large 1 and large 2 peasant households are roughly those that are net hirers of labour, though households from the medium peasant class also fall in the labour hiring category. Households from the semi-medium peasant class are balanced in their labour hiring practices and the small and marginal farmers are net labour selling households. The workers from small and marginal households also work as manual workers in both agricultural and non-agricultural activities. The primary reasons for not including them in the manual workers household category are ownership of land and cultivation on land. The rent receivers are the households who are living off the rent received from leased out land. The households included in salaried, pension/remittance/handout receiver and non-agricultural self-employed categories are those which mainly live off that source of income and do not have any other major source of employment and income. The manual workers are households who sell their labour power and also do not own any productive means of production.

The first section of the chapter discusses the basic composition of assets across surveyed villages. The second section explores the distribution of assets in different household

[56] The classification methods described in Vakulabharanam (2010), Surjit (2008), Patnaik (1987), and Ramachandran *et.al.* (2010) are used.

groups. The third section discusses the inequality in asset holding. Inter-caste and class inequality are discussed in the fourth section. The fifth section explores the sources of inequality in the asset distribution and the last section concludes the chapter.

7.2 *Basic Composition of Asset Holding in Villages*

To analyse the value of a household's assets, all goods owned by the households at the time of survey are taken into account other then financial deposits and ornaments because it is difficult to collect accurate information on these two. The information on asset holding is compiled under different categories like, agricultural land (includes orchards also), other agricultural means of production (all agricultural equipment other than land), other land and building (includes homestead land, cattle-shed, plots, all residential and non-residential buildings), livestock, nonfarm business equipment, other durable assets (includes electrical equipment, furniture etc.), means of transportation and tress (other than orchards). The value of these assets collected from the households is the resale value of the assets at the time of survey.

Table 7.1 provides basic statistics on asset holding in both villages, 25 F and 63 F. It is evident from the table that the average value of household total assets is four times higher in the middle reaches village, 25 F, than the tail end village, 63 F. In other words, on an average, one household in 25 F holds four times as much assets as one in 63 F.

Table 7.1: *Basic asset statistics in surveyed villages, 25 F and 63 F*

	Villages	
	25 F	63 F
Number of households	293	106
Average total Assets (Rs.)	18,300,333	4,373,781
Median Total Assets (Rs.)	327,136	1,519,844
Average per capita Assets (Rs.)	3,599,306	1,002,502
Median per capita Assets (Rs.)	77,716	413,983
Average per capita net worth (Rs.)	3,556,293	958,737

Note: Net worth: Net worth is calculated after deducting the amount outstanding of loans from the total value of all assets.

Source: Survey data 2015.

Just as in the case of the average value of assets, there is a large difference between the median value of the total assets of households, but contrary to the picture of average values, the median value of all assets is higher for the tail end village, 63. F. To be precise the median value for 63F is more than four times higher than that for 25 F. The table also reveals the differences between the average and median values of total assets in both the villages, pointing to the concentration of asset holding in the hands of some households of a village. This difference between average and median value is more prominent in 25 F as compared with 63 F, which means the concentration of asset holding is higher in 25 F as compare to 63 F.

The difference between average and median value can also be explained by the level of landlessness in the villages. In 25 F, almost 70 per cent of households are landless (Table 7.2) but the average value of asset holding per household is Rs. 18,300,333 (Table 7.1). The higher average value of total assets is because of very high concentration of assets among few households. The high average values of total assets also eliminates the effect of landlessness in 25 F. On the other hand, the median value is low because it is not affected by extreme values, and thus takes into account the effect of landlessness in the distribution of asset holdings in the village.

Table 7.2: *Proportion of landless households in surveyed villages, 25 F and 63 F* in per cent

Village	Share of landless households
25 F	69.3
63 F	8.5

Source: Survey data 2015.

In the tail end village, 63 F only 8.5 per cent households are landless and the difference between average and median value of asset holding per household is six times less than the middle reaches village. In the case of 91.5 per cent of households in 63 F the total asset value includes the value of ownership land. As a result, the difference between average and median value is lower in this village as compared to 25 F.

Table 7.3 provides detailed information on different asset categories and their contribution to total asset values of 25 F and 63 F. In both the surveyed villages, land is the most important asset in terms of its share in total asset value, which is more than 80 per cent in both the villages. The next important asset is other land and building which account for 14 per cent and 10 per cent of total asset values in 25 F and 63 F respectively. Combined these two assets account for 96.4 per cent of total asset value in 25 F and 94.2 per cent in 63 F. Other asset categories have very small share in total asset value in both the surveyed villages. The reason for the difference in the share of agricultural land and other buildings and other factors is a result of ease of valuing an assets. And also the assets such as agricultural machinery, domestic durable assets, means of transport, livestocks etc. have lower resale value and the value of these assets deprecates over the period.

Table 7.3: *Share in total asset value and mean and median value of assets, by asset group and by village, by asset group and by village*

Assets group	Share in total asset value (per cent)		Mean value (Rs.)		Median value (Rs.)	
	25 F	63 F	25 F	63 F	25 F	63 F
Agricultural land	82.3	84.2	15069447	3678001	0	1200000
Other means of production (agriculture)	0.9	2.4	156031	107027	0	8953
Other land and buildings	14.1	10	2575587	439015	282240	200000
Livestock	0.6	1.4	118833	61679	20000	56750
Non-farm business equipment	0.7	0	121262	774	0	0
Other durable assets	0.4	0.9	67193	40078	16190	27450
Transport	0.8	0.5	149782	23798	750	750
Trees	0.2	0.5	42199	23409	0	7566
All asset	100	100	18300333	4373781	327136	1519844

Source: Survey data 2015.

Even though 69 per cent of the households in 25 F are landless, the average value of land is around four times higher than in the tail end village, where 92 per cent of households have land ownership. In 2015, the median value of irrigated agricultural land was Rs.

1,541,982 per acre in 25 F and Rs. 484,445 per acre in 63 F. As land has the largest share in total asset value, the large difference in the average value of land between the villages leads to the large differences in average asset value as well. This, rather than the composition of assets in surveyed villages, is the principal determinant of asset value differences..

The price of agricultural land is determined primarily by the quality of land and then by other factors such as location of land, distance form market place, village infrastructure etc. The quality of land is attributed mainly to the availability of irrigation which affects the cropping pattern and land productivity. As the ground water in the study region is saline and is used only on a small scale, access to canal irrigation becomes even more important. As discussed in chapter 5, on an average the water access per acre is around 36 per cent lower in the tail end village 63 F as compared with the middle reaches village, 25 F. low water access in 63 F has resulted in low productivity and also limits the intensity of cropping. Secondly, 25 F is located in a semi-peripheral area which has easy access to urban areas, but in case of 63 F which is located in a peripheral area, access to urban areas is limited to some extent. These two factors have resulted in the large difference in the average price of agricultural land across the middle reaches village and tail end village.

Similarly, the average value of homestead land in 25 F is also higher as compare to 63 F because of its location near to a town. In 2015, the average price of 0.01 acre of homestead land in 25 F was Rs. 73,181 whereas the average price of homestead land in 63 F was Rs. 31,189.

As discussed above access to irrigation, affects the productivity of land hence the agricultural output is higher in 25 F as compared with 63 F. High agriculture output affects agricultural income positively and this high income contributes to investment. Hence, the level of investment in other productive assets like agricultural machinery, livestock, non-farm equipment, transport and durable assets is higher in 25 F than 63 F. That explains the higher average value of every asset group in 25 F as compared with 63

F. The non-farm business equipment in both the surveyed villages have either no or only little contribution to total assets, which is also indicative of the lower level of investments in the nonfarm businesses. In other words, income is basically determined by agricultural assets and not by non-farm investments.

Table 7.4: *Proportion of households with basic amenities in surveyed villages, 25 F and 63 F* in per cent

Basic amenity	25 F	63 F
House	96	100
Electricity	94	95
Toilet	88	93
Water connection in the house	78	90

Source: Survey data 2015.

Other than household assets, availability of basic amenities is also greater in the tail end village 63 F as compared with the middle reaches village 25 F (Table 7.4). In 63 F, all households have their own house, but in 25 F, 4 per cent of households do not have own house. Other than this, 93 per cent households have toilets in their houses, and 90 per cent have water connections on their premises in 63 F. In the case of 25 F, 88 per cent households have toilets and only 78 per cent households have water connection in their house premises.

7.3 *Distribution of Assets Holdings across Different Household Groups*

In order to further understand the asset distribution among households in surveyed villages, households are classified into two different categories, based on their caste and class.

7.3.1 *Distribution of asset holding among Dalit and non-Dalit households*

Tables 7.5 to 7.8 present evidence on the distribution of asset holding across Dalit and non-Dalit households in both the surveyed villages. While 65.5 per cent of all households in 25 Fare Dalit households, these households hold only 1 per cent of total assets in value

in the village. The remaining 99 per cent is with non-Dalits households. In 63 F, 19 per cent of non-Dalit households hold 47 per cent of total assets. The Dalit households (81 per cent of total households) account for 52.6 per cent. In both the villages, the average value of all assets owned by Dalit households is lower than the average value of all assets owned by non-Dalit households, by as much as169 times in 25 F and 4 times in 63 F. The ratio of share in total asset value to share in total number of households for Dalit households is 0.01 and 0.64 in 25 F and 63 F respectively and for non-Dalit households it is 2.86 and 2.5 respectively. In other words, non-Dalit households in both the villages have higher ownership of assets.

Table 7.5: *Basic asset statistics, by caste group and village, in 2015* in per cent and rupees

	25 F			63 F		
	Dalit	Non Dalit	All	Dalit	Non Dalit	All
Share in all households (per cent)	65.5	34.5	100	81.1	18.9	100
Share in total assets (per cent)	1.1	98.9	100	52.6	47.4	100
Mean total assets (Rs)	310177	52498863	18300133	2831154	10990415	4370637
Median total assets (Rs.)	246305	38492830	327136	1174077	6537816	1519844

Source: Survey data 2015.

The shares of Dalit households in village asset holding by category are also low in25 F because they do not have more than a 10 per cent share in any asset category except livestock and other durable assets. Overall non-Dalits have control over all productive and nonproductive assets in this village. In 63 F, on the other hand, Dalit households have more than 50 per cent share in every asset category except non-farm business equipment and means of transportation. And even in means of transportation their share is 43 per cent.

Table 7.6: *Percentage share of different asset category, by caste, by village, in 2015* in per cent

Asset category	25 F			65 F		
	Dalit	Non Dalit	All	Dalit	Non Dalit	All
Share of total households	65.5	34.5	100	81.1	18.9	100
Agricultural land	0.2	99.8	100	50.4	49.6	100
Means of production (agriculture)	0.3	99.7	100	64.8	35.2	100
Other land and buildings	5.9	94.1	100	62.2	37.8	100
Livestock	10.9	89.1	100	78.3	21.7	100
Non-farm business equipment	1.4	98.6	100	13.4	86.6	100
Other durable assets	12.9	87.1	100	65.7	34.3	100
Transport	1.3	98.7	100	43.5	56.5	100
Trees	0.3	99.7	100	77.4	22.6	100
All assets	1.1	98.9	100	52.6	47.4	100

Source: Survey data 2015.

Four per cent of Dalit households in 25 F do not even own their own house and homestead land and reside in the houses provided by the employers. The important assets in Dalits households in 25 F were domestic durables. On other hand, in the tail end village where 90 per cent of Dalit households own agricultural land, assets other than domestic durables dominate. The extent of ownership in different asset groups except for non-farm business equipment is higher than 50 per cent for Dalit households. The ownership of non-farm equipment is very low in the village which points to low investment in non-farm activity in 63 F.

Table 7.7: *Rate of ownership of different asset by village, and caste group, in 2015* in per cent

Asset category	25 F			65 F		
	Dalit	Non Dalit	All	Dalit	Non Dalit	All
Agricultural land	2	85	31	90	100	92
Means of production (agriculture)	1	66	24	56	75	59
Other land and buildings	96	100	98	100	100	100
Livestock	64	70	66	95	95	95
Non-farm business equipment	6	8	6	2	5	3
Other durable assets	99	100	99	100	100	100
Transport	49	92	64	62	90	67
Trees	7	82	33	78	95	81

Source: Survey data 2015.

Table 7.8: *Average value of different asset owned by households by village, and caste group, in 2015* in Rs.

Asset category	25 F			65 F		
	Dalit	Non Dalit	All	Dalit	Non Dalit	All
Agricultural land	39193	43641811	15069447	2284140	9671604	3678001
Means of production (agriculture)	754	451212	156031	85494	199619	107027
Land and buildings	231480	7031710	2575587	334336	872472	435871
Livestock	19689	306725	118633	59508	71016	61679
Non-farm business equipment	2617	346803	121262	128	3550	774
Other durable assets	13228	169780	67193	32459	72837	40078
Transport	2993	428824	149782	12745	71325	23798
Trees	222	121997	42199	22343	27993	23409
Total assets	310177	52498863	18300133	2831154	10990415	4370637

Source: Survey data 2015.

Despite the fact that Dalit households have more widespread ownership of assets in 63 F, the average value of total assets owned by Dalit households is much lower than the average value of assets owned by non-Dalit households .However, the difference between the average value of total assets owned by Dalit and non-Dalit households is much greater in 25 F. This is because of differences in the type and quality of assets in each category which determines the resale value of these assets. For example, in case of 'other assets', most of the Dalit households own bicycles as means of transportation, while most of the non-Dalit households own scooters or motor cycles which creates a difference in the average value of transport category. Similarly, in case of ownership of animal resources, most Dalit households have sheep and goats and a small share of milch cattle, whereas non-Dalit households own cows and buffalos which also have higher market values.

7.3.2 *Distribution of asset holding in different classes*

In both the surveyed villages the largest share of households are manual worker households (54.3 per cent in 25 F and 22.6 per cent in the 63 F). 23.2 per cent households

in 25 F and 70.8 per cent households in 63 F are peasant households. The largest share in total assets is also owned by medium, large 1 and large 2 peasant class households in both the villages. These peasant households have large shares in the ownership holding of land. The ownership of land stimulates the accumulation of other assets, as a result of which these households with large ownership holdings, have higher shares in total asset values as well.

The segregated analysis of share of peasant classes in different asset categories, reflects a clear pattern in 25 F. The share in agricultural land increases with the increase in the size class of ownership holdings. The larger classes not only have the largest share in the value of land holdings but also in the value of other assets. In 25F, the medium, large 1 and large 2 classes, which account for only 18.8 per cent of households, hold 83 per cent of total assets, with the 2 largest households having a 48 per cent share. The ownership of land has been the major source of income for these households, which facilitates further accumulation of other complementary assets in agriculture such as agricultural machinery, as well as accumulation of other productive and durable assets. The share of marginal and small peasant households in the value of total assets is very small (0.1 per cent for each class), but the share of these households in all households is also very small as these classes together constitute 1 per cent of all households. Other than households from peasant and receiver classes, only a small share of households (4 per cent) own agricultural land in the middle reaches village. The manual workers households, which account for the largest 54 per cent of the population, have only 0.8 per cent of total assets in value.

The picture on asset holding in 63 F, is different from that of 25 F. The distribution of land holding among peasant classes is wide as compared to 25 F. Medium peasant households have the largest share in land holding and along with large 1 and large 2 peasant households, own 73.3 per cent of total land holding of the village. The manual workers households also have a 4.4 per cent share in the ownership of agricultural land. Non-farm equipment is distributed among the small peasant households and among the households dependent on self-employment in non-agriculture.

Table 7.9: *Basic asset statistics, by class and village, in 2015*

Class	25 F				63 F			
	Share in all households (per cent)	Share in total assets (per cent)	Average value of total assets (Rs.)	Median value of total assets (Rs.)	Share in all households (per cent)	Share in all assets (per cent)	Average value of total assets (Rs.)	Median value of total assets (Rs.)
Marginal	0.7	0.1	2615656	2615656	18.9	4.3	989666	939488
Small	0.3	0.1	6501489	6501489	20.8	7.8	1642615	1408848
Semi-medium	3.4	2.9	15705061	15339286	8.5	6.6	3397775	3270608
Medium	6.5	11.5	32372520	29414375	18.9	51.7	11983453	12878827
Large 1	6.5	23.3	65695276	64507584	2.8	9.1	14097609	11423413
Large 2	5.8	47.9	151000000	150122025	0.9	10.1	46799250	46799250
Manual workers	54.3	0.8	274862	247253	22.6	4.9	947166	674998
Salaried	4.4	2.3	9451453	662812	0.9	0.1	261750	261750
Self-employed in non-agriculture	9.2	1.6	3132743	269000	1.9	1.9	4441611	4441611
Pension/ Remittances/ handouts	4.4	0.3	1067170	140210	0.9	0	94000	94000
Rents	4.4	9.2	38034074	36927970	2.8	3.5	5459281	6720106
All	100	100	18300133	327136	100	100	4373781	1519844

Source: Survey data 2015.

Table 7.10: *Percentage share of different class groups in different asset categories in 25 F, in 2015* in per cent

Class	Agricultural land	Other means of production (agriculture)	Other land and buildings	Livestock	Non-farm business equipment	Other durable assets	Transport	Trees	All
Marginal	0.1	0	0.1	0.1	0	0.1	0	0	0.1
Small	0.1	0	0.2	0.1	0	0.6	0.3	0.5	0.1
Semi-medium	3.2	4.8	1.5	2	0	3.9	0.4	6.2	2.9
Medium	11.3	22.5	8.7	5.5	79	14.6	10.5	32.9	11.5
Large 1	25.4	28.2	11.2	7.8	16	23.8	30.6	17	23.3
Large 2	45.6	43.4	64.6	71.7	0	27	40.4	30.4	47.9
Manual workers	0	0.3	4.9	9.6	0.2	10.8	1	0.3	0.8
Pension/ Remittances/ handouts	0.2	0	0.4	0.3	0	1	0.3	3.2	0.3
Rents	10.3	0.8	4.1	0.4	0	9.8	8.6	8.1	9.2
Salaried	2.4	0.1	1.7	0.7	0.4	4.6	6	1	2.3
Self employed in non-agriculture	1.4	0	2.6	1.8	4.3	3.9	1.9	0.3	1.6
All	100	100	100	100	100	100	100	100	100

Source: Survey data 2015.

Table 7.11: *Percentage share of different class groups in different asset categories in 63 F, in 2015* in per cent

Class	Agricultural land	Other means of production (agriculture)	Other land and buildings	Livestock	Non-farm business equipment	Other durable assets	Transport	Trees	All
Marginal	3.1	7.8	10.6	18	0	9.8	3.9	7.8	4.3
Small	7.4	8.2	9.1	18.7	13.4	13.7	5.7	9.1	7.8
Semi-medium	6.4	9.3	6.4	14.2	0	10.5	2.6	6.8	6.6
Medium	53.9	49.7	38.7	30.4	0	38.6	51.4	43.7	51.7
Large 1	8.7	8.1	12.9	5.4	0	9.9	5.6	23.8	9.1
Large 2	10.7	4.2	8.6	0.5	0	3.7	12.7	0.4	10.1
Manual workers	4.4	0.3	8.9	9.1	0	9.6	8.1	5.7	4.9
Pension/ Remittances/ handouts	0	0	0.2	0.2	0	0.2	0	0	0
Rents	3.5	12.4	2.1	1.4	0	2.4	9.4	1.3	3.5
Salaried	0	0	0.4	0.8	0	0.1	0	0	0.1
Self employed in non-agriculture	2	0	2.1	1.4	86.6	1.4	0.5	1.5	1.9
All	100	100	100	100	100	100	100	100	100

Source: Survey data 2015.

Because medium, large 1 and large 2 households have the highest share in land holding, they also have the highest share in the value of other assets categories assets. But, unlike in 25 F, in 63 F all other households also have a small share in asset holdings.

As discussed earlier, manual worker households have no share in agricultural land holding in 25 F. However, homestead land and house are an important asset among them, with only around 4 per cent of households among manual workers not owning a house and living in houses provided by their employers. Livestock is another important asset among the manual worker households and 66 per cent households have ownership of these in 25 F. On the other hand, in the tail end village, 70.8 per cent of households from the manual worker class own some agricultural land and some of them also own other agricultural means of production. All households from the manual workers class have their own house and 83.3 per cent of them own livestock. To put it differently, the access to agricultural land has not only provided greater access to other agricultural means of production and livestock but has also provided access to basic amenities as well, in 63 F.

For all the households classes, whether peasants or outside the peasantry, the access index (ratio of share in asset holding value to the share in total number households) is higher in 63 F except for salaried households. This means that despite the fact that this village has less access to irrigation and connectivity, it has less unequal distribution of assets as compared to the middle reaches village.

It is clear from Tables 7.14 and 7.15 the average value of every asset category as well as average value of total assets per household is higher in 25 F irrespective of its class. The value of all means of production is based on their market price which is determined by the availability of a market for these goods. 63 F has less access to urban market areas and with lower levels of income (chapter 5 and 6) in the village, the value of the means of production tends to be lower. Other than the difference in average values of different asset categories between the surveyed villages, this difference is visible within the villages as well. The households from the large 2 peasant class have a higher access index and share in assets value in both 25 F and 63 F.

Table 7.12: *Rate of ownership of different asset by class group in 25 F, in 2015* in per cent

Class	Agricultural land	Other means of production (agriculture)	Other land and buildings	Livestock	Non-farm business equipment	Other durable assets	Transport	Trees
Marginal	100	0	100	100	0	100	0	0
Small	100	0	100	100	0	100	100	100
Semi-medium	100	90	100	90	0	100	70	100
Medium	100	100	100	94.7	5.3	100	100	100
Large 1	100	100	100	89.5	15.8	100	100	100
Large 2	100	100	100	82.4	0	100	100	100
Manual workers	0.6	1.3	95.6	66	2.5	100	49.1	7.5
Pension/ Remittances/ handouts	7.7	7.7	100	15.4	0	84.6	30.8	15.4
Rents	100	7.7	100	15.4	0	100	100	69.2
Salaried	30.8	7.7	100	46.2	7.7	100	92.3	30.8
Self employed in non-agriculture	11.1	0	100	63	37	100	66.7	11.1
All	30.7	23.5	97.6	65.9	6.5	99.3	64.2	32.8

Source: Survey data 2015.

Table 7.13: *Rate of ownership of different asset by class group in 63 F, in 2015* in per cent

Class	Agricultural land	Other means of production (agriculture)	Other land and buildings	Livestock	Non-farm business equipment	Other durable assets	Transport	Trees
Marginal	100	55	100	95	0	100	65	75
Small	100	77.3	100	100	9.1	100	72.7	90.9
Semi-medium	100	88.9	100	100	0	100	55.6	100
Medium	100	100	100	100	0	100	90	100
Large 1	100	100	100	100	0	100	100	100
Large 2	100	100	100	100	0	100	100	100
Manual workers	70.8	4.2	100	83.3	0	100	45.8	58.3
Pension/ Remittances/ handouts	0	0	100	100	0	100	0	0
Rents	100	66.7	100	100	0	100	66.7	100
Salaried	0	0	100	100	0	100	100	0
Self employed in non-agriculture	100	0	100	100	50	100	50	50
All	91.5	59.4	100	95.3	2.8	100	67	81.1

Source: Survey data 2015.

Table 7.14: *Average value of different assets owned by different classes, s in 25 F, in 2015* in Rs.

Class category	Asset category								
	Agricultural land	Means of production (agriculture)	Other land and buildings	Livestock	Non-farm business equipment	Other durable assets	Transport	Trees	All assets
Marginal	2258333	0	325000	18473	0	13850	0	0	2615656
Small	4818694	0	1350000	40000	0	110300	120000	62495	6501489
Semi-medium	14080000	218082.2	1168220	68000	0	76840	17325	76593	15705061
Medium	26180263	540314	3466000	100913	1476954	150929	242724	214424	32372520
Large 1	59067789	677873	4442789	142211	300000	246636	707263	110713	65695276
Large 2	118000000	1168015	28665608	1465534	0	313238	1042059	221379	151199730
Manual workers	4716.981	910	231363	21076	516	13356	2662	262	274862
Pension/ Remittances/ handouts	769231	923	233595	7766	0	14458	10558	30640	1067170
Rents	35100000	27059	2380637	9692	0	148332	291712	76642	38034074
Salaried	8125769	2000	1011446	19517	11538	69438	202327	9417	9451453
Self employed in non-agriculture	2270679	0	720813	23605	56870	28140	31296	1339	3132743
All	15069447	156031	2575587	118633	121262	67193	149782	42199	18300133

Source: Survey data 2015.

Table 7.15: *Average value of different assets owned by different classes, in 63 F, in 2015* in Rupees

Class category	Asset category								
	Agricultural land	Means of production (agriculture)	Other land and buildings	Livestock	Non-farm business equipment	Other durable assets	Transport	Trees	All assets
Marginal	604273	44397	246950	58684	0	20745	4960	9657	989666
Small	1308848	42382	192109	55485	500	26486	6561	10243	1642615
Semi-medium	2769115	116977	332935	103233	0	49585	7222	18708	3397775
Medium	10500508	281686	900722	99456	0	82014	64850	54216	11983453
Large 1	11291404	304851	2000000	117000	0	140550	47167	196637	14097609
Large 2	41800000	482000	4000000	30000	0	157100	320750	9400	46799250
Manual workers	716412	1389	172972	24845	0	17063	8552	5934	947166
Pension/Remittances	0	0	75000	11500	0	7500	0	0	94000
Rents	4510330	469384	325000	30384	0	34350	79083	10749	5459281
Salaried	0	0	200000	55000	0	6000	750	0	261750
Self employed in non-agriculture	3828375	0	479000	45250	35500	29650	5750	18086	4441611
All	3678001	107027	439015	61679	774	40078	23798	23409	4373781

Source: Survey data 2015.

In 25 F, households from the large 2 peasant class have a 550 times higher average value of assets as compared with manual workers households and 58 times higher average value of assets as compared with marginal peasant households. The closet average value of assets to that of the large 2 class of peasant households is of the large 1 peasant households (2.3 times lower) and rentier class households (4 times lower). The average asset value of households from the large 2 peasant class is 47 times higher than that of the marginal peasant household, 49 times higher than that of manual worker households, and 179 times higher than that of salaried households in 63 F.

Realising the maximum produce from owned land, requires complementary assets like irrigation, agricultural machinery, etc. So to maximize production from land these large peasant households gain control over other assets like tractors, threshers, combine harvesters, ploughs, harrows, computerised levelers, sowing machines, tubewells etc. Marginal, small or semi-medium peasant households do not have ownership of most advanced agricultural equipments, other than tractors, owning instead carts, levelers, sprayers, ploughs, etc. Nonetheless, these machines also contribute to the difference in the average value of assets owned by these classes. The value of land and buildings is decided by the size of plot, condition of house, number of rooms in the house, type of roof etc. and the majority of the marginal, small peasant, pensioner, and manual worker households have very small sized plots with one- or two-room houses, with poor quality of house construction. So, the value of these assets is not as high as the value of houses owned by medium, large 1 and large 2 peasants.

The marginal and small peasants in both the villages have sheep, goats and poultry, but only few households from this class have bovine animals. Other than these, all durable assets owned by these households have lower market value as most of these are either purchased second hand or are in poor condition. The households from these classes do not have much access to electric appliances. The mean of transportation for most households in the marginal, small peasant and manual workers classes are bicycles, whereas the medium, large 1 and large 2 peasant households, salaried and rentier

households, own vehicles such as motor cycles and cars. So in other words, the diversification in assets owned in each asset category affects the value of assets along with the extant or number of assets. In these terms, the asset base of economically backward classes is very weak in both the surveyed villages. Landlessness has a major role in this backwardness, particularly in 25 F.

7.4. *Inequality in Asset Holding*

From the above discussion it is clear that in both the surveyed villages the distribution of assets is very unequal and the ownership of assets is concentrated in the hands of few households of these villages. Further to analyse the inequality in distribution of assets, the value of Gini coefficient is calculated. The value of Gini coefficient is 0.83 and 0.64 in 25 F and 63 F respectively, which again indicate the high level of asset inequality in the surveyed villages. The inequality in asset holding is1.30 times higher in the middle reaches village than the tail end village. The higher incidence of landlessness in 25 F is an important factor explaining this.

Table 7.16 shows the share of each decile group in the value of total assets owned by households. In 25 F, the lowest 70 per cent of households only own 1.17 per cent of total assets in value, and the remaining 98.98 is owned by the highest 30 per cent of households. In the case of 63 F, the lowest 70 per cent owns 19.45 per cent of assets in value and the top30 per cent households owns 80.54 per cent. The top 20 per cent households own90.14 per cent of total assets in 25 F. The share of the top 10 per cent households in the value of total assets is 65 per cent and that of the bottom 10 per cent is 0.03 per cent in 25 F. In the case of the tail end village, the top 10 per cent households have a share of 44.88 per cent in total value of assets. The bottom 10 per cent households in 63 F have a share of 0.37 per cent. The ratio of the top 10 per cent to bottom 10 per cent is significantly high in both surveyed villages (1947.72 in 25 F and 121.97 in 63 F).

The inequality levels in 63 F are undoubtedly very high but it is still lower than in the middle reaches village. To understand the depth of inequality Table 7.17 provides some

revealing numbers. In both the villages the highest one per cent households have more than 10 per cent share in total asset value. The top 5 per cent of households have 42.8 per cent and 29.4 per cent shares in total asset value of 25 F and 63 F respectively. This clearly points to the concentration of assets in the hands of very small number of households in both villages with the concentration being higher in the case of the middle reaches village.

Table 7.16: *Distribution of household wealth across decile of households* in per cent

Deciles of households	25 F	63 F
1	0.03	0.37
2	0.07	1.26
3	0.10	1.89
4	0.13	2.21
5	0.16	3.21
6	0.22	4.28
7	0.46	6.23
8	8.69	11.46
9	25.01	24.20
10	65.13	44.88
All Households	100	100
Ratio of Decile 10 and Decile 1 (10/1)	1947.72	121.97

Source: Survey data 2015.

Table 7.17: *Share in total asset value in the top percentiles* in per cent

Share in total asset value	25 F	63 F
Top 1 percent households	13.4	10.1
Top 5 percent households	42.8	29.4
Top 10 percent households	65.1	44.9

Source: Survey data 2015.

Table 7.18 presents the value of the Gini coefficient in different households groups, which reveals the inequality within social categories. In 25 F, the value of the Gini coefficient of total asset value within Dalit households is 0.43 and within non-Dalit households is 0.52. On other hand, in 63 F the value of the inequality index within Dalit households is 0.62 and within non-Dalit households is 0.47. This shows that in the tail end village where Dalits have land ownership, the level of inequality among Dalit households is higher as compared with non-Dalit households.

Table 7.18: *Value of Gini coefficient by different household categories and village*

Category	25 F	63 F
Total assets	0.8266	0.6413
Gini of total assets by social group		
Dalit	0.4331	0.6171
Non-Dalit	0.5249	0.4743
Gini of total assets by household class wise		
Marginal	0.0209	0.2835
Small	0	0.2752
Semi-medium	0.0967	0.2392
Medium	0.2309	0.2791
Large 1	0.1284	0.1619
Large 2	0.2014	0
Manual workers	0.3573	0.4622
Pension/ Remittances/ handouts	0.8429	0
Rents	0.2776	0.3508
Salaried	0.769	0
Self employed in non-agriculture	0.8686	0.123

Source: Survey data 2015.

Table 7.19: *Decomposition of Gini coefficient by social group and household class, in surveyed villages*

	25 F		63 F	
	Absolute contribution in Gini	Relative contribution in Gini	Absolute contribution in Gini	Relative contribution in Gini
By social group				
Within	0.2568	31.07	0.42857	66.83
Between	0.56984	68.93	0.21275	33.17
By household class				
Within	0.04718	5.71	0.09832	15.33
Between	0.77946	94.29	0.543	84.67

Source: Survey data 2015.

The class wise inequality points out that the level is lower within the peasant classes in both the surveyed villages as compare to the other classes. In 25 F, the highest level of asset inequality within classes is among households from the self-employed in non-

agriculture categories (0.87), followed by pensioner/remittance/handout receivers (0.84) and households from the salaried class (0.77). In 63 F, the highest level of asset inequality within a class is among manual workers (0.46) followed by rentier households (0.35). The reason behind the low level of asset inequality within the peasant classes is the manner of classification. These classes are defined on the basis of incomes, labour ratio and ownership of agricultural land, which also has the highest share in total asset value. Therefore, the households belonging to any peasant class must have a similar asset base. But on the other hand, all other classes are categorised on the basis of their source of income, hence their asset bases are likely to be different because their earnings are dependent on various sources and their pattern of asset accumulation also varies.

In 63 F, some classes, such as Large 2 peasants, pensioner/ remittance/handout receiver households and salary earning households have shown near perfect equality within the class. The households from the small peasant class in 25 F have also perfect equality within the class. The main reason for this perfect equality within a class is the small number of households within these class categories, with in some cases only one household in a category.

To analyse the contribution of within and between components of different household groups the Gini coefficient is decomposed by using the Yitzhaki method.[57] The result of Gini decomposition for social group and household class is given in the Table 7.19. In village 25 F asset inequality between the social groups has a larger contribution to overall asset inequality of the village. In the tail end village, asset inequality within the social groups has a larger contribution to overall village asset inequality. In other words, it can be concluded from this decomposition that access to different assets is influenced by social group of household in the middle reaches village, whereas in the tail end village caste does not matter to a similar extent and access to different assets is not affected as much by the social group or caste of household. The decomposition of Gini coefficient by household class points to the clear impact of inequality between the classes on overall asset inequality.

[57] As cited in Vakulabharanam (2010) and Anand and Thampi (2016).

7.5 *Source of Inequality*

The Gini coefficient is also decomposed by different asset group to identify the source of asset accumulation. The same Yitzhaki method is used for this decomposition. The result of this decomposition is given in Tables 7.20 and 7.21 for village 25 F and 63 F. The value of the inequality index for every asset category is more than 0.80, except for other durable assets in 25 F. Table 7.20, shows that the distribution of all the assets is unequal in this village. In other words, agricultural land does contribute a dominant share in the value of total assets, and the ownership of all other assets also plays an important role in the pervasive inequality among social groups and classes in 25 F. In the tail end village, the inequality index of different asset categories' is lower than 25 F. In both the villages the value of the Gini coefficient is near perfect inequality for nonfarm business equipment, but as very few households have ownership of these assets the estimation of inequality in this category cannot be taken as of significance.

Table 7.20: *Decomposition of Gini by source of inequality, 25 F*

Asset category	Share in total asset value	Gini coefficient	Absolute contribution to Gini	Relative contribution to Gini	Percentage change in Gini
Agricultural land	82.35	0.8296	0.68153	82.45	0.0011
Other land and buildings	14.07	0.8485	0.11696	14.15	0.0008
Livestock	0.65	0.8919	0.00512	0.62	-0.0003
Means of production (agriculture)	0.85	0.8721	0.00694	0.84	-0.0001
Non-farm business equipment	0.66	0.9933	0.00537	0.65	-0.0002
Other durable assets	0.37	0.6648	0.00231	0.28	-0.0009
Transport	0.82	0.8447	0.00661	0.8	-0.0001
Trees	0.23	0.8794	0.00174	0.21	-0.0002
All assets	100	0.8266	0.8266	100	

Source: Survey data 2015.

Table 7.21: *Decomposition of Gini by source of inequality, 63 F*

Asset category	Share in total asset value	Gini coefficient	Absolute contribution to Gini	Relative contribution to Gini	Percentage change in Gini
Agricultural land	84.09	0.6749	0.56473	88.06	0.0397
Other land and buildings	10.04	0.5887	0.04944	7.71	-0.0233
Livestock	1.41	0.4446	0.00276	0.43	-0.0099
Means of production (agriculture)	2.45	0.7782	0.01437	2.24	-0.0021
Non-farm business equipment	0.02	0.9869	6.40E-05	0.01	-0.0001
Other durable assets	0.92	0.4808	0.00353	0.55	-0.0036
Transport	0.54	0.8166	0.00353	0.55	0.0001
Trees	0.54	0.7415	0.00289	0.45	-0.0009
All assets	100	0.6413	0.6413	100	

Source: Survey data 2015.

As discussed in the second part of the chapter, agricultural land and 'other land and building' have the highest share in total asset value. The results of the decomposition of assets by asset categories shows that land is the main source of the unequal distribution of assets in both the villages as its relative contribution to the overall Gini coefficient is more than 80 per cent in both the villages. Land is the predominant form of asset accumulation in these village. Other than agricultural land, 'other land and building' is the main contributor to asset inequality in the village. In 25 F all other asset categories have negligible contribution to asset accumulation (relative contribution to Gini coefficient is less than 1 per cent). In 63 F among all remaining asset categories only other agricultural means of production have a 2.24 per cent relative contribution to the Gini coefficient.

7.6 *Change in the Asset Distribution since 2007*

As a part of project on Agrarian Relations in India (PARI) village 25 F was surveyed in year 2007. During this survey, information on asset owned by households was collected. The information from this survey is available in a published village report and various

papers published under this project. Previous chapters in the thesis (chapter 5 and 6) discuss the changes in the cropping pattern, cropping intensity, crop incomes, and employment in the village. In order to understand the impact of these changes on village economic development, a brief attempt is made here to analyze the changes in asset distribution of the village between 2007 and 2015.

Table 7.22: *Distribution of household wealth across decile of households by years in 25 F* in per cent

Deciles of households	2007	2015
1	0.02	0.03
2	0.07	0.07
3	0.1	0.1
4	0.13	0.13
5	0.17	0.16
6	0.28	0.22
7	1.81	0.46
8	11.31	8.69
9	24.29	25.01
10	61.83	65.13
All Households	100	100

Source: Village survey 2015 and Swaminathan and Rawal, 2015.

According to Swaminathan and Rawal(2010), the distribution of assets in 25 F was very unequal and 65 per cent of households were landless in 2007. As the agrarian economy of 25 F has witnessed a change since 2011-12, the inequalities in asset holding have also increased. The scale of landlessness has increased by 6.6 per cent between 2007 and 2015. In 2015, 69.3 per cent households were landless. In 2007, the top10 per cent of households had a 61.83 per cent share in total asset value, which increased to 65.13 in 2015. Only the two highest deciles (9^{th} and 10^{th}) experienced an increase in their shares. This implies that between 2007 and 2015 the concentration of asset ownership in 25 F has increased.

The increase in the level of asset inequality in 25 F is also reflected in the ownership of assets owned by different social groups. The access index for Dalit households for all assets has gone down from 0.02 to 0.01. The decline of the index which was already very low points to the decline in ownership of assets among Dalit households and the increase

in control of non-Dalit households over assets over the time period. During this time period the average value of total assets has increased for both Dalit and non-Dalit households, but at a higher rate among non-Dalit households (3.21 times). Along with this, the difference between the average value of agricultural land owned by Dalit and non-Dalit households has also widened.

Table 7.23: *Basic statistics of households by their caste group in 25 F, in 2007 and 2015*

	2007		2015	
	Dalit	Non-Dalit	Dalit	Non-Dalit
Access index (Share in total asset value/ Share in total number of households)	0.02	2.49	0.01	2.87
Average value of household total asset (Rs.)	91496.05	11983168	246305	38492830

Note: The prices for 2007 are converted to 2014-15 using CPI (AL).
Source: Village survey 2015 and Rawal, 2014.

7.7 *Conclusion*

This chapter is an attempt to understand the economic conditions of households within a village and as well as in villages situated horizontally in the Gang canal region. To this end, the chapter focused on an analysis of the distribution of asset holding which is an important indicator of the economic condition of households as well as of villages.

The asset distribution is more unequal in the middle reaches village as compared to the tail land village. The middle reaches village, 25 F, has a higher level of asset inequality as the value of the Gini coefficient for this village is 0.82, as compare with0.64 for63 F. The high level of inequality in asset holding is associated with a high degree of landlessness. In 25 F, 69 per cent of households are landless and in 69 F only 8 per cent of households are landless.

Out of total households in 25 F, 65.5 per cent are Dalit households who have only 1 per cent share in total asset value. The remaining 99 per cent of total assets value is with non-Dalits households, among whom Jat Sikh is dominant caste. On the other hand, in 63 F, where the level of asset inequality is low, 19 per cent of non-Dalit households have a 47

per cent share in total asset value and the Dalit households (81 per cent of total households) have a 52.6 per cent share.

The distribution of assets is also highly unequal across class categories in the villages. Apart from households in the peasant and rent receiver classes, a small share of households own agricultural land in the middle reaches village. The major asset among manual worker households is 'other land and building'. In the tail end village, households from all classes have some share in the agricultural land. Households from the manual worker class have a 4 per share in agriculture land. In 25 F, the unequal distribution of agricultural land has led to unequal distribution of all other assets as well. But in 63 F the distribution of all assets is less unequal as households have a strong asset base through holding of agricultural land.

Access to more productive land and more irrigation has not developed the village economy of 25 F to the point where all households have their own houses. Four per cent of households in the village still do not own house. On the other hand, in 63 F, all households own houses. The situation with respect to all basic amenities is better in 63 F as compared to 25 F.

Agricultural land is the most important asset of the all asset categories. The share of agricultural land in total asset value is more than 80 per cent in both the villages. Other than this, 'other land and building' also has a significant share in asset value. The ownership of agricultural land not only results directly in a larger share in asset holding but it also stimulates the ownership of all other assets. As analysed by the decomposition of the Gini coefficient of different asset groups, the value of land has the highest relative contribution to the Gini coefficient in both the villages. So it is clear that the high level of asset inequality has been generated by a highly unequal distribution of land in the villages.

Chapter 8

Summary, Conclusions and Policy Implications

8.1 *Introduction*

This chapter summarises the findings of the study and draws conclusions from the analyses carried out in the preceding chapters. The next section presents a summary of the findings followed by a discussion in the subsequent section. The last section brings out in brief the policy implications for effective distribution of water across the villages and households in the region.

8.2 *Summary of Result*

This study is an attempt to understand the role of irrigation in influencing cropping pattern and employment generation. A brief discussion on the development of irrigation in the pre-and post-independence periods is carried out. The budgetary expenditure on irrigation is also analysed in brief. Further, the access to and distribution of water resources across households is analysed using Land and Livestock Holdings Survey (LHS) and Situation Assessment Survey of agricultural households (SAS) of NSSO. Other then NSSO, data provided by the various rounds of the agricultural census is also examined. Further a household level census survey was conducted in one village each in the middle reaches and tail end of the F distributory of Gang canal. The access to irrigation across households within the village and across the villages is studied. The role of irrigation and other factors, in determining the cropping pattern is examined. Also, the impact of irrigation and cropping pattern on employment and asset accumulation is explored. The findings of this study are summarised in the subsequent discussion.

First, with the decline in public investment in the 1980s and later the shift in the focus of policies away from agriculture in the 1990s, the agricultural sector witnessed slow growth. The share of government expenditure on irrigation development also witnessed a

decline from 22.5 per cent in the first plan to 6.8 per cent in the tenth plan. In the period after the 1980s, the share of tubewell irrigation in total irrigation has increased sharply. The area irrigated with canal water has been stagnant since the 1990s and this source witnessed a decline in the share of total area irrigated.

The land which was partly irrigated got greater access to irrigation between 1990 and 2010, particularly with an increase in private investment. In other words, private irrigation since the 1990s has developed more in the areas which have had access to irrigation earlier rather than in new areas. The household level data collected by NSSO on irrigation indicates that the share of crop irrigated in the rabi season is higher than in the kharif season in both India and Rajasthan, as the kharif season has higher requirement of water in general because of temperature and other climatic factors.

The access index for irrigation increases with the increase in the size of operational holdings in India. For households which have operational holdings of less than 2.5 acres, the access index was 0.23 in 2012-13 in India, whereas the access index for households with operational holdings of 25 acres and above was 16.02. This pattern was true for Rajasthan as well. The south eastern zone (by NSSO definition) of Rajasthan, in which Sri Ganganagar district falls, has even higher levels of inequality in water distribution. This region of the Rajasthan state has also high level of inequalities in land ownership and operational holdings as well. The households with operational holdings of less than 2.5 acres have an access index for irrigationof0.2. The households with operational holdings of 10 to 25 acres and 25 acres and above, have access indices of 4.95 and 22.61 respectively. That is, households with operational holdings of 25 acres and above have much greater access to irrigation. The difference in the other regions of Rajasthan state was not as high as in the south eastern zone.

It is well established in the literature that irrigation increases cropping intensity and crop production. The share of food crops is higher in the irrigated areas, followed by that of oilseeds. In 2012-13, the cropping intensity for irrigated land was around two for all India

and Rajasthan state as well, i.e., the irrigated land was cultivated twice in an agricultural year.

The data on the Gang canal region, which is part of Sri Ganganagar, indicates that the introduction of irrigation has affected the agrarian structure of the region. The area under food crops witnessed an increase after the arrival of canal in the region, followed by cotton and oilseeds. The water in the Gang canal region is distributed via different distributories and minors, in order to provide access across the region. In order to understand the difference in the access to irrigation and its impact across the region, two villages (one from the middle reaches and another from the tail end) which received irrigation from F distributory of Gang canal region were selected. The distribution of water not only affects the economic structure but also the social structure of the villages. The land distribution in the middle reaches is highly concentrated with high levels of landlessness, whereas around 91 per cent of households in the tail end village have ownership of holdings. But the majority of households in the latter belong to the marginal, small and semi medium size classes of holding. Jat Sikhs own and operate the agricultural land in 25 F, and Dalit households are landless labourers. In 63 F, a majority of Dalits (Bawari caste) have ownership and operational holdings. The proportion of dalit households in both the surveyed villages is high, respectively 66 per cent and 81 per cent in 25 F and 63 F. But the share of Jat Sikh households in the tail end village is only 9 per cent and 29 per cent of households that reside in the middle reaches village are Jat Sikhs. Jat Sikhs are the prominent land holdings caste in the region.

The majority of agricultural land in the surveyed villages fall in the command area of Gang canal via different minors on the F distributory. The use of ground water resources is very limited in the region because of salinity of water. Most of the land which had some access to tubewell irrigation in the villages is primarily irrigated with canal water. But the availability of canal water is also very scarce in the region, the households with operational holdings of 25 acres and above, in the middle reaches mix tubewell water with canal water for irrigating land before sowing in the rabi season. The access to irrigation across households in each village is more unequal than across the villages. The

primary reason for the differences in the access to irrigation among households within each village is the location of land, of holding and fragmentation of land. On an average, land in the tail end village receives 36 per cent less irrigation for an acre as compared with the village in the middle reaches.

The access to irrigation affects the cropping intensity, cropping pattern, employment structure and also the accumulation of assets in the surveyed villages. There is not much difference in the cropping intensity across the middle reaches and tail end villages. Both villages cultivate guar in the kharif season, which is a less water intensive crop. But the cropping pattern in the rabi season is different across the villages, as the intensity of barley crop (an irrigated crop) cultivation is almost double in the middle reaches villages. And in the tail end village, the intensity of chick pea (less water intensive crop) cultivation is 7 times higher than in the middle reaches. Other then these crops, highly water intensive crops, such as sugarcane and kinnu orchards are cultivated only in the middle reaches, though the share of these crops in the operational holding is small (6.3 per cent).

A comparison of the cropping pattern with that observed in an earlier survey of 2006-07 in 25 F (by FAS, as part of Project on Agrarian Relations in India) suggests that the cropping pattern of the region has changed drastically. The reasons for the cropping pattern change is the scarcity of irrigation water, an enormous rise in price of guar and high cost of cultivation of cotton. As discussed, the availability of water for irrigation is very limited and it was particularly scarce in the kharif season earlier. As a result, a large share of operational holdings were kept fallow in the kharif season. Also, the sharp increase in the prices of guar in the financial year2011-12 and the high cost of cultivation of the cotton crop resulted in changes in cropping pattern, involving bringing a large area under guar cultivation. With the cultivation of guar (a less water intensive crop), both seasonal fallow land was brought under cultivation and guar replaced cotton significantly. As a result cropping intensity has also increased from 1.24 in 2006-07 to1.77 2014-15 in 25 F. The change in the kharif season cropping pattern also changed the cropping pattern in the rabi season in the village, as the remains of the guar crop can also be used a manure

for wheat and barley. In the rabi season the area under rapeseed witnessed a decline and the area under wheat and barley cultivation increased. Interestingly, even with the subsequent sharp decline in guar prices after financial year 2012-13, the cropping pattern in the village has not changed. This is because the cost of cultivation of cotton is almost double that for guar, so that per acre net incomes from guar cultivation are higher by around Rs. 2000 in 25 F and around Rs. 5000 in 63 F in 2014-15.. The per acre net incomes have witnessed a decline in 25 F from 2006-07 due to decline in the minimum support price in real terms. But with the increase in cropping intensity the households are still able to earn higher profits annually.

The economic impact of irrigation indicates that increased irrigation of land changes the per acre net income enormously. As the households with large operational holdings have greater access to irrigation, therefore these households also have high per acre income. However, this is not to say that only irrigation determines crop production or crop incomes, since the access to irrigation affects the use of other inputs and technologies, which affect production levels.

The changes in the cropping pattern towards the less water intensive crop and then the increase in the cropping intensity have increased the incomes of cultivator households. On the other hand, wage employment in agriculture is affected adversely because guar is not only a less water intensive crop but also a highly mechanised crop unlike cotton which is a labour intensive crop.. The average days of employment in agriculture in 25 F, where workers were mainly wage workers in agriculture, has declined sharply between 2006-07 and 2014-15. As a result, a large proportion of workers are working in both the agricultural and non-agricultural sectors now, in order to earn their livelihood. The impact of the changes in the cropping pattern was particularly adverse on women workers, who were mainly wage workers in agriculture due to lack of alternative employment opportunities. The displaced workers from the farm sector have been working in the non-farm sector, but that sector has not been able to provide similar levels of employment to displaced female workers from agriculture. The important source of non-farm employment for female workers is the MGNREGS. Male workers are primarily

casual workers in the construction sector or in MGNREGS projects. Construction work is also very temporary in nature as the demand for house construction rose after the income earned from guar increased, and will fall subsequently once demand has been met.

The level of employment varies across the middle reaches and the tail end because of differences in the agrarian structure of the villages. First, the small scale of holdings in the latter have lower levels of hired labour in agriculture; and, secondly, the lower levels of diversification and mobility in the tail end village also limits opportunities in the non-farm sector. The availability of wage work for female workers is even lower. Self-employment in small scale businesses is also not sufficient for economic survival of households belonging to poor or marginalized backgrounds. Therefore, these households have to depend upon wage employment in MGNREGS due to lack of regular employment.

Lastly, the average wage rate of casual workers has increased immensely between 2006-07 and2014-15. In 2014-15, there was not much difference in the average agricultural and non-agricultural wage in the middle reaches villages. Wage employment in agriculture is available only for a small number of days during the harvesting season, though the harvesting and post harvesting operations generally have had higher wages in agriculture and as result there is not much difference in the agricultural and non-agricultural wage in the village. The average wage in the MGNREGS is almost 50 per cent lower than the average casual wage in the non-farm sector. The wages for MGNREGS in the surveyed villages are much lower than the minimum wage (Rs. 197 per day) for unskilled workers in 2015.

The irrigation availability along with other inputs, affect the cropping intensity, cropping pattern, incomes from cultivation, and employment and wages in rural India. Analysis of distribution of asset holding is an important indicator of the economic condition of the households as well as of the village. The high level of inequality in asset holding is associated with a high degree of landlessness and high level of income inequality in the

village because land as an important means of production has the highest share (more than 80 per cent) in the value of total assets as well.

Middle reaches village, 25 F, has a high level of asset inequality as the value of the Gini coefficient for this village is 0.82 as comparedwith0.64 in 63 F. A decomposition of these Gini coefficients by different asset groups shows that the value of land has the highest relative contribution to the Gini coefficient. So it is clear that high level of asset inequality has been generated by a highly l unequal distribution of land in the village which is evident from the level of landlessness. In 25 F, 69 per cent of households are landless and in 63 F almost 8 per cent households are landless.

The concentration of land and other assets are the basis of class power in the region. Of all households in 25 F, 65.5 per cent are Dalit households who have only 1 per cent share in total asset value of the village. The remaining 99 per cent of total assets value is in the hands of non-Dalit households and among non-Dalits, mainly in the hands of Jat Sikhs. On the other hand, in 63 F, where the level of asset inequality is low, 19 per cent of non-Dalit households have 47 per cent share in the total asset value and the Dalit households (81 per cent of total households) have a 52.6 per cent share. Other than these social classes the distribution of assets in different economic classes is also very unequal. Other than households from peasant classes and rent receivers, a small share of households own agricultural land in the middle reaches village. The share of manual worker households with agricultural land holding is negligible (0.6 per cent) in 25 F and very low in 63 F (4.4 per cent). ‘Homestead land and house’ remain an important asset among manual workers. Concentration of land not only increases the concentration of productive means of production of agriculture in particular, but also increases the concentration of household assets because it is the most important source of income generation in rural areas. Therefore, the share of manual worker households in the other means of production of agriculture, non-farm productive assets, means of transport and trees, is also negligible. Other than land and building, they have only ownership of livestock as their main asset.

8.3 *Discussion*

This study finds that canal water distribution varies according to the length of the distributory or minor, the size of outlets, and also with the location of the village on the distributory. The length of distributories/minors and also the size of the outlets were planned in such a way that each plot of land receives equal amount of water. Water availability declines towards the tail end.

As a result of this inequality in water distribution, the earnings of tail end farmers are lower than those in the middle reaches village. The households with greater access to land in the surveyed villages have higher access to water as well. As a result of higher control of water resources the per acre net incomes are much higher of households with large holdings than the per acre net income of households with small and marginal holdings. In other words, the households with large operational holdings (25 acres and more) not only have most of the land but also the best land. The cropping pattern of the region changed from water intensive crop to less water intensive crop because of various reasons such as short falls in the availability of irrigation, increase in the price of guar and also because of the high cost of cultivation of cotton. However, while household crop incomes have witnessed an increase because of increase in cropping intensity, the cultivators of the area are exposed to larger market risks, especially with trade liberalisation, as there is no government support price for guar.

The labour use in agriculture is not only determined by the cropping pattern but the technologies used in cultivation. Besides, size of holdings also determine labour use. As the cropping pattern in the surveyed villages has changed from a labour intensive crop, cotton, to a mechanised crop, guar from between 2007-08 and 2014-15, there has been a displacement of workers from agriculture. The sudden rise in the prices of guar increased agricultural incomes enormously, which resulted in high demand for labour in the construction sector in 25 F. As a result, the employment created in the non-farm private sector are directly linked to agricultural incomes in 25 F. The employment in the construction sector in 63 F is, however, not as high as in 25 F. The reason for this is the

small size of holdings and lower level of income per household as comparedwith25 F. Non-farm sector employment in the public sector is only in MGNREGS, in which too the average days of work provided is much lower than planned under this scheme. With the limited availability of non-farm sector employment, larger labour reserves are created, of female workers in particular. It is also too early to arrive at the conclusion that private investment in the non-farm sector can provide employment to the displaced workers from agriculture, as the incomes of the households are directly linked with the demand generated by the higher prices of guar in the international market. Irrigation not only affects production levels but income generation as well, which matters as a majority of rural households still dependent on agriculture.

The control over land and higher access to irrigation affects the accumulation of assets by the households. The share of different assets indicate that the investment in non-farm businesses is low in the surveyed villages. The main focus has been on accumulation of agricultural land and agricultural means of production. That is, agriculture not only remains the main source of income but also larger volumes of agricultural assets are accumulated by these farmer households, because of land being the source of social and economic power in the village.

8.4 *Policy Implication*

The results of the study point to some strategic issues that need immediate policy attention.

The unequal distribution of water resources across the households and villages needs immediate government intervention, so that each plot of land receives equal amount of water across the head, middle and tail ends. To start with, the size and height of the outlets on the distributories and minors needs to be changed according to the level and location of land on the respective distributories and minors. Also completion of the modernisation project of the Gang canal is imperative, so that the wastage of water through seepage etc is controlled and the households get greater water access.

Other than equality in water distribution, land reforms and the land ceiling acts also need to be implemented in the region, as the households which concentrate land in their hands also benefit from public water resources.

With the changes in the policies over time since the 1990s towards market liberalisation, the rural markets are opened for trade as well. On the other hand, the government support for crops has declined in real terms. In the case of certain crops such as guar, there is no MSP being provided, and the cultivation of such crops is driven by market demand. In other words, these crops are exposed to larger market risks.

As discussed above the employment in the non-farm private sector is generated by the forward for backward linkages with agriculture. The only source of public employment is MGNREGS, but the days of work provided under scheme is very low. The non-farm employment in the private sector is directly influenced by the incomes of the cultivator households. This linkage needs to be weakened so that non-farm employment is a sustainable alternative for those being displaced from agriculture.

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