CONTENT

EXECUTIVE SUMMARY

In the 1960s, India witnessed the Green Revolution: an era of historical, unprecedented enhancement in agricultural production (Krishna Kumar et al. 2004) that helped avert potential regional famine conditions (Hazel 2009). Growth and intensification of irrigation was a significant chunk of Green revolution: India's 40 % agricultural production comes from irrigated crops and 80–90 % of all water withdrawals in India are for irrigation purposes (Douglas et al. 2006; Mall et al. 2006; Lal 2011). Amongst the gush of coercion to human survival perhaps the most urgent but least ranked lies below our foot: groundwater. Statistics about India's groundwater depletion are depressing. India is the chief consumer of groundwater in the world with agriculture sector accounting for 78 per cent of water use in the country (NABARD,2018) and, because of the green revolution, groundwater replenishment has been incompetent to endure aquifers across many parts of the country. Conferring to a 2016 report by the Indian parliamentary committee on restructuring the Central Water Commission and the Central Ground Water Board, "the growing dependence on groundwater has taken the form of unsustainable over-extraction, which is lowering the water table and adversely impacting drinking water security." India accounts for 25 per cent of the world's extracted groundwater and contamination is a grave delinquent all over the country, with many crucial agricultural regions suffer from both groundwater overexploitation and pollution. Central Ground Water Board also reports that Rajasthan follows Punjab among the states of India in the rate of groundwater depletion in India. There are no such reports that rank the tehsils and villages of Rajasthan. So there is a need for a village-specific study to get a holistic picture of the groundwater status and causes of depletion of the villages of Rajasthan.

Among the villages of Rajasthan, Khohar village in Ramgarh Taluk has a unique significance due to its acute water scarcity and distressed seasonal migration. The study area is inhabited by approximately 150 households with an estimated population of 800 (census, 2011). Located at the foothills of Aravalli, the village has a vast potential of harvesting rainwater, but due to lack of water storage structures, the rainwater runoff into village farmland is extensively causing damage to the soils. An analysis of water scarcity challenges in Khohar village advocates that water security is one among the main problems that hinder the economic development and food security of the area. The village has an acute water shortage due to constant depletion of groundwater with the depths of bore wells stretching from 1000 to 1200 feet since 2016. Maximizing water productivity is the primary challenge to agricultural sustainability in Khohar. Depletion of groundwater sources is magnified by both demand-side practices of the villagers and the specific hydrogeological settings of the aquifer. Despite significant challenges, solar desalination, wastewater management and groundwater recharge provide opportunities for improving the water security in the region. In this backdrop, SM Sehgal Foundation has constructed a check dam in considered location of the village for promoting groundwater recharge to combat the impacts of over-exploitation. The construction commenced from July 2014. The

construction of check dam has permitted seasonal monsoon rains to be detained for far longer, maximising the accessibility of a natural resource ecologically. This practice, in turn, has enabled farmers to become significantly more efficient and therefore makes agriculture more profitable. Despite the widespread presence of groundwater recharge check dams and research around it, few studies have been impressed using mixed approach to measure the functionality and impact of the structure thus constructed. The current study attempt to capture the overall impact of check dam in Khohar village on the livelihoods of villagers and the extent to which the dam has addressed the water-related issues in village. The study evaluates water trade and agrarian markets of Khohar and its significance post check dam. The study also tries to understand community's perception towards water conservation using check dam

For this purpose, the study adopted a mixed method approach that includes quantitative, qualitative, UAV and GIS-based approaches for data collection. The study employed Participatory Rural Appraisal (PRA) tools like Focus Group Discussions[1], Key Informant Interviews, non-participatory observation, Transect walk and Informal interviews. In order to capture the differential perspective of villagers, information is collected from the people of various sections in the village, i.e. senior people of the village[2], owners of bore-wells, those who purchase water for irrigation, the landless, women of the community and members of the Water Management Committee. Data was collected from them on the aspects such as significant events in the village in the past, how water was procured, how it changed, significant post check dam *etc*. They were queried whether there are wide gaps between these events recall method. The results/entries were validated. Alongside PRA, GIS and UAV (Unmanned Aerial Vehicle) were used to depict non-spatial information spatially. Geographical Information System (GIS) was used to store, and analyse geographic data. In the study, for impact analysis, UAV and GIS we used to 1) investigate the change in green cover post check dam and 2) depict the groundwater level information of the village on a digitised map to analyse the Water Foot Print (WFP). Software used for analysis was ERDAS and Quantum GIS. The study adopted the indicator approach in measuring sustainability of livelihood. The index included six significant components: Socio-Demographic Profile, Livelihood Strategies, Social Networks, Health, Food and Water. Each component comprised of several indicators or sub-components. These were developed based on a review of literature of each component, as well as the feasibility of collecting the needed data through household surveys. The LVI in the present study uses PCA (Principal Component Analysis) to assign weight where each sub-component contributes differently to the overall index, and each principal component is comprised of a different number of sub-components. investigates the gendered differentials of migration through research. The study also attempts to give a holistic view on seasonal migration wherein entire family leaves for agricultural labour work to Punjab and Gujarat every year. As the migrants are purposively selected from the population, Heckman probit model was used to estimate the variables that contribute

to the decision to migrate. Qualitative methodology was used to analyse the gendered perspectives on migration Perception towards check dam was determined by using perception scale. In psychology, an attitude is a psychological construct; it is a mental and emotional entity that inheres in or characterises a person. They are complex and an acquired state through experiences. The method of summating rating suggested by Likert (1932) and Edward (1957) was followed in the development of the scales.

The study concluded that radical changes in water level that reflects on the groundwater table over a period of two years. Low recharge along with excessive exploitation is the primary cause of rapid depletion. Therefore, the planned recharging of groundwater along with proper irrigation could be a promising solution to reduce WFP. Farmers need to monitor and make their water use more efficient in keeping with what is available by altering their crops and swapping to more efficient irrigation systems. Irrigation scheduling involves managing the soil reservoir so that water is open when the plants need it. Evapotranspiration monitoring and weather forecasting should be used to determine the time of irrigation, soil texture, cropping pattern and how much water for irrigation. Unanimously, the low height structure of the dam is found to be the primary concern of the villagers, which, according to them is unable to store more water for an extended period. They want an increase in the depth of the dam to accumulate and retain more rainwater, which eventually will recharge the groundwater in a short span of time. The Livelihood Vulnerability analysis reveals that the medium farmers are more vulnerable than small and large farmers. Medium farmers are entirely dependent on agriculture with less livelihood diversification index and less crop diversification index. Probit model shows that there are significant differences in the socio-economic variables of migrating and non-migrating farmers The perception scale reveals that people generally agree that there is acute water scarcity and steps should be taken to conserve water. However, they blame the erratic rainfall and structure of dam as magnifying causes instead of putting an effort to conserve water. Awareness is not the issue, and attitude change is the need. Constructing a check dam in Khohar will not only help in curbing the future water struggle but will also increase the agricultural output, provide a guarantee to food security, enhance groundwater resources and potentially reduce uncontrolled migration and poverty of the village in the coming time.

[1] Six group discussions were held with the people of cross sections in the village. Each FGD was containing people from 5 to 10 persons. One FGD was held separately with the women of the village to capture the gender perspective regarding water markets and trade.
[2]Senior people are those persons above 60 years of age and was residing in Khohar for more than 40 years.
[3]For is maintaining sustainability of structures built under the project like check dams, Sehgal foundation forms Village Development Committees (VDCs) that take leadership role in operation and maintenance of structures. Community contribution is collected to create a feeling of ownership among beneficiary communities. These contributions are channelised into maintenance funds managed by VDC members. VDC ensures long-term sustainability of physical infrastructure.

Chapter I

Introduction

1.1. The Background

Conventionally, in India, water was stored through various water conservation and harvesting techniques for the dry seasons of the year. *Tankas, kund, kundi, Talab, Vadis,* step wells etc. are just a few means to practice conservation and harvesting. However, these traditional water harvesting technologies have been outdated due to negligence and negligence through time. Recently, intrastate and interstate water conflicts in the country, increased pressure on agricultural land, lessening in natural resources, increased dependency on government supplies and overutilization of groundwater resources (80% of the country's drinking water is from groundwater resources). Thus the present condition has demanded determined efforts from all the concerned sectors, public and private, to manage water right from catchment to conserve all the run-off for optimal utilisation.

Along with this line, the literature suggests that 'check dams' are the most commonly constructed structure in many lands and water conservation programmes. A recharge check dam is a barrier that is placed across a river or channel to slow the movement of water, facilitating groundwater recharge. Check dams are a cost-effective way for intentional recharge of groundwater aquifers. They are defined as a solid mass that breaks the flow of water. Water which then is retained percolates in the soil. Water which infiltrates in the soil can then be put to several uses, which in the absence of check dam can go unutilized if it percolates into a saline water area or creates water-logging problems due to zero percolation.

Understanding the multitude of benefits of constructing a check dam, SM Sehgal Foundation with support from Mosaic Company Foundation, S M Sehgal Foundation implemented the project titled "Construction of Check Dam for Rainwater Harvesting at Devi Mandir Khola, village-Khohar(Alwar) Rajasthan" in Khohar village of Alwar district of Rajasthan. The foundation team initiated work in the year by organising focus group discussions, community mobilisation meetings and site identification during this period. Khohar check dam is a wall like structure that is standing as a barricade in front of flowing water from hills during monsoon. After the rain is over, water which is retained by check dam percolates in soil within 48 hours. Excess rainfall sometimes results in an overflow of water. Apart from the wall which is called the spillway, there are four *nallah* bunds, four loose stone structures and two recharge wells. Nallah bunds and freestone structure act as a speed breaker for flowing water; recharge wells are constructed to facilitate the infiltration of flowing water.

Check dams are primarily relevant for reducing the velocity of water that aids in the recharge of groundwater. There are so many check dams across India that restores groundwater and helps in maintaining the water table, but there is lack of pertinent data and the difficulty in capturing the status of every individual check dam. There is no specific research evidence available on the effect and

function of these check dams. However, it can be triangulated that, as the dams store water for irrigation, the sediments and nutrients also get stored while they are entrained by a stream (Agoramoorthy Hsu, 2008). In line with this, the foundation decided to evaluate a pre-and post-dam scenario concerning the cropping pattern, livelihood changes, water table changes and perception changes. For this purpose, semi-structured interview schedule, PRA techniques, GIS maps, drone survey of the area to create a very detailed base map of agriculture land holdings and a satellite image-based study of last year's cropping pattern was carried out.

The report is divided into eight chapters. The chapter one gives introduction to the groundwater situation, importance of check dam, primary objectives, the project and significant issues. Chapter two provides a detailed review of the literature on regional development and backwardness done majorly in the context of India. Chapter three provides a detailed overview of water markets and water trade. In the fourth chapter, an analysis of agriculture and its water footprint is done. Chapter five provides a micro-level analysis of the livelihoods and the factors that determine the sustainability of the livelihoods Chapter six gives an idea about the perception of farmers towards check dam. Chapter seven is the concluding chapter, and chapter eight gives the references used.

1.2. The Study Area: Khohar is a village in Alwar district of Rajasthan (Figure 1). It shares its border with Haryana state. Total geographical area of the village is 378.0 Hectare (1 Hectare=2.5 acre). Khohar has 170 households of which 125 are landholders. Table 1 shows the significant demographic details of the village. Land under cultivation is approximately 450 bigha (farmers of Rajasthan report land units in bigha, equivalent to 0.625 acres). The 450 bigha land is spread within the 5 km square range from check dam. Soil of the area is light in texture, particularly sandy, sandy loam and clay loam. The upper hills are mostly barren. The district area is mainly underlain by alluvium of Quaternary age which forms the principal groundwater reservoir. Some amount of groundwater also occurs in fractures, joints and crevices of hard rocks found as strike ridge in the district. Groundwater in the upper zone is known to exist down to 70 m depth and hold water under phreatic condition. Aquifers that occur at more profound levels are confined to semi-confined. Central Ground Water Board (CGWB) has carried out exploratory drilling in the area with the depth ranging from 39 m - 291 m. The data of exploratory boreholes reveal that in the deeper zones, alluvial formation comprises sand, clay and kankar in varying proportions. These sediments rest upon the basement of rocks of Delhi System. Alluvium thickness varies from almost insignificant near to the hill range to above 291 meters in the area. The exploratory drilling in the area indicates highly undulating bedrock in entire area.

In 2014, the check dam constructed by Sehgal foundation in collaboration with village farmers was to conserve water when it rains and uses at a later date. Since the topography immediately to the west of

the village was hilly, it was found to be most appropriate to construct the dam just upstream of the village.

Table 1: Village demographics of Khohar

Village Demographics	**Census Figures**
Total Population	890
Total No of Houses	170
Female Population %	47.9 %
Total Literacy rate %	57.1 %
Female Literacy rate	20.9 %
Scheduled Tribes Population %	0 %
Scheduled Caste Population %	0 %
Working Population %	73.5 %
Child(0 -6) Population by 2011	108
Girl Child(0 -6) Population % by 2011	45.4 %

(Census,2011)

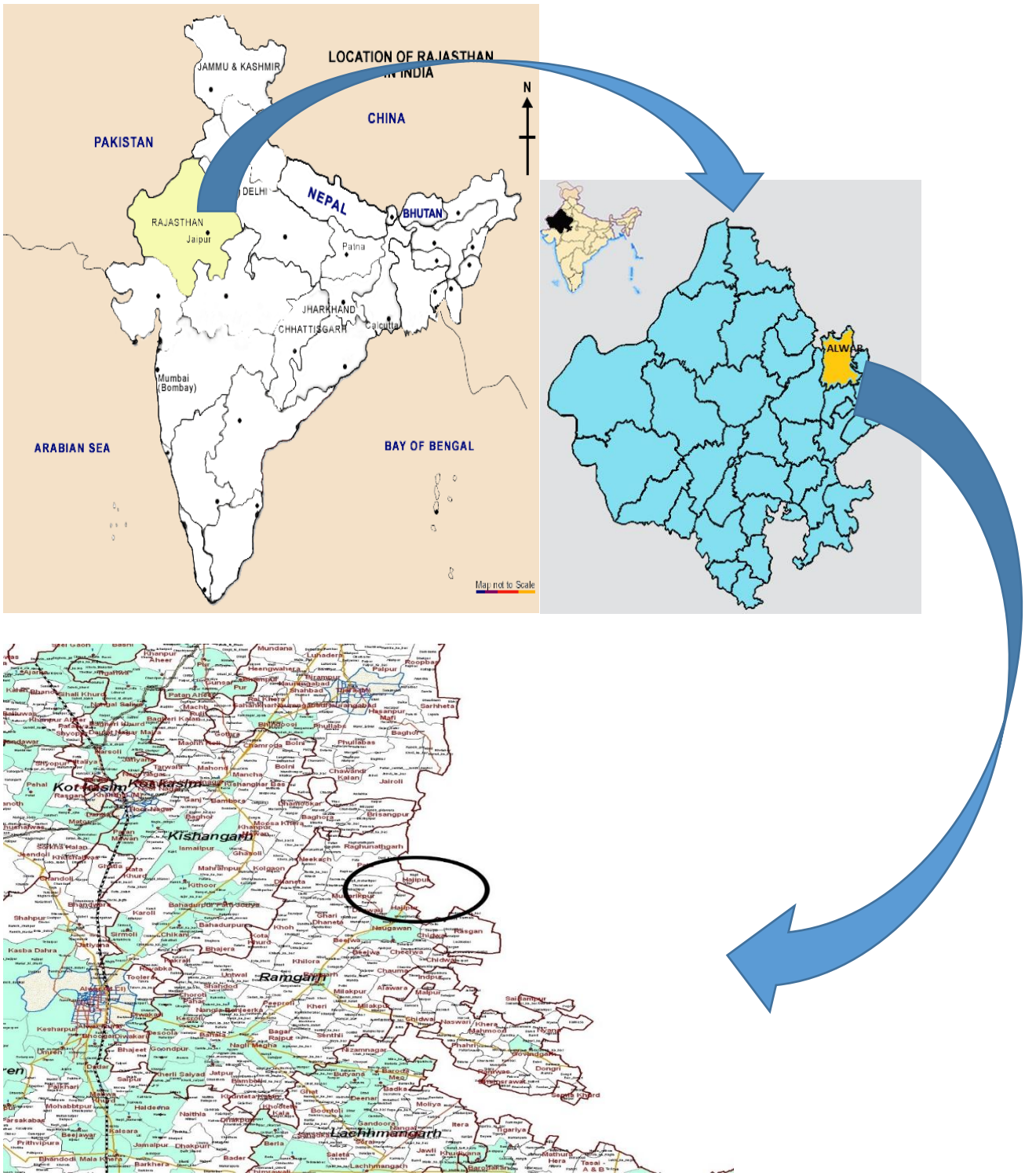
1.3. The major issues:

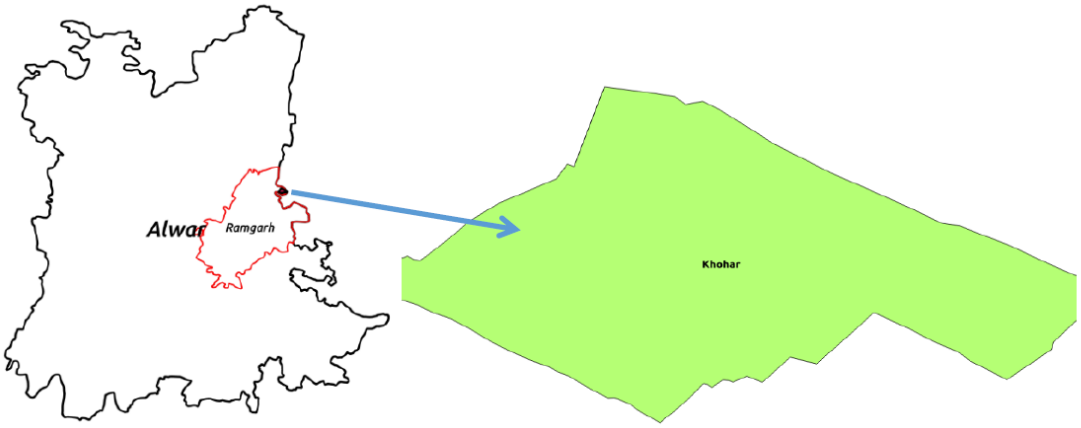
Contamination and over-extraction are compounding problems in Khohar. Khohar has stressed aquifers are generally more susceptible to water quality problems. The socio-economic implications are severe in the long term, as groundwater problems are concentrated in provinces with large populations and high agricultural productivity. The area faces severe water shortages and groundwater quality problems due to over-exploitation of groundwater for agriculture and domestic purposes, too much use of fertilisers, pesticides in agriculture and due to the scarcity of rainfall.

The other issues are high gradient and low retention time for rainwater runoff, low permeability leading to poor groundwater recharging, excessive pumping for domestic and agricultural use, rapidly depleting fresh groundwater aquifers and encroachment of saline groundwater over freshwater resources.

Water availability was not an issue in the region until a few years ago. It was due to an increase in population, shrinking agricultural area and change in cropping pattern that water availability became an issue. Due to its proximity and excellent connectivity to major cities like Alwar, Gurugram and big Metros like Delhi and Jaipur, the local farmers are attracted to produce cash crops like vegetables (onion, brinjal, tomato etc.). In the absence of micro-irrigation facilities, flood irrigation has resulted in rampant exploitation of groundwater resources, and groundwater levels and drying off many bores well.

Over last few years, water resulted in reduction of domestic water supply to the village to alternative days barely for 1 hour only during summers.





Khohar Village boundary inside District and Sub-District boundary

Figure 1: Map of Khohar

1.4. About the Project:

The project is located at the Chamunda Mata Mandir, Khola in the village Khohar. It involves the construction of a 185-meter-long and 3-meter-high check dam with a capacity to hold 32 crore litres of rainwater. Two piezometers have been installed for regular monitoring of recharging water. As per the Project Progress Report (PPR), a good number of community mobilisation program for sensitisation, capacity buildings were conducted. A water management committee has been constituted with 13 members selected from the village for the maintenance of the dam. The project implementation process commenced in July 2014.

1.5. About the study

1.5.1. Objectives

Keeping in view the above circumstances, the present study entitled “Mapping Water Market Value Chain and Impact Analysis of Check Dam on the Livelihoods of Khohar Village, Rajasthan, India” is conceptualized with the following objectives:

1. Investigate the water market value chain in Khohar
2. Analyse the impact of check dam on livelihoods of water buyers and water sellers of Khohar
3. Analyse the impact of check dam on the agricultural situation of Khohar
3. Understand community's attitude and perception towards water conservation

1.5.2. Research Questions

Q1. How did the water markets and water trade evolve in Khohar? Is there any significant difference post check dam?

Q2. To what extent does agriculture result or contribute to water footprint in Khohar?

Q3. What is the impact of check dam on-farm livelihoods of water sellers and water buyers?

Q4. What is the impact of check dam on non-farm livelihoods on water sellers and water buyers?

Q5. How has the cropping pattern changed after construction of check dam?

Q6. What are the factors which affect the community's decision making, perception and attitude towards water conservation, uses and issues?

1.6. Methodology and Tools

1.6.1. Theory of Change

Theory of Change is mostly a comprehensive description and illustration of how and why the desired change is expected to happen in a particular context. It is focused in particular on mapping out or “filling in” what has been described as the “missing middle” between what a program or change initiative does (its activities or interventions) and how these lead to desired goals being achieved. It does this by first identifying the desired long-term goals and then works back from these to identify all the conditions (outcomes) that must be in place (and how these related to one another causally) for the goals to occur. These are all mapped out in an Outcomes Framework. Our theory of change is predicted by the fact that inception of check dam by Sehgal Foundation brought about an impact on the livelihood and groundwater level (Figure 2).

1.6.1.1. Assumptions

The study is developed with the hypothesis that check dam facilitates groundwater recharge thereby aiding irrigation and also provides water for human and animal consumption.

The fundamental assumptions underlying the theory of change for Khohar Check dam intervention are:

- There is over-exploitation of groundwater for agricultural purposes

- The crop determination is directly linked to market access, not to water availability
- Check dam along with other water harvesting measures recharges groundwater
- Attitude and perception of people regarding water conservation are equally essential to save water.
- Training and awareness imparted can exert a positive influence on farmer's decisions.

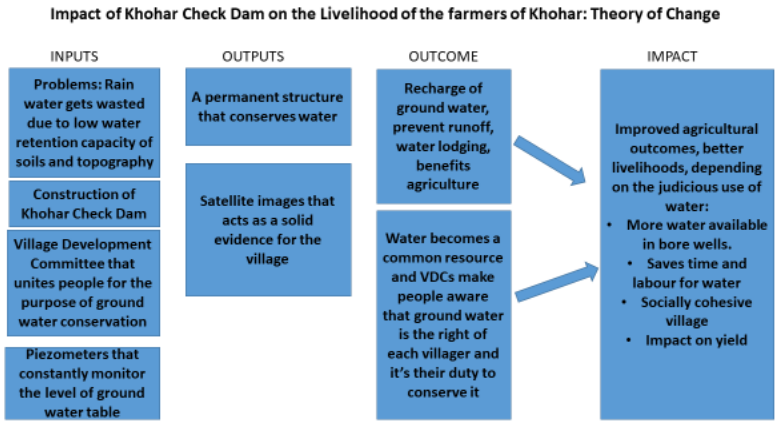


Figure 2: Theory of Change framework

1.6.2. Research Design: Exploratory, diagnostic and mixed research design was followed.

Exploratory research, as the name states, intends merely to explore the research questions and does not intend to offer final and conclusive solutions to existing problems. Thus in the present study, to analyse the water markets and water trade, to determine the nature of the problem exploratory research design is used. Being concerned with the specific characteristics and existing social problems, the diagnostic research design endeavours to find out the relationship between specific causes and also suggests ways and means for the solution. Thus, the diagnostic studies are concerned with discovering and testing whether specific variables are associated. Therefore for the livelihood analysis, the diagnostic method is used. For the study, GIS and satellite methodology was used to confirm the impact of check dam that employs mixed research design.

1.6.3. Sampling

The check dam was constructed in Khohar village of Ramgarh tehsil in Alwar district of Rajasthan. Thus the selected village for the study was Khohar. For construction of check dam, Alwar district of Rajasthan was selected purposively as this district is facing acute water scarcity issues and there is a scope for a water conservation structure like check dam near to the hills. The entire population of village was surveyed for the study.

1.6.4. Data Sources

The study employed majorly primary data collected from the farmers of Khohar. A questionnaire was designed, tested and administered at the household level to collect socio-economic and demographic

profile of respondents. Primary data on water, social networks, livelihood strategy, health, food component were collected administering semi-structured interview and through participatory rural appraisal techniques like transect walks, focus group discussions, timelines, seasonal calendar, key informant interview and problem tree analysis. Primary data collected from farmers was validated with the progressive farmers, data from previous studies and through Patwari (land record officer) of Khohar. The study also utilised secondary data sources such as NCEP/NCAR Reanalysis meteorological data from NOAA ESRL Physical Sciences Division (PSD) data sources, IMD data and CRU 3.23 (Climate Research Unit, UK). Climatic indicators were calculated from the high resolution daily gridded temperature and rainfall data for the Indian region during the period of (1901–2018). Secondary data on the district-wise demographic features like population density, percent of females engaged in agriculture, rural literacy rate and household data like rural households availing banking services, households not having drinking water sources at their home premises were taken from the official website of Census of India.

Chapter II

LITERATURE REVIEW

The review of literature chapter is divided into three primary sections according to the objectives of the study.

2.1. Impact of Check dam:

Several studies have been conducted to assess the multiple dimensions of the impact of check dam on beneficiary communities. Impact of groundwater depletion is more apparent at the regional scale in an agrarian system whose irrigation depends on groundwater table and monsoon. Artificial recharge is a technique used to prevent over-exploitation of groundwater resources. Artificial recharge is the progression of replenishing groundwater by augmenting the natural infiltration of rainwater or surface water into subsurface aquifers through several methods depending on the slope, geomorphology, geology and soil conditions. Check dams are artificial recharge structures, an ancient technique that can be dated back to second century AD (Mississippi Department of Environmental Quality, 2014), it acts as a barrier across a stream and its basic principle is reserving potential energy by interrupting the flow of water (Marsh, 2010). The artificial recharge through the check dam was proven to be higher than the natural rainfall recharge concluded by the comparative estimation between the percentage of natural rainfall recharge and artificial recharge in the granitic terrain of Hyderabad (Murlidharan, 2007 Ashraf et al. (2007) leading to an improvement in vegetation, which consequently enriched the biodiversity (Saxena et al. 2010). Researches also suggest that increasing the number of wells around the check dam structure can yield maximum benefit (Mudrakartha, 2003). Research on the impact of check dam in agricultural activities of local farmers, especially in the summer season yields that the check dam has increased the scope of growing cash crops even during summers period which was not happening before the check-dam (Balooni et al., 2008). Researchers also indicated that the check dam has increased the recharge from 6% to 40% (Neumann 2004; Gale et al. 2006; Muralidharan 2007; Alderwish 2010).

The impact of dams on livelihoods emphasises the need for an integrated assessment to solve the problem of inequitable distribution of water among upstream and downstream users. Impact of small water harvesting and artificial recharge interventions in Singoda river basin, coastal Saurashtra, India was made by Niranjan and Srinivasu (2012). They compared the pre-monsoon water levels of the wells located near to the check dam and far from the check dam. The study findings indicated that the average rise in groundwater levels in the wells near the check dams was 9.63m as compared to the increase of 7.64 m for the wells located away from the check dam. Further, the wells located within the influenced area yields 3 to 7.35 litre per second and water spread area in the basins increased by 3,024 hectares during monsoon season. Pandey et al. (2004) assessed the influence of a check dam in Rozam, Gujarat, India by observing the groundwater levels in 50 open wells. They observed that the water table had gone up by 2.57m in the year 2002 and 2.10m in the year 2003 in 50 open wells. The excellent yield had increased from 0.64 litres per second to 1.50 litre per second in the year 2002 and 1.72 litres per second in the year 2003 after the programme intervention. The comparison of pre and post programme

data indicates that the programme had resulted in increased productivity, improved income and better food availability. These studies indicate that the recharge of water stored by check dams increases groundwater level. It is better to locate the extraction wells at an optimum distance from the check dam in order to get the maximum benefit of recharge. Check dam can function more efficiently by periodical silt removal or discharge the water at periodic intervals to increase the recharge on the downstream. Examination of the impact of check dams on agricultural development and farmers was carried out by Khlifi (2010) in Northwestern Tunisia. A socio-economic survey was carried out by questionnaire with the farmers living around the dams. The water conserved by the structure was used by the farmers to irrigate seasonal vegetable crops, fodder, and especially fruit tree plantations, indicating shifts in the farming systems. Sheep productivity was doubled as a consequence of better foddering due to the availability of water. The average annual net income for the local community doubled due to increased production of crops and livestock. Evaluation of the sociological impact of a check dam in Madhya Pradesh, India was carried out by Khosla (1999). Quantitative data related to check dam impact was gathered through household surveys using the pre-tested questionnaires. The survey indicated that construction of check dam led to increased water availability. People eventually built better homes due to increased income as sustained agriculture was made possible due to the check dam. Most of the research work on check dam by Mudrakartha (2003), Palanisami et al. (2003), Gale et al. (2006), Neumann et al. (2004)) indicate a positive impact on livelihood. Researchers who have used groundwater level measurements to evaluate the impact of check dams as explained in previous sections have also looked into its impact on the community. A set of questioners distributed to people living around the check dam helped them determine that the check dam has increased crop production, the yield of well for irrigation and livestock. All these had led to an increase in the income of farmers

2.2. Groundwater quality

Quality of water is equally important as is quantity. Water stored in the check dam is primarily rainfall drained as runoff from different land use of the catchment. Hence, the recharge of this water may change the hydrochemical characteristics of the groundwater. Regarding groundwater quality, studies indicate no significant improvement due to recharge (Gale et al. 2006). Whereas, specific studies ((Palanisami et al. 2006; Bijukumar & Abraham (2009); Samarah et al. (2009)) indicated a decrease in concentration of ions in groundwater due to recharge from the check dam. Bijukumar & Abraham (2009) find that the groundwater quality has deteriorated due to recharge from check dam. Improvement in groundwater quality is dependent on the quality of water stored by the check dam.

A study cites that Check dam in Gujarat had improved the groundwater quality and even reduced the concentrations of toxic ions such as arsenic, fluoride and boron due to the dilution from recharge (Mudrakartha, 2003). Impact of check dams on the groundwater quality of a tropical river in Kerala, India was studied by Bijukumar et al. (2009). Electrical conductivity, alkalinity, nitrite, sulphate and total suspended solids of surface water from both upstream and downstream areas did not vary much

throughout the year whereas, phosphate, nitrate and total dissolved solids exhibited significant seasonal variations in the upstream area of the check dam. The high concentration of water in the upstream of check dam was due to the use of impounded water for washing, bathing coupled with leaching of nutrients from the nearby agricultural fields. This research indicated that recharge of this water would affect the groundwater quality. In another study, groundwater level measured by Gale et al. (2006) indicated that water level raised only by a few centimetres due to a check dam in Tamil Nadu, India in a region comprising of gneissic and charnockite rocks. Due to the poor recharge from the check dam no significant improvement in groundwater quality was observed by them. In general, research carried out on the impact of check dam indicates a decrease in concentration of ions in groundwater due to the recharge of relatively good quality water from the check dam. However, improvement in groundwater quality is dependent on the quality of water stored by the check dam. Hence, it is important to maintain the quality of water stored in the check dam by taking certain precautions like preventing discharge from the nearby agricultural lands, dumping of domestic wastes, release of sewage etc. The utility of check dams for dilution of fluoride concentration in groundwater was assessed by Bhagavan and Raghu (2005) in Andhra Pradesh, India. Fluoride concentration in the groundwater was 1.6ppm to 3.5ppm which is beyond the permissible limit (1.5 ppm) for using it as drinking water in the study. A check dam was constructed in the upstream part of the region with high fluoride groundwater. They reported that after the construction of check dam, the fluoride concentration was reduced to the amount 1.5 ppm which is not harmful to human health. Evaluation of quality of groundwater recharged by the check dam was made by Samarah et al. (2009) at Southern Jordan Valley, Saudi Arabia. The concentrations of samples at different periods indicated that there was an increase in total dissolved solids (TDS) in all the wells except the wells located near to the check dam. They observed a decrease in TDS due to the dilution effect of recharge of water stored in the check dam. Thus, it becomes evident that check dam can augment groundwater quality provided the catchment area is kept free from contamination.

2.3 Livelihoods and Migration

Migration is a ubiquitous reality in India. Better employment opportunities and higher wages are one of the common reasons for migration apart from marriage, natural calamities and migrating for prosperity among others. Labour migration includes all individuals who are currently employed, unemployed or seeking employment in the place of destination (ILO, 2015). Migration can be of various kinds and does not necessarily result in better standards of living. The people worst affected are the ones lying at the bottom of the hierarchy, that is the seasonal migrants defined as “A worker employed in the unorganized, informal labour market, engaged for 3 months or more at a work destination, away from his/her native rural block.” (Aajeevika Bureau, 2014). Roughly 70 to 80 million workers in the country are seasonal migrants, making it 15 to 20 percent of India’s workforce. Female labour migration seems to be on a rise as well. It witnessed a 101 percent increase between 2001 and 2011, and female migration because of business increased by 153 per cent which is four times more than the rate for men (GoI, 2017). Migration should always be a choice; however, when it happens out of necessity, which is

the case for maximum rural migrants in the country, it is responsible for some challenges and hardships the migrating families and individuals essentially face which ultimately affect their livelihood. A common type of migration is the seasonal or temporary migration wherein the individual ultimately comes back to his origin after spending some considerable time working in another location. “In India, the number of internal seasonal migrants was estimated to be more than 100 million” (Deshingkar and Akter, 2009). The intensity of seasonal migration is found to be highest in the States of Madhya Pradesh and Kerala where during the lean agricultural season people move to bigger cities in the same State or nearby States (Keshri and Bhagat, 2010). Seasonal migration happens to be one of the most critical livelihood strategy adopted by the poorest households in the country. Another interesting observation by Keshri and Bhagat looks at the migration patterns between rural and urban areas. In rural areas, temporary migration is seen to be maximum among the illiterate people and their mobility declines with increasing education. While somewhat the opposite seems to be true for urban areas where individuals with a modest educational qualifications seem to have higher mobility compared to illiterates in urban areas. It is important to note here that it is not only the poor or the marginal people and households who always migrate. Both the rich as well as the poor households report out-migration while the reasons for migrating and the nature of jobs they acquire can vary. A study undertaken by Amitabh Kundu and Niranjan Sarangi suggests that the poor families in an urban area are likely to send one or more of their adult members to other locations for better livelihood prospects while migration for relatively better of households usually means shifting of the entire family. It is also important to note that the rural-urban migrants have a higher risk of being below the poverty line than the urban-urban migrants but both report a lower risk than non migrants (Kundu and Sarangi, 2007). In the last few decades, empirical works on the reasons and significance of migration in many developing countries has been recorded (De Haan, 1999). However, until today migration pattern of people of Khohar a small village in the Alwar district of Rajasthan has not been recorded identifying the major determinants in a gendered angle.

Chapter III

Methodology

The study adopted a mixed method approach that includes quantitative, qualitative, UAV and GIS-based approaches for data collection.

3.1. Vulnerability Assessment:

The study employed Participatory Rural Appraisal (PRA) tools like Focus Group Discussions[2], Key Informant Interviews, non-participatory observation, Transect walk and Informal interviews. In order to capture the differential perspective of villagers, information is collected from the people of various sections in the village, i.e. senior people of the village[2], owners of bore-wells, those who purchase water for irrigation, the landless, women of the community and members of the Water Management Committee. Quantitative data from all 154 households in the village was collected with the help of a structured interview schedule, surveying the entire population and covering the socio-economic, agricultural and migration details of each household. Data was collected from them on the aspects such as significant events in the village in the past, how water was procured, how it changed, significant post check dam etc. The total sample is categorised in to three according to standard deviation and mean. They were classified into three categories viz., low category (below Mean – 0.425 S.D.), medium category (in between Mean ± 0.425 S.D.) and high category (above Mean + 0.425 S.D.). Thus the number of small farmers are 78, medium farmers are 51 and large farmers are 25 constituting a total sample size of 154. They were queried whether there are wide gaps between these events recall method. The results/entries were validated. The study adopted the indicator approach in measuring sustainability of livelihood. The index included six significant components: Socio-Demographic Profile, Livelihood Strategies, Social Networks, Health, Food and Water. Each component comprised of several indicators or sub-components. These were developed based on a review of literature of each component, as well as the feasibility of collecting the needed data through household surveys. The LVI in the present study uses PCA (Principal Component Analysis) to assign weight where each sub-component contributes differently to the overall index, and each principal component is comprised of a different number of sub-components. After selection of suitable indicators, PCA was run separately for major components of LVI so as to determine the weights by the factor loadings and Eigen vectors were obtained. According to the number of Eigen values greater than 1, the same numbers of components were extracted by using varimax rotational method for each indicator as shown in rotational component matrix. The values obtained were added in case of each indicator to get weight for that particular indicator. Likewise, weights were obtained for all major components. The study also attempts to

give a holistic view on seasonal migration wherein entire family leaves for agricultural labor work to Punjab and Gujarat every year. As the migrants are purposively selected from the population, Heckman probit model was used to estimate the variables that contribute to the decision to migrate. Qualitative methodology was used to analyse the gendered perspectives on migration Perception towards check dam was determined by using perception scale. In psychology, an attitude is a psychological construct; it is a mental and emotional entity that inheres in or characterises a person. They are complex and an acquired state through experiences. The method of summating rating suggested by Likert (1932) and Edward (1957) was followed in the development of the scales.

[1] Six group discussions were held with the people of cross sections in the village. Each FGD was containing people from 5 to 10 persons. One FGD was held separately with the women of the village to capture the gender perspective regarding water markets and trade.
[2]Senior people are those persons above 60 years of age and was residing in Khohar for more than 40 years.
[3]For is maintaining sustainability of structures built under the project like check dams, Sehgal foundation forms Village Development Committees (VDCs) that take leadership role in operation and maintenance of structures. Community contribution is collected to create a feeling of ownership among beneficiary communities. These contributions are channelised into maintenance funds managed by VDC members. VDC ensures the long-term sustainability of physical infrastructure.

3.2. JJAS seasonal rainfall anomaly:

In the present study, regridding is done which is the process of interpolating from one grid resolution to a different grid resolution. Thus it is a process of is the process of interpolating from a source grid (SRC) to a destination grid (DST). Spatial interpolation is followed which is a combination of the intended use of the interpolated data and the structure of the original variable. UV CDAT and Python regridding interface that supports multiple interpolation tools are used for the purpose. Climatic indicators were calculated from the high resolution daily gridded temperature from IMD sources and rainfall data for the Indian region during the period of (1901–2018).

3.3. The groundwater quality and water level quantification:

The groundwater quality and water level quantification was done in the study area by using Quantum GIS based on Inverse Distance Weighted (IDW) interpolation techniques. The interpolation procedure is utilized when you have information for specific areas and need to appraise the values in between them. The output is a raster layer with continuous values based on the available data. Spatial analysis is the process of manipulating spatial information to extract new information and meaning from the original data. In the present study spatial analysis is carried out with a Geographic Information System (GIS). A GIS provides spatial analysis tools for calculating feature statistics and carrying out geo processing activities as data interpolation.

3.3.1: Spatial interpolation in detail: Spatial interpolation is the process of using points with known values to estimate values at other unknown points. In the present study, to map the ground water levels, there aren't a large number of points. Spatial interpolation can estimate ground water levels at locations without recorded data by using known piezo metric readings. This type of interpolated surface is often called a statistical surface. Elevation data, precipitation, snow accumulation, water table and population density are other types of data that can be computed using interpolation. Because of high cost and

limited resources, data collection is usually conducted only in a limited number of selected point locations. In GIS, spatial interpolation of these points can be applied to create a raster surface with estimates made for all raster cells.

3.3.2. Inverse Distance Weighted (IDW): In the IDW interpolation method, the sample points are weighted during interpolation such that the influence of one-point relative to another declines with distance from the unknown point you want to create Inverse Distance Weighted interpolation based on weighted sample point distance (left). Weighting is assigned to sample points through the use of a weighting coefficient that controls how the weighting influence will drop off as the distance from new point increases. The greater the weighting coefficient, the less the effect points will have if they are far from the unknown point during the interpolation process. As the coefficient increases, the value of the unknown point approaches the value of the nearest observational point.

Rasters are used in the present study for representing data that changes continuously across a landscape (surface). They provide an effective method of storing the continuity as a surface. They also provide a regularly spaced representation of surfaces

3.4. Analyse the Cropping Pattern Change: Alongside PRA, GIS and UAV (Unmanned Aerial Vehicle) were used to depict non-spatial information spatially. Geographical Information System (GIS) was used to store, and analyse geographic data. In the study, for impact analysis, UAV and GIS we used to 1) investigate the change in green cover post check dam and 2) depict the groundwater level information of the village on a digitised map to analyse the Water Foot Print (WFP). Software used for analysis was ERDAS and Quantum GIS.

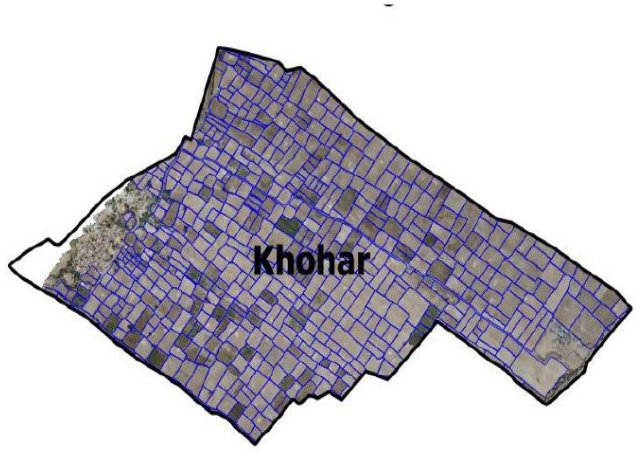
The ground water exploitation is the major variable that influences the ground water level. Agricultural practices and cropping pattern changes also contributes to the water foot print of the region. Thus the analysis of trends in cropping pattern gives the impact of check dam. For this purpose, UAV was flown on 29th of March 2018 in Khohar village. Total 8 flights were taken off to cover approx. 2 square kilometre area. The use of lightweight unmanned aerial vehicles (UAVs) usually implies lower economic costs than other remote sensing techniques when surveying relatively small areas [Zhang et al, 2016; Anderson and Gaston, 2013] and their low flight speed and flight altitude enables ultra-high spatial resolution (better than 20 cm) imagery [Zhang et al, 2016] to be taken.

Season	Image Details	Date (D/M/Y)
Rabi	RGB	29-03-2018

Satellite Data: Sentinel-2 optical images, LISS-4 and Landsat satellite data were used for detailed study. Images details and data acquisition dates are given below:

Season	Image Details	Date (D/M/Y)
Rabi	LISS-IV	17-12-2004
Rabi	LISS-IV	27-01-2010
Rabi	LISS-IV	15-12-2014
Rabi	Sentinel-2	30-01-2018
Kharif	LISS-IV	29-09-2015
Kharif	LANDSAT	26-09-2010
Kharif	LISS-IV	1/9/2005
Kharif	LANDSAT	4/9/2017

3.4.1. Cadastral Map: Cadastral map helps connecting land ownership information of a particular agricultural field in a village. It provides khasra number (Survey number), based on which we can obtain land ownership details. The cadastral maps using the conventional method take months to be produced. The cadastral map, collected from an authorized government department will gets integrated with UAV data to retain land ownership details. (In this case, cadastral map was provided by Patwari, Khohar).
UAV images: A Large number of flights were conducted to get sufficient overlap between two images and ensuring that there are no gaps left in coverage. These images are then mosaicked seamlessly, geographically referenced by taking control points from google maps. Further, digitization was done to create crop field boundaries as polygons which then could be used to add crop names for current and past years. Two significant crops were identified based on the visual interpretation which is Wheat and Mustard, majorly grown crops during Rabi season 2017-18 in this area. Some crop signatures were also collected at the time of field survey to interpret the crop type from images.



Crop fields digitized on UAV images

3.4.2. Satellite data: is processed in ERDAS Imagine software. Crop signatures were collected in various agricultural fields during a field visit to identify crops on satellite images. Satellite images of two main cropping season (Kharif & Rabi) were used to monitor cropping pattern during this season. A time series study was carried out to obtain changes in crop acreage.

Historical crop survey: The first cut classification of past year satellite images, 2-3 unique signatures were segregated, and their survey number was identified by overlaying the digital cadastral map. The specific survey numbers with anticipated crop name were given to Sehgal foundation, whose representatives got in touch with corresponding farmers and enquired them on the name of the crop grown by them in the past years (2004, 2005, 2010, 2014, 2015 and 2017) of interest. These were used as GCPs to arrive at crop classification for remaining crop fields in the village.

3.5. Gendered Analysis of the Livelihood Determinants and Vulnerability of Seasonal Migration

Study adopted a mixed method approach to examine the livelihood vulnerabilities of migrants and non-migrants in Khohar and to analyse the determinants responsible in influencing the decision to migrate. It also investigates the gendered differentials in migration through qualitative research, studying men and women perspectives on migration. Quantitative data from all 154 households in the village was collected with the help of a structured interview schedule, surveying the entire population and covering the socio-economic, agricultural and migration details of each household. Qualitative information on gendered perspectives on migration was collected with the help of Focused Group Discussions (FGDs) and Key Informant Interviews (KIIs) with a sample representative of the migrant population in the village. Five FGDs were conducted with 6-7 members each comprising of adult female migrants (25 to 60 years old), adult male migrants (25-60 years old), adolescent female migrants (15 to 19 years old), adolescent male migrants (15 to 19 years old) and with aged female family members of migrants (50 to 75 years old). Details regarding their migration patterns, nature of job at destination, challenges faced during migration and the effect on their livelihood were discussed with the participants.

3.5.1. Analytical Methods: As the migrants were purposively selected from the population, Heckman two step model was used to estimate the determinants of household migration decision and total annual income of the household at the farm household level. Heckman model was used to avoid the sampling bias. Household migration decision is the selection dependent variable which is a dummy variable taking value 1 as households that are migrating, that is, households with migrant population and 0 for households without migrant population.

$$M = \alpha_0 + \sum \alpha_K X_K + \varepsilon$$

$$I = \alpha_0 + \sum \alpha'_{K'} X'_{K'} + \varepsilon'$$

Selection model

M is the probability of the variable indicator of the sign of the selection criteria, that is the decision to migrate or not.

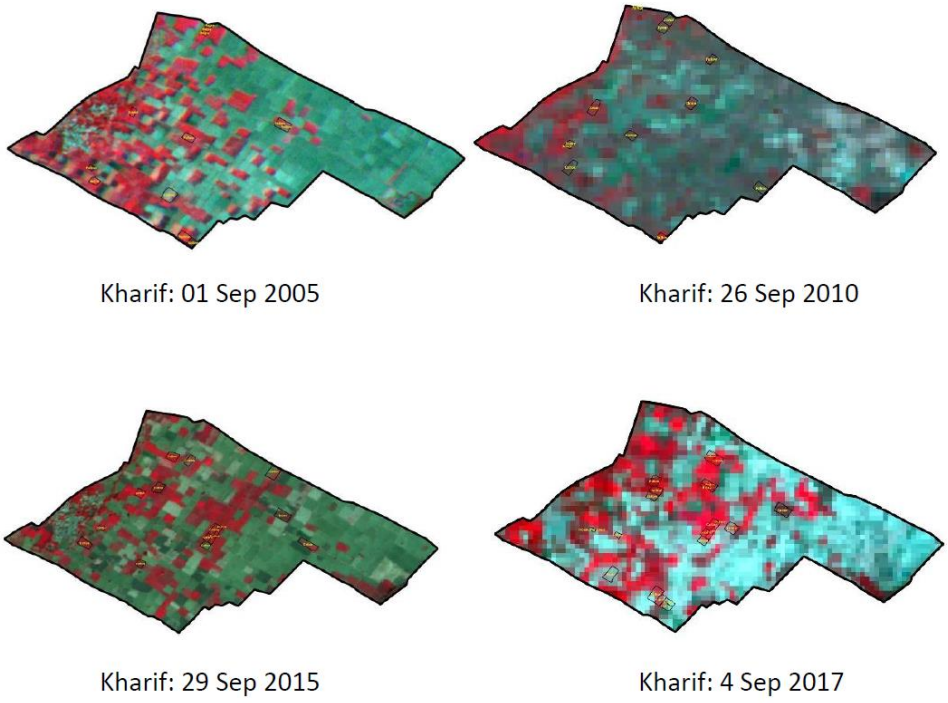
X_K represent the independent variables of the selection equation identification and those of the income equation respectively.

Income model

I represent the migratory income. The inverse mills ratio itself evaluates as the ratio of probability and cumulative density functions from the selection equation. Heckman (1979) argues that this function is a monotone decreasing function of the probability that an observation is selected into the analysed sample.

3.4.3. Satellite Image Classification: Unsupervised classification is a form of pixel based classification and is essentially computer automated classification. The user specifies the number of classes and the spectral classes are created solely based on the numerical information in the data (the pixel values for each of the bands or indices). Clustering algorithms are used to determine the natural, statistical grouping of the data. The pixels are grouped together into based on their spectral similarity. The computer uses feature space to analyze and group the data into classes.

GCP survey (Kharif Season): Parcel-wise GCP plotted on satellite image.

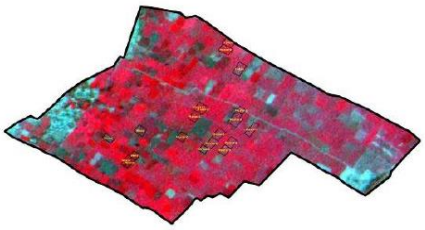


Kharif: 01 Sep 2005 Kharif: 26 Sep 2010

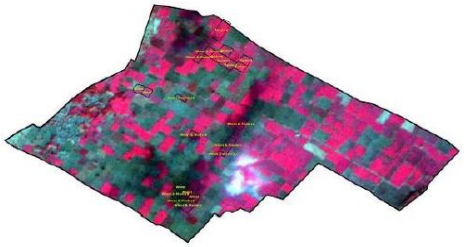
Kharif: 29 Sep 2015 Kharif: 4 Sep 2017

GCP survey (Rabi Season): Parcel-wise GCP plotted on satellite image.

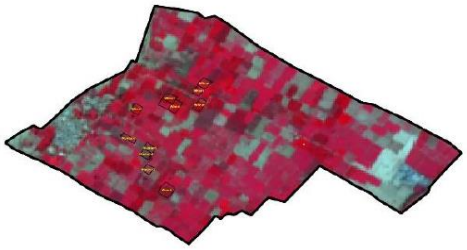
Rabi: 17 Dec 2004



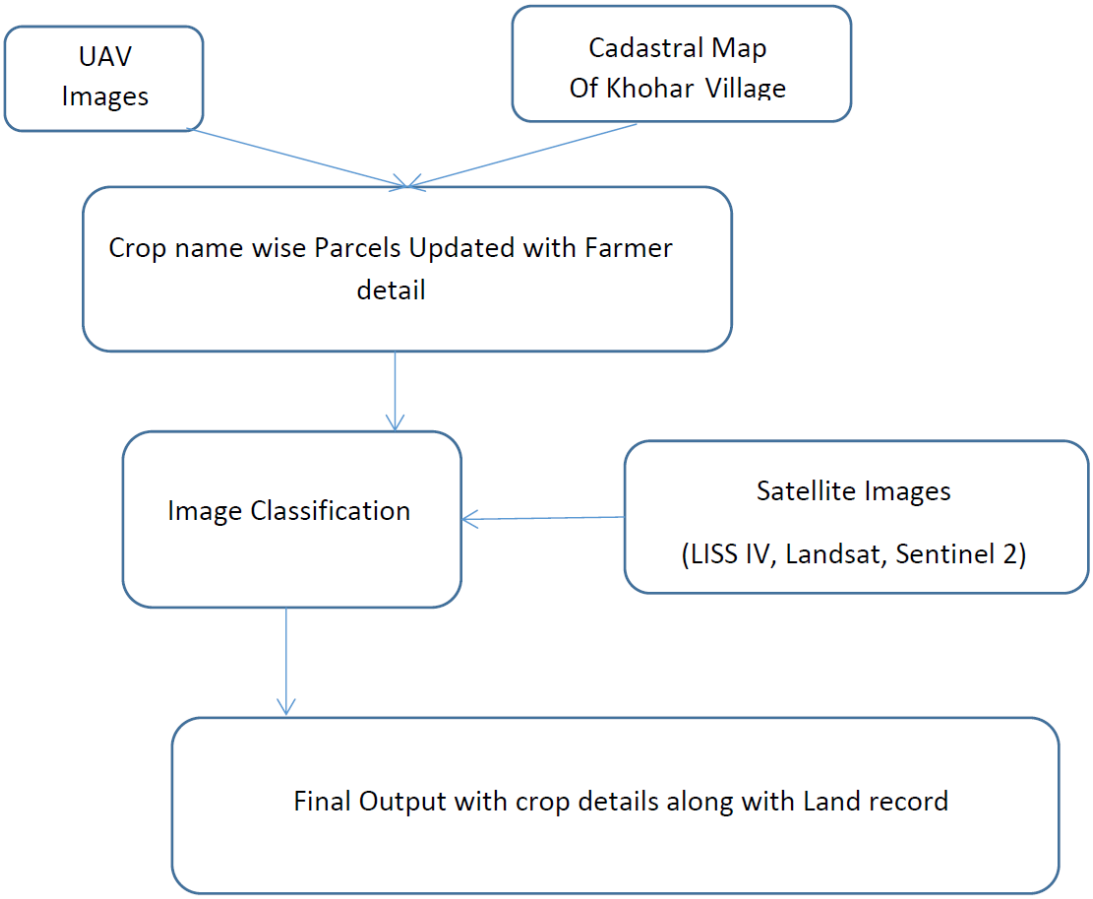
Rabi: 27 Jan 2010



Rabi:15 Dec 2014



Rabi: 30 Jan 2018



Work flow diagram

3.5 Migration Analysis

A. Data and Study Area: The following study was conducted in Khohar, a village located in the Ramgarh tehsil of Alwar district, Rajasthan. Situated near the Aravali mountain range, Khohar stretches upto 372 hectares in area and has a population of close to 800 people. It is largely an agrarian economy with 154 households in total of which 125 are landholders. Land under cultivation is approximately 113 hectares (farmers of Rajasthan report land units in bigha which is equal to one third of an acre). The cultivated land is spread within the 500-hectare square range from check dam. The soil of the area is light in texture, particularly sandy, sandy loam and clay loam. The upper hills are mostly barren. The district area is mainly underlain by alluvium of Quaternary age which forms the principal ground water reservoir. Some amount of groundwater is found in fractures, joints and crevices of hard rocks found as strike ridge in the district. The groundwater in the upper zone is known to exist down to 70 m depth and hold water under phreatic condition. The aquifers at greater depths are confined to semi-confined. Situated in a hot and dry region with no natural water source in the village, Khohar has a huge issue of water scarcity, as a result of which the village witnesses' seasonal household migration every year.

B. Sample Selection: Rajasthan is one of the largest states in the country with 75 percent of its population living in rural areas (Census of India, 2011). Migration, seasonal or permanent is a common phenomenon in the state due its water problems and climatic conditions that add to the plight of the residing population. Khohar was chosen as the area for this research because of rampant seasonal migration of families evident in the village compared to the rural areas surrounding it. For the study, purposive random sampling was undertaken to focus on migrating households in the village.

C. Collection of Data: Study adopted a mixed method approach to examine the livelihood vulnerabilities of migrants and non-migrants in Khohar and to analyse the determinants responsible in influencing the decision to migrate. It also investigates the gender differentials in migration through qualitative research, studying men and women perspectives on migration. Quantitative data from all 154 households in the village was collected with the help of a structured interview schedule, surveying the entire population and covering the socio-economic, agricultural and migration details of each household. Qualitative information on gender perspectives on migration was collected with the help of Focused Group Discussions (FGDs) and Key Informant Interviews (KIIs) with a sample representative of the migrant population in the village. Five FGDs were conducted with 6-7 members each comprising of adult female migrants (25 to 60 years old), adult male migrants (25-60 years old), adolescent female migrants (15 to 19 years old), adolescent male migrants (15 to 19 years old) and with aged female family members of migrants (50 to 75 years old). Details regarding their migration patterns, nature of job at destination, challenges faced during migration and the effect on their livelihood were discussed with

the participants.

D. Analytical Method: As the migrants were purposively selected from the population, Heckman two step model was used to estimate the determinants of household migration decision and total annual income of the household at the farm household level. Heckman model was used to avoid the sampling bias. Household migration decision is the selection dependent variable which is a dummy variable taking value 1 as households that are migrating, that is, households with migrant population and 0 for households without migrant population.

$$M = \alpha_0 + \sum \alpha_K X_K + \varepsilon$$

$$I = \alpha_0 + \sum \alpha'_{K'} X'_{K'} + \varepsilon'$$

Selection model

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I represent the migratory income. The inverse mills ratio itself evaluates as the ratio of probability and cumulative density functions from the selection equation. Heckman (1979) argues that this function is a monotone decreasing function of the probability that an observation is selected into the analysed sample.

Chapter IV

Livelihood Analysis

4.1. The socioeconomic and profile of the village

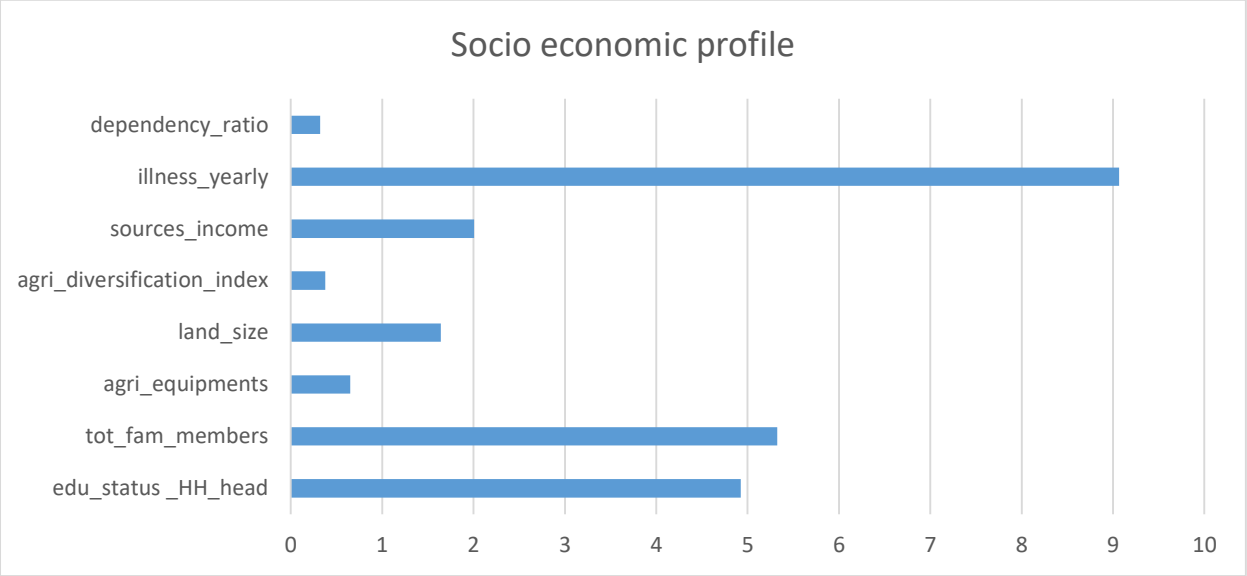


Figure 4.1: Socioeconomic profile of the village (N=154)

Out of the total population of Khohar, 33.11 percent are medium farmers (1-4 bigha of land), 16.2 percent of them are large farmers (more than four bigha of land), and 50.6 percent of them are small farmers (equal to or less than one bigha of land). The small farmers are mainly migrating farmers. Figure 4.1 shows the socioeconomic profile of the villagers of Khohar. Dependency ratio indicates an age-population ratio of those typically not in the labor force and those typically in the labor force. It is used to measure the pressure on productive population. In Khohar, the dependency ratio is very less, which is a positive indicator. However, due to child labor, the income earners of the village became high that is a negative indication of the socio-economic status of a village. The illness yearly is found to be very high due to migratory diseases, inadequate access to quality drinking water, lack of access to proper health facilities etc. The sources of income are 2 or more than two as there is diversification in the livelihood options. The agriculture diversification index is an average value as the diversification is more only for the large farmers who have multiple agricultural options. The average land size is less than two bigah as only large farmers have more significant land area. Only large farmers own agricultural equipment. The average family size ranges from 5 to 6. The average education status of household head is usually up to primary level.

4.2 Livelihood Vulnerability Index of Farmers

The vulnerability indices of the farmers vary from 0.24 to 0.88 (Table 4.1). The vulnerability index values for water component of LVI shows that small farmers of Khohar are most vulnerable and large

farmers are least vulnerable. In Khohar, majority of the farmers are small, marginal or landless. Water component is least for small farmers as Average time per day required to fetch water in summer and water availability is least for them. None of them is near to water sources, and they get priority to fetch water lesser than medium farmers. Small farmers are less influential compared to medium farmers, and both small and medium farmers report water conflict compared to large farmers.

Table 4.1: INDEXED Sub Components, Major Components for Overall LVI of Farmers (N=154)

Major Components	Sub Components	Small farmer (n=78)	Medium farmer (n=51)	Large farmer (n=25)
Socio-demographic profile	Dependency ratio	0.38	0.33	0.25
	Percent of female-headed households	0.56	11.77	8
	Percent of households where head of household has not attended school	32.05	35.29	16
	Percent of people below poverty line	20.51	13.73	8
	Percent of people under AAY	34.62	29.41	8
	Percent of households where people migrate	61.53	0	0
Livelihood	Percent of people who depend on wage employment	32.05	41.7	28
	Percent of people who depend on casual labor	96.5	88.24	40
	Percent of households dependent solely on agriculture as a source of income	2.56	80.39	100
	Average Livelihood Diversification Index (range: 0.20-1)^a	0.43	0.3	0.34
Health	Average number of times a family member fell severely ill in a year due to water borne diseases	7	3	1
	Percent of households with family members with chronic illness	8.97	5.8	4
	Average amount one household spends on illness per year in hospitals and PHC	14067	22265	58852
	Average distance of household from the health facility centre	7.79	6.7	7.12
	Average number of deaths due to illness	10	14	4
Social Networks	Percent of households that participate in SHGs	5.12	9.8	16
	Percent of households that participate in political institutions	41.02	27.45	44
	Percent of households that participate in Kisan Manch	5.13	23.53	44
	Percent of households that participate in Gram Panchayat	41.03	35.29	60
	Percent of households that participate that participate in religious organisations	41.03	33.33	28
	Average Social Participation percentage	22.22	21.56	32
Food	Percent of households dependent on family farm for food	2.5	80.33	100
	Percentage of households that rear livestock to support agriculture	25.64	68.62	96
	Average Crop Diversity Index (range: >0-1)^a	0.2	0.11	0.33
	Percent of households that do not save crops	97.5	85	100
	Percent of households that do not save seeds	85	40	14
Water	Percent of households reporting water conflicts	100	100	64

	Average time per day required to fetch water in winter	56	53	39
	Average time per day required to fetch water in summer	108	97	83
	How far is the water source for the household?	385	400	200

In case of socio-economic and demographic profile, small farmers were found to be most vulnerable than large farmers. The education level of small farmers is shallow and placed among the least in the country, hence the government schools of Khohar are brought under the scheme of Krishi Jyoti school renovation project. Despite renovation, due to caste-based canvassing, the enrolment status of the government schools was found to be decreasing. In the academic year 2014-15, out of a total 71 students, 33 students migrated during October-December to participate in labor work in Gujarat. In 2015-16, out of a total 64 students, 34 students migrated during October-December to participate in labor work in Gujarat. In 2016-17, out of a total 53 students, 37 students migrated during October-December to participate in labor work in Gujarat. In the current academic year, out of a total of 62 students, thus far 24 students have migrated during October-December to participate in labor work in Gujarat. It is interesting to note that the student strength in the school since 2014 is on a decreasing curve except for the current academic year. However, at the same time, the education status of the children of large farmers of village is found to be increasing with more students enrolling at private schools. The percentage of students migrating is found to be decreasing in private schools with an increased enrolment rate. In one among the private school Sultan Ucch Prathmik, in the academic year 2014-15, out of a total 34 students, 12 of them have migrated. Two of the migrated students migrated to Gujarat to participate in labor work. The reasons behind the migration of the rest of the students are yet to be investigated. Those who have migrated, migrated during the period of October-December. In the academic year 2015-16, out of a total 23 students, 3 of them have migrated during October-December to participate in labor work in Gujarat. In the academic year 2016-17, out of a total 40 students, four students have migrated during October-December to participate in labor work in Gujarat. In the current academic year, out of a total 40 students, 1 of them has migrated in 2017 during October-December to participate in labor work in Gujarat. The low socioeconomic and demographic component of small farmer and medium farmers are due to larger dependency ratio and due to more significant percentage of people BPL and under AAY.

The livelihood vulnerability component was also found to be low for medium and large farmers (Figure 4.2). Cultivation of Rabi crops like Wheat, Mustard and Kharif crops like Bajra, cotton and vegetables and cattle rearing was the primary source of livelihood, but due to the erratic rainfall and drought, the trend had changed. More and more land turned out to be fallow, and people started working on government and private jobs. From small, most of the family members are found to be migrating to other states like Gujrat. This phenomenon increases the vulnerability as the family members may return with

certain social vices or health challenges and the family labour available for farm operations also decreases. However, the small farmers have multiple livelihood options like casual labour, agricultural labour and migration labour thus their livelihood diversification index is high

Table 4.2: INDEXED Sub Components, Major Components (Standardised Values) for Overall LVI of Farmers (N=154)

Major Components	Sub Components	Small farmer	Medium farmer	Large farmer
Socio-demographic profile	Dependency ratio	-0.91877	-1.0488	-0.96672
	Percent of female-headed households	-0.91354	-0.69537	-0.74116
	Percent of households where the head of household has not attended school	0.001529	0.03126	-0.50832
	Percent of people below poverty line	-0.33381	-0.63482	-0.74116
	Percent of people under AAY	0.07621	-0.1504	-0.74116
	Percent of households where people migrate	0.858186	0.841924	-0.97399
Livelihood	Percent of people who depend on wage employment	0.001529	-0.06884	-0.15907
	Percent of people who depend on casual labour	1.874378	1.922295	0.190186
	Percent of households dependent solely on agriculture as a source of income	-0.85542	1.424589	1.936458
	Average Livelihood Diversification Index (range: 0.20-1)^a	-0.91732	-1.04973	-0.9641
Health	Average number of times a family member fell severely ill in a year due to water-borne diseases	-0.7264	-0.96631	-0.94489
	Percent of households with family members with chronic illness	-0.66915	-0.87981	-0.85758
	Average amount one household spends on illness per year in hospitals and PHC	-0.52104	-0.37114	0.738865
	The average distance of household from the health facility centre	-0.70344	-0.85201	-0.76677
	Average number of deaths due to illness	-0.63922	-0.62648	-0.85758
Social Networks	Percent of households that participate in SHGs	-0.78103	-0.75623	-0.50832
	Percent of households that participate in political institutions	0.262187	-0.21095	0.306605
	Percent of households that participate in Kisan Manch	-0.78074	-0.33206	0.306605
	Percent of households that participate in Gram Panchayat	0.262478	0.03126	0.772277
	Percent of households that participate that participate in religious organizations	0.262478	-0.02929	-0.15907
	Average Social Participation percentage	-0.28412	-0.39292	-0.04265
Food	Percent of households dependent on family farm for food	-0.85716	1.422736	1.936458
	Percentage of households that rear livestock to support agriculture	-0.18474	1.060964	1.82004
	Average Crop Diversity Index (range: >0-1)^a	-0.92022	-1.0556	-0.96817
	Percent of households that do not save crops	1.903437	1.567012	1.936458
	Percent of households that do not save seeds	1.5402	0.176772	-0.56653

Water	Percent of households reporting water conflicts	1.976084	2.030425	0.888695
	Average time per day required to fetch water in winter	0.69749	0.610313	0.161082
	Average time per day required to fetch water in summer	2.208555	1.937742	1.441681
	How far is the water source for the household?	-0.91862	-0.96817	-1.04664

The social networks component (Figure 4.3), of medium and small farmers, are decidedly less compared to large farmers. The participation in SHGs, Kisan Manch and Political Institutions are very less for small farmers and medium farmers compared to large farmers. However, the participation in religious institutions is high for small and medium farmers. The large farmers are found to be over dominating the social institutions; they are respected as they lend water and other financial assets to other farmers. The average time required to reach the health facility centre is almost same for all the farmers. As far as the number of persons getting chronic ailments, it is maximum for small farmers but the amount spent on the treatment of diseases are very less for them. Affordability of large farmers are high, so they spent more money to treat diseases.

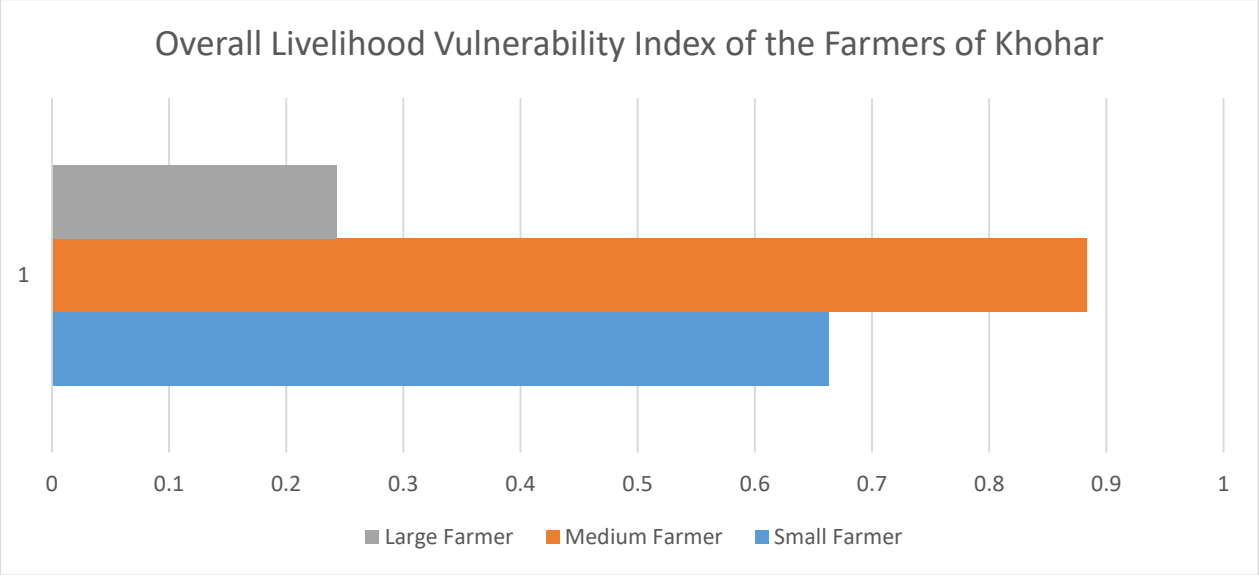


Figure 4.2: Overall LVI of the farmers of Khohar

Figure 4.3 depicts that the water is a threatening resource in Khohar. Khohar faces arid to a semi-arid climate with short spells of showers brought by the southwest monsoon. The climate of the region has been classified as semi-arid with scorching summers experiencing temperatures rising to 47°C, followed by cold winters.

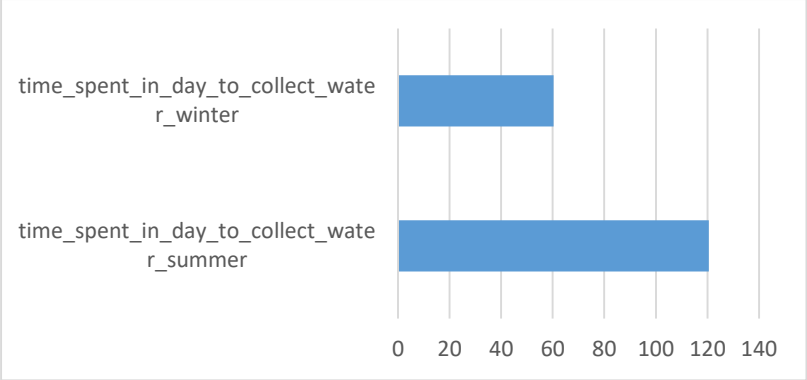


Figure 4.3: Average time spend in a day to collect water

The potential evapotranspiration rates are quite high, especially during May and June. The village faces a rampant problem with water scarcity for all households, rich and poor alike. Procuring water for domestic as well as agricultural purposes is a critical issue they face every day. Lack of a water body in or around the village makes farming a challenging task, leaving the people having to rely only on rain to cultivate crops. The average time spends in a day to collect water for a household varies from 1 hour to 2 hours.

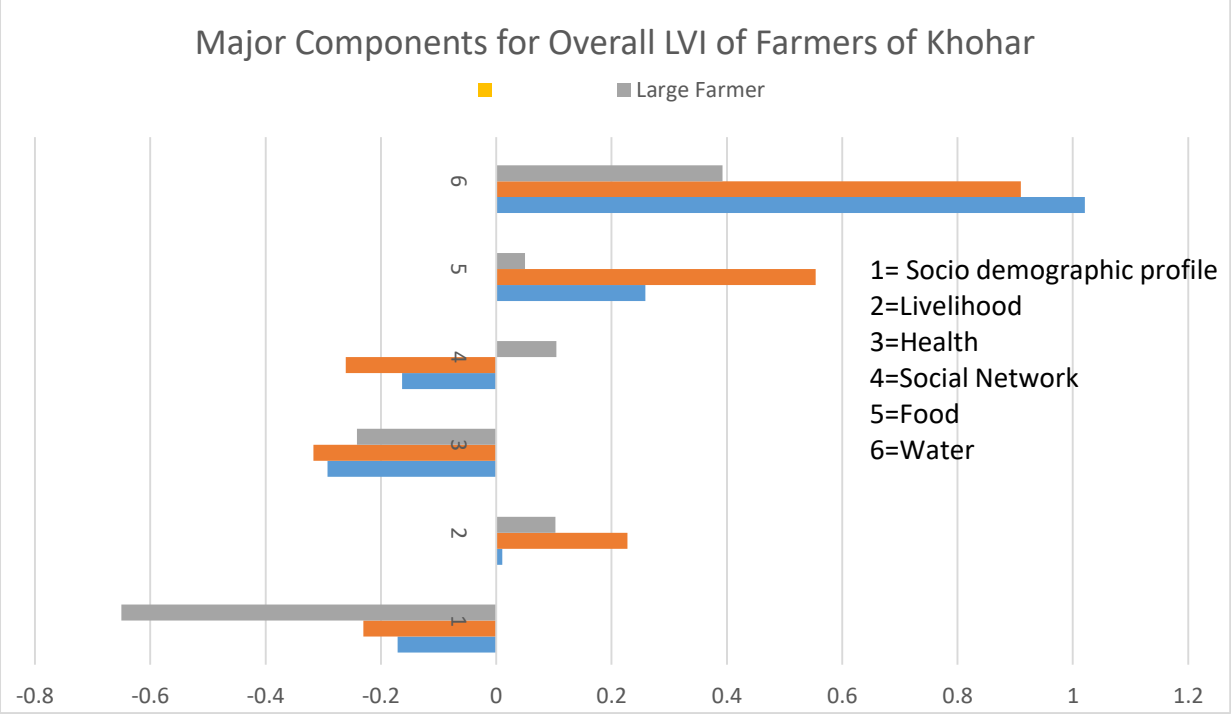


Figure 4.3: Major Components for Overall LVI of Farmers of Khohar

Farmers with large landholdings are capable of spending essential resources of digging bore wells, but marginal farmers do not have the funds for the financial risk it entails, as the excavation may or may not result in hitting the water table. The excessive cost of bore well mining along with fuel, electricity and labour changes resulted in water trade among farmers. This aggravated the economic inequality preventing the improvement of the quality of life of the marginalised population. Thus the more

substantial farmers that own bore well has better water component, medium farmers have bad and small farmers have worst water component. A regular heptagon was made as background, and the radar diagram was constructed for Khohar by scoring the livelihood vulnerability components and indicators for the respondents and assigning weight. The shape of the heptagon was used to show the variation in vulnerability schematically. Figure 4.4 shows a skewed heptagon indicating the livelihood vulnerability of the farmers of Khohar. For medium farmers, livelihood strategies were found to be less diverse that indicates more agrarian distress and migration. Accessibility to food is less for small farmers with more malnourishment in this region

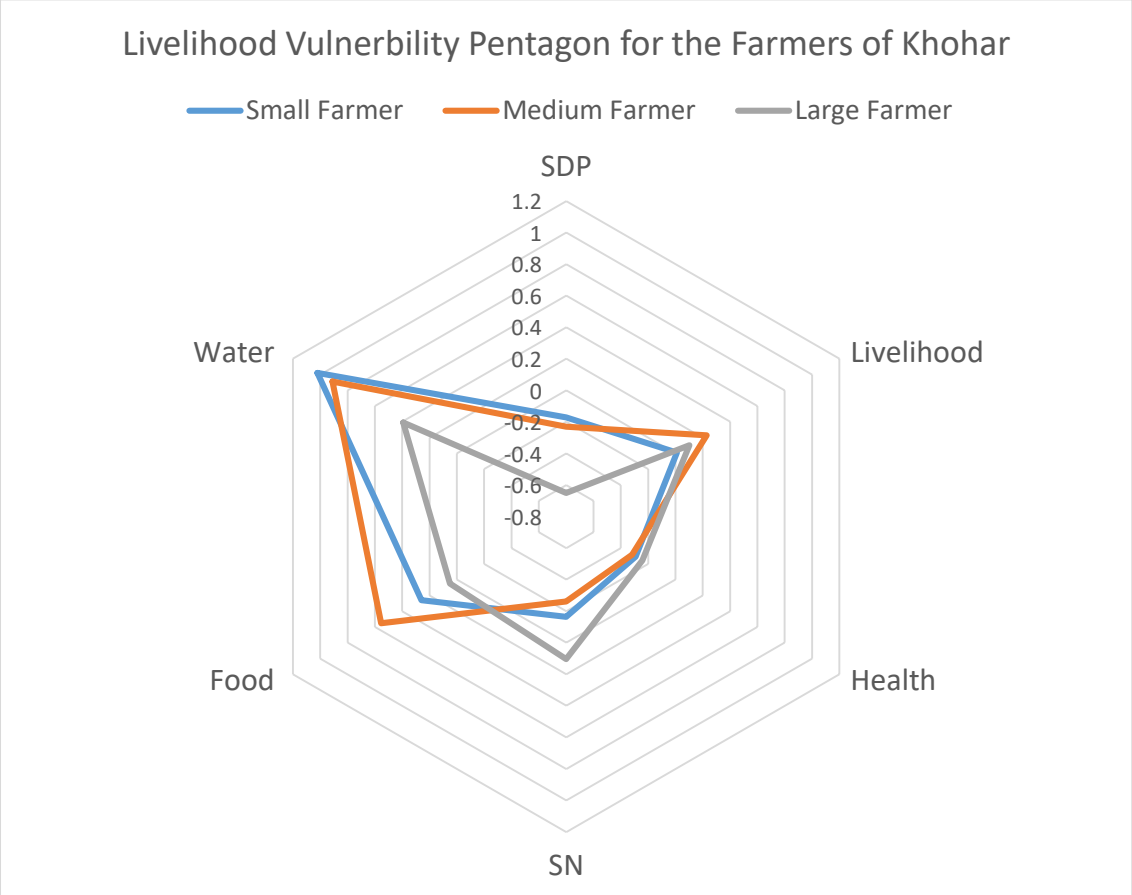


Figure 4.4: Livelihood Vulnerability Pentagon for the Farmers of Khohar

Chapter V

How do the water markets and water trade evolve in Khohar? Is there any significant difference post check dam?

Water scarcity is not a recent concern for the villagers of Khohar who have traditionally been migrating out of the village to earn their livelihood. Women and children running up and down for fetching water is a common sight in the village of Khohar. The villagers cite that this was not something we would have viewed ten years back where the water level was not more than 200 feet and only since 2000, the conventional wells got replaced by bore wells. The village is inhabited by approximately 150 households with an estimated population of 800. Agriculture is the primary source of livelihood for more than 80 percent of the population of Khohar. The only source of water for farmers is bored wells, and since time immemorial they have been excavating the water from aquifers that are now nearly dry. Last year the community bore well that was connected to two community tanks that provided piped water to most of the households, dried up leaving most of the villagers' dependent on the individual bore well owners for all their needs of water from drinking to irrigation.

Borewell was first introduced in the village in the year 2005. At present, there are around 13 bore wells, among them, 10/11 will be functional. When a borewell was dug in an already existing well, the initial depth of that bore well was 415ft (250 well + 165 bore well). It worked well for first five years and then completely dried up. Several other bore wells came up after that. The most recent increase in depth was till 1100 ft. Around 50% of the agricultural land of the village is owned by few influential households, who also own the majority of bore wells in the village. Farmers with large landholdings are capable of spending essential resources of digging bore wells, but marginal farmers do not have the funds for the financial risk it entails, as the excavation may or may not result in hitting the water table. The excessive cost of bore well mining along with fuel, electricity and labour changes resulted in water trade among farmers. This aggravated the economic inequality preventing the improvement of the quality of life of the marginalised population.

Water trade in Khohar Village

The terms of trade in Khohar is giving on a third of the wheat produced for five irrigations. 4000 rupees for two mustard irrigations, one-fourth of the produce for two cotton irrigations and one-fifth of the crop for seven onion irrigations which are not at all beneficial to recipient farmers, as access to water is only obtainable once the owner has provided essential irrigation to his/her field. This often results in untimely and scarce irrigation according to the crop cycle that diminishes the productivity of the crop, and consequently its fiscal realisation. This forces the farmer to depend on the farmers having borne wells, local money lenders, banks etc. eventually forcing the farmer to enter into a liability ploy.

Table 5.1: Market details of Wheat crop cultivated in Khohar

Market	Name of Variety	Cost of seeds	Transportation cost to storage area in the village	Transportation cost to Market	Selling Price per quintal
Nawgoan	Raj 1482 711 Lok 1 PB 343 Shri Ram 231 Shri Ram 172 Super 20-51 Super 20-60 Lok 1 Lok 1 711 143 Shri Ram- Super 152	950/40kg	400/ bigha	600 per trolley (20 quintal wheat/trolley)	1625
		1650/40kg			
Jirkha		1150/40 Kg	400/ bigha	700 per trolley	1600-1650
		1200/40 Kg			
Mubarikpur		1160/40kg	400/ bigha	700 per trolley	1650
		1150/40kg			

Table 5.2.: Market details of Cotton crop cultivated in Khohar

Market	Name of Variety	Cost of seeds	Transportation cost to storage area in the village	Transportation cost to Market	Selling Price per quintal
Nawgoan	Ajit 155 Ajit 133 Rasi 602 Shri Ram 6488 Shri Ram 65 Rasi 602 Ajit 155 Ajit 133 Lok 1 711	800/450gm	300/ bigha	600 per pickup lorry	4800-5000
Jirkha		1150/40 Kg	300/ bigha	700 per pickup lorry	4800-5000
		1200/40 Kg			

Khertal	143 Shri Ram- Super 152	1160/40kg 1150/40kg	300/ bigha	1500 per pickup lorry	5000-5400

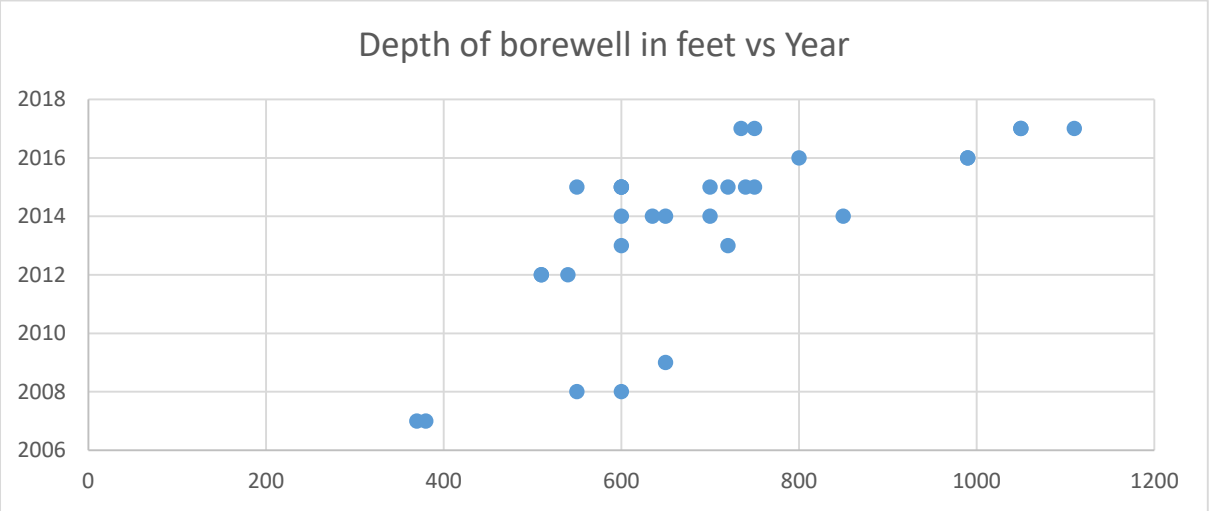
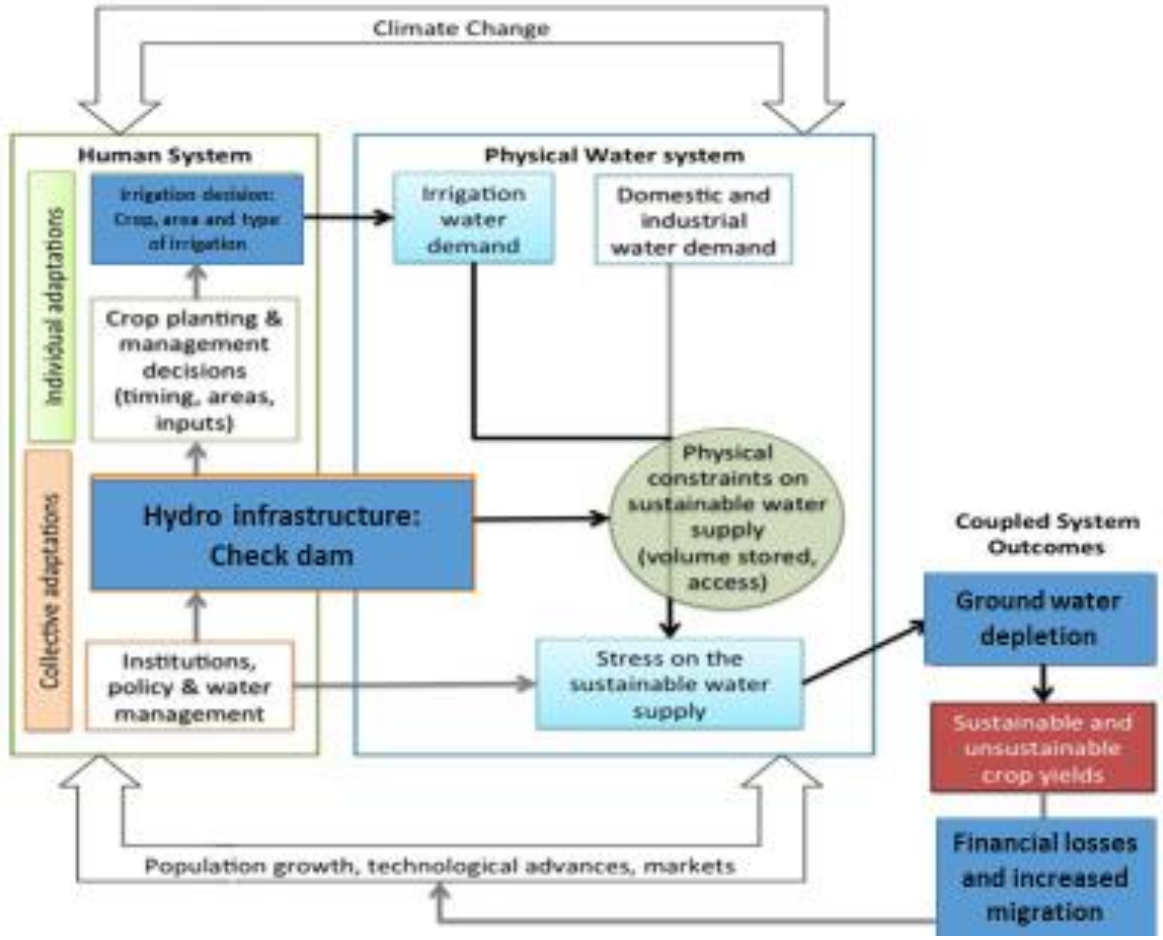


Figure 5.1: Trend in the depth of bore well from 2006 to 2018 for Khohar and Patan villages

Even though water conservation was done using hydro infrastructures like check dam, drip irrigations and laser levelling, due to low rainfall coupled with an excessive area under water-intensive crop causes a steep decline in the groundwater levels. Figure 3 shows the variation in depth of bore well from 2006 to 2018 for Khohar and its adjacent village Patan. From 2014 to 2018, there are bore wells having more than 1000 feet depth. Thus agriculture is leaving a considerable water footprint in Khohar as years pass that is a severe threat to the agricultural sustainability itself. This implies that there is an urgent need to set a water footprint cap that sets a maximum to the water volume that can be allocated for various human purposes, accounting for environmental water needs. WFP needs to be measured as a multi-dimensional indicator, showing water consumption volumes by sources and polluted water volume by the amount of pollution. Low recharge along with excessive exploitation is the primary cause of rapid depletion, therefore planned recharging of groundwater along with judicious irrigation could be a promising solution to reduce WFP. Farmers need to control their water use in keeping with what is available by altering their crops and swapping to more efficient irrigation systems. Irrigation scheduling involves managing the soil reservoir so that water is open when the plants need it. Soil moisture and weather monitoring are used to determine when to irrigate, and soil capacity and crop type are used to determine how much water should be applied during irrigation.

So the conceptual framework for coupled human-physical water system modelling of the regions groundwater future was developed by slight modification of the frame of Zaveri *et al.*, 2016. Climate change, population growth, technological advances, and markets (including agricultural product prices, trade, and GDP) directly impact multiple components of both the human and physical water systems. Components within these systems respond individually to external changes, but also impact each other. Check dam constructed to conserve the ground water is a key component of both the systems. The individual adaptations include the practices of doing laser levelling and installation of drip irrigation systems in the field. If the proper planning is not done at individual and group level, the sustainability of the whole system will be a great threat.



Precise water measurement and soil moisture checking are critical components of efficient on-farm water management practices. Irrigation flow meters can be used to help calculate the efficiency of irrigation systems, identify water loss from leaks in conveyance systems, and to accurately apply only

the necessary amount of water based on soil moisture levels and weather conditions. Soil moisture monitoring is used in conjunction with weather data and crop evapotranspiration requirements to schedule irrigation. Fields should be designed for efficient water use by grading land with laser equipment, creating furrow dykes to conserve rainwater, and by retaining soil moisture through conservation tillage. WFP benchmarks will enable the actors along supply chains – from farmers through intermediate companies to final consumers – to compare the actual WFP of products against certain reference levels (Hoekstra, 2014). The benchmark values can be used to measure performance, to set WFP reduction targets and monitor progress in achieving these targets.

The majority of farmers face credit constraints, incomplete markets, lack of information, and low levels of human capital. They have limited ability to quickly adopt new technologies or to improve upon existing ones. WFP is always being related to a tool, application, promotion, awareness, quantify the water use for baselines, end lines and, now, to water management decision-making. Since irrigation is a short-term adaptation response by farmers in the face of inter-annual monsoon variation, WFP calculations made year to year helps to conserve groundwater with increased efficiency. So far, the role of water footprints in water policy has been limited to a few examples in the research, experiments and the corporate perspectives. We accomplish that the evolution of the WFP concept from elementary quantitative studies to a potent advocacy tool can aid the provision of strategy formulation, policymaking and agricultural risk awareness for sustainable water use. WFP raises a lot of questions about the sustainability of water use and agriculture, solving those questions would be the most significant challenge for the policymakers.

Chapter VI

How much extent does the agriculture produce water foot print in Khohar?

Introduction: Water Foot Print (WFP) in agriculture helps one understand the amount of water being consumed for agricultural purposes. It includes the water used directly, that is supplied to plant as irrigation water and the water used indirectly, the water plants absorb from soil and atmosphere. There are a series of criteria and procedures for the calculation of the water footprint (WFP), classified in blue, green and grey. The blue WFP contemplates the consumptive uses of surface water and groundwater, and the green WFP those in which the source is rainwater. Grey WFP is the fresh water needed to assimilate contaminant loads (Perry, 2014). India's water footprint is 980 cubic meters per capita that positions beneath the global average of 1,243 cubic meters but its 1.2 billion people together add to a substantial 12% of the world's total water footprint. This number, say, experts, is alarming and crucial actions need to be implemented by the government, corporates and citizens to optimally manage this fast diminishing precious resource (Hoekstra, & Chapagain,2006). The International Water Management Institute forecasts that by 2025 in India alone, one-third population will live below "scarce water" situations.

One such water-scarce area is Khohar village (area of 5 km square) situated at the foothills of Aravalli bordering the states of Haryana and Rajasthan. Water is a threatening resource in Khohar. Khohar faces arid to a semi-arid climate with short spells of showers brought by the southwest monsoon. The climate of the region has been classified as semi-arid with scorching summers experiencing temperatures rising to 47°C, followed by cold winters. The potential evapotranspiration rates are quite high, especially during May and June. The JJAS seasonal rainfall anomaly shows a decline in trend added by the excessive groundwater exploitation by the villagers (Figure 1). The soil is mostly alluvial, and the village has no access to any perennial stream or canal. A seasonal stream fed by the rainwater flows through the village and deposits silt in the agricultural fields of the villagers.

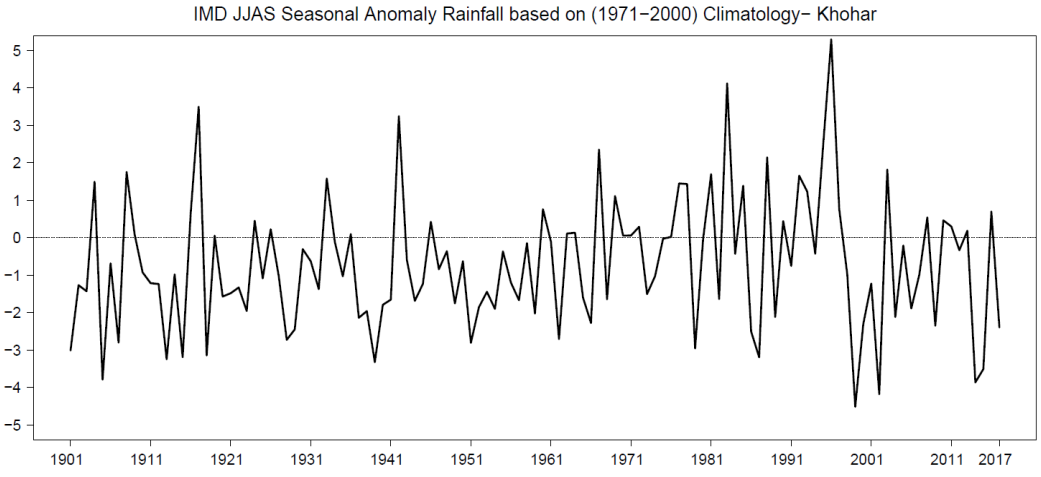


Figure 6.1: JJAS annual rainfall anomaly from 1901 to 2017 for Khohar Village

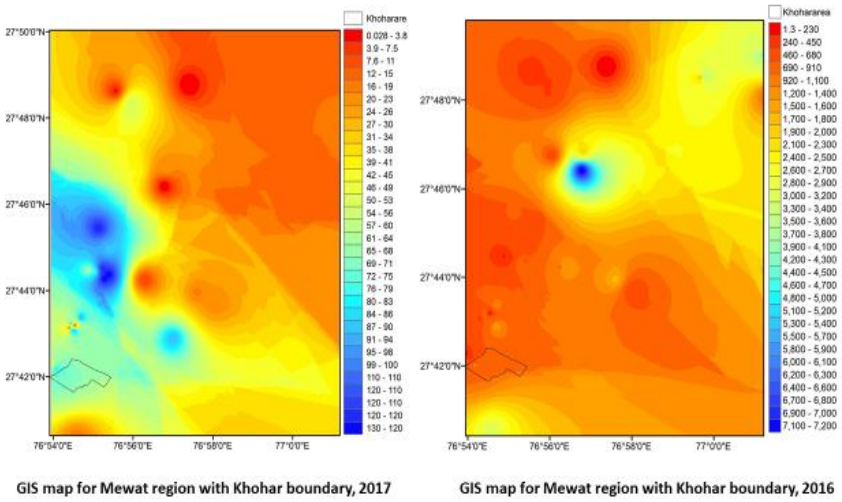


Figure 6.2: GIS map shows the extent of vulnerability of region to water scarcity. For the year 2016, the non-uniform distribution of rainfall over the months along with excess exploitation of water led to higher level of water scarcity compared to 2017.

Figure 6.3: Kharif Crop Trend Analysis of Khohar (Pre Check Dam)

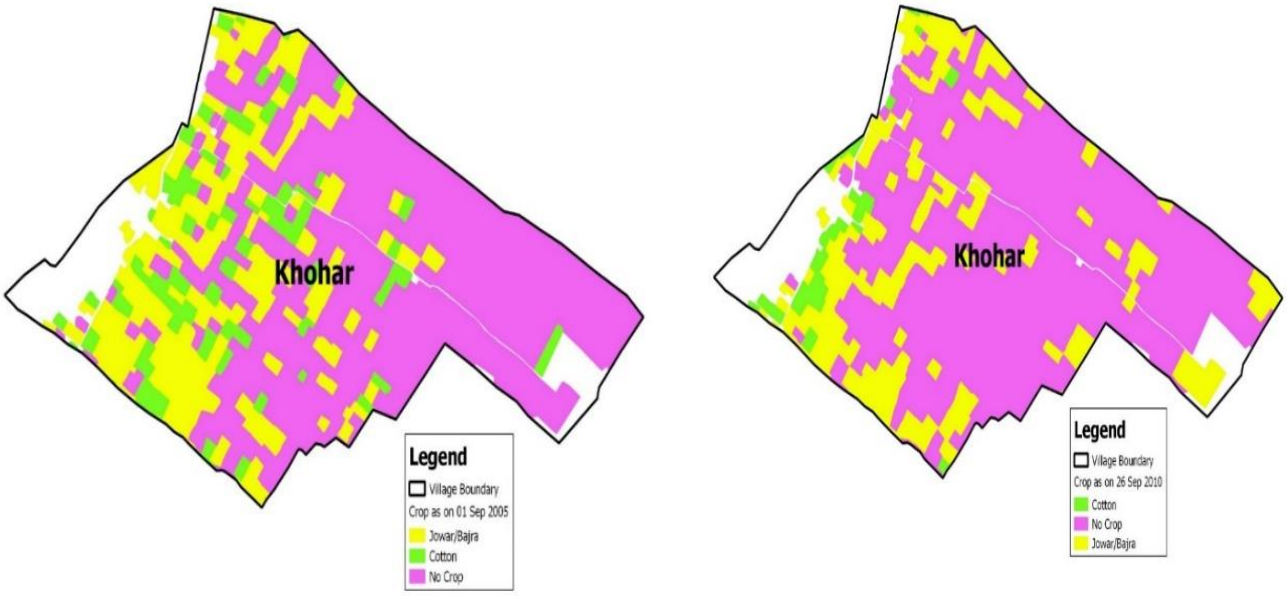
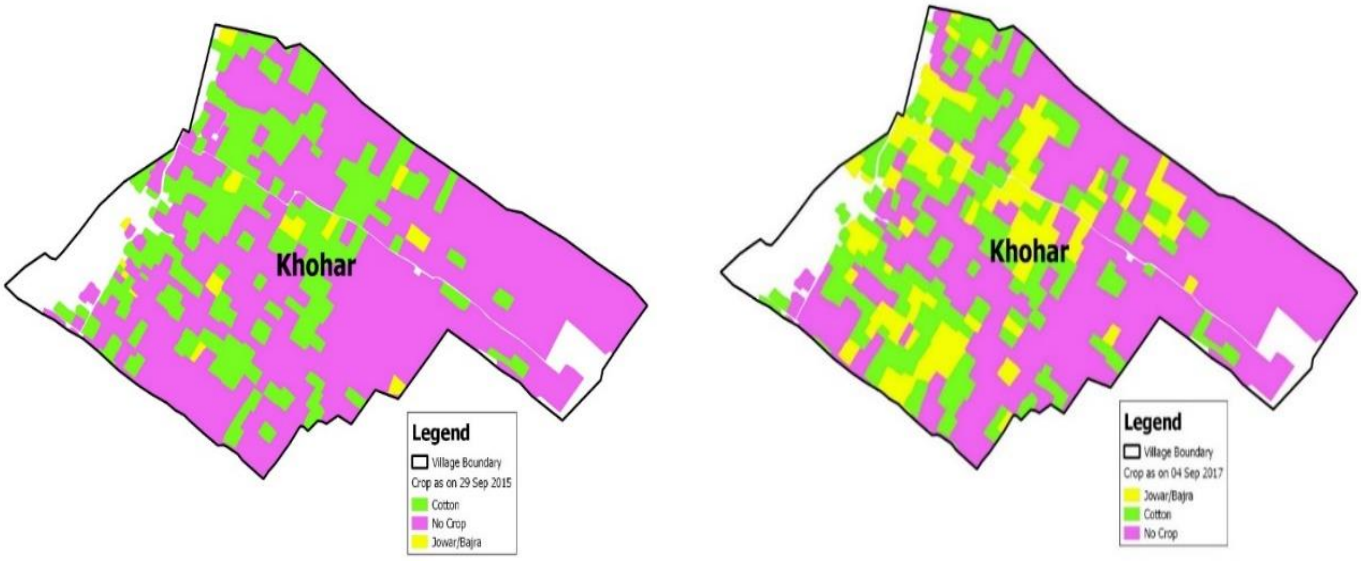
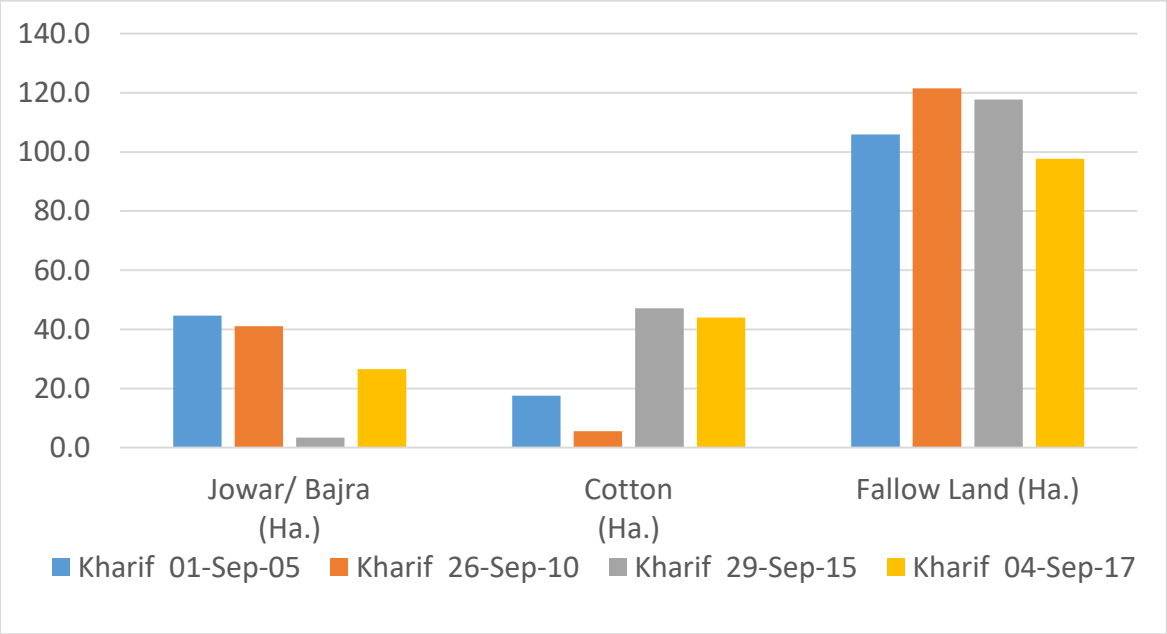


Figure 6.4: Kharif Crop Trend Analysis of Khohar (Post Check Dam)



Kharif season in Khohar is mainly the season of fallow lands, but after the inception of check dam, the area under Kharif fallow land reduced from 118Ha to 98 Ha. This, in turn, will benefit the returns of large farmers.

Figure 6.5: Trend in Kharif Crop Area of Khohar



The market linkages for wheat are more appropriate than mustard that is the reason for an increase in area under wheat. The farmers also anticipated that as the check dam got incepted, the groundwater level will increase, so tremendous exploitation of groundwater was done to cultivate wheat.

Figure 6.6: Rabi Crop Trend Analysis of Khohar (Pre Check Dam)

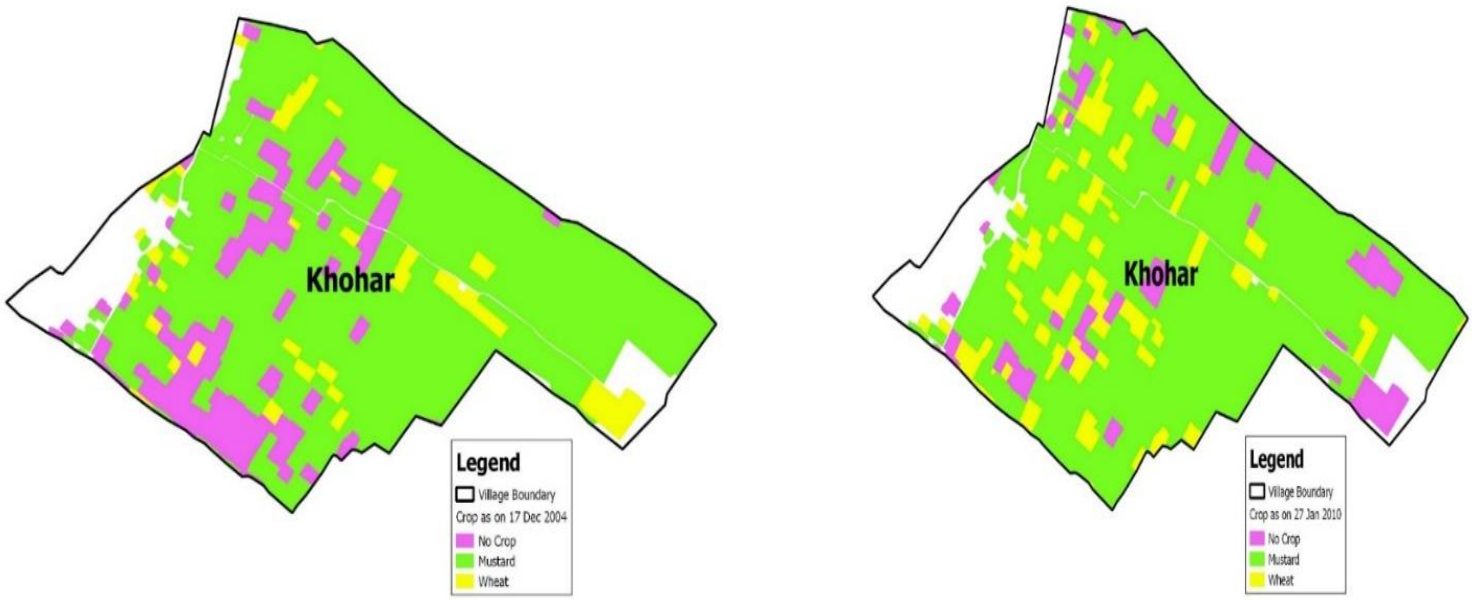
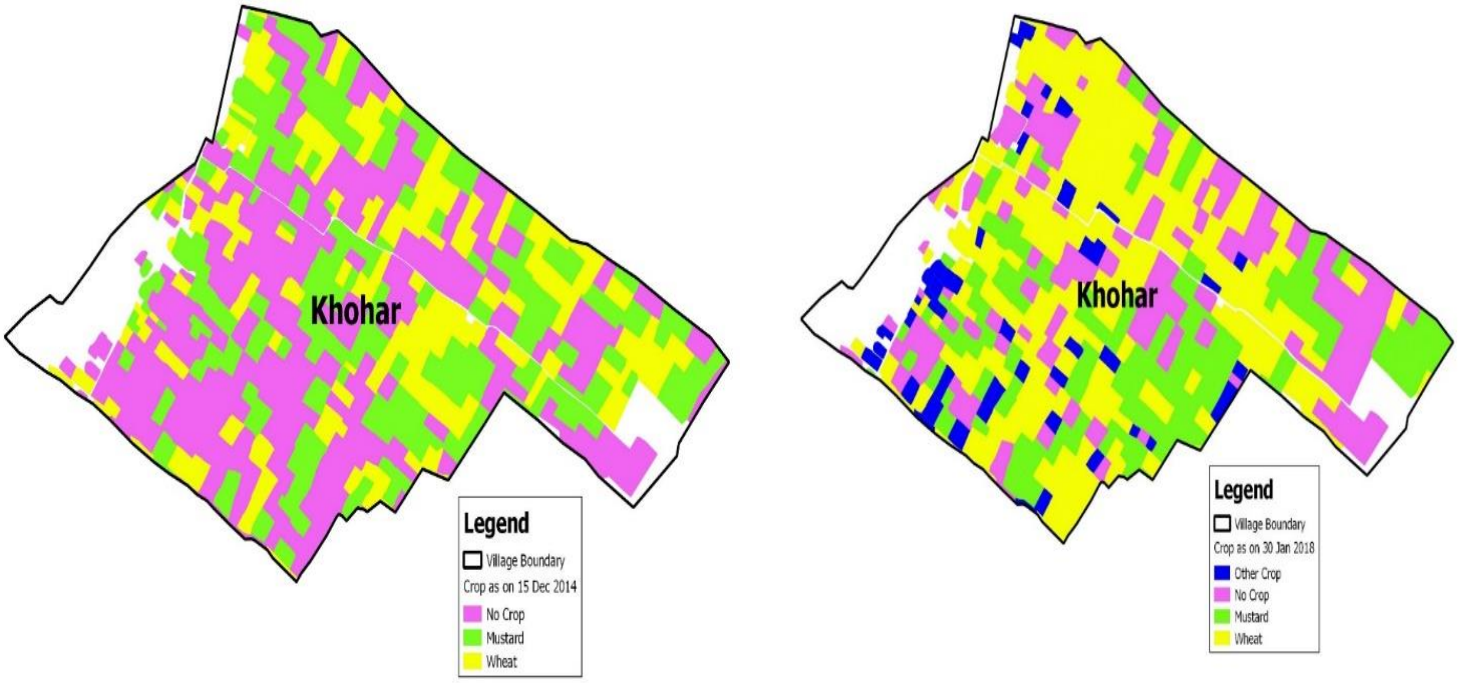
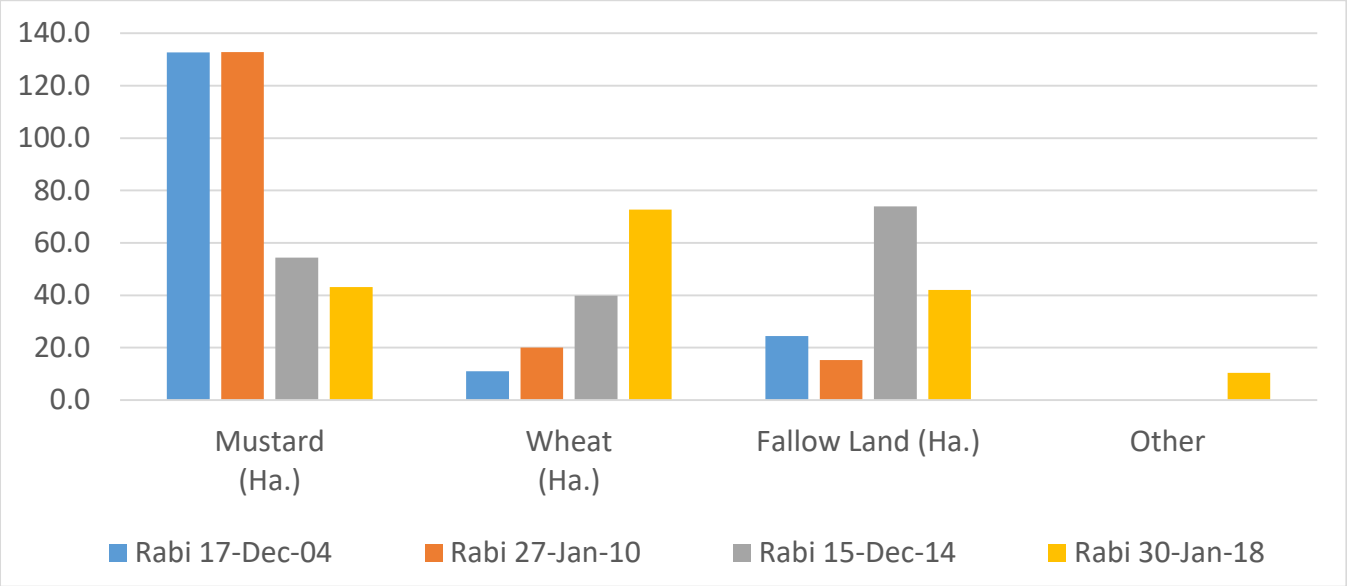


Figure 6.7: Rabi Crop Trend Analysis of Khohar (Post Check Dam)



The figure 6.6 and 6.7 clearly shows that the area under mustard is decreasing. Out of the total area of village around 138 Ha in the year 2004 that reduced to 40 Ha in 2018. It is evident from the figure that post check dam inception, the area under mustard has been converted to wheat whose area increased from 11 Ha in 2004 to 73 Ha in 2018. The rabi fallow land area decreased from 74 Ha to 42 Ha in 2014 that shows the significant impact of check dam.

Figure 6.8: Trend in Rabi Crop Area of Khohar



There is a shift in trend from jowar based production system to cotton based production system in Kharif season and wheat-based production system from mustard in Rabi season.

Chapter VII:

An Analysis of the Livelihood Determinants and Vulnerability of Seasonal Migration in Khohar Village, Rajasthan, India.

Seasonal migration is a common phenomenon in Khohar Village of Rajasthan. Yet, its challenges and consequences are mostly unexplored. This study examines livelihood vulnerability of migrants and non-migrants analysing the determinants responsible for decision making on seasonal migration. This paper unlike most previous works investigates the gender differentials of migration through research. It attempts to enables to give a holistic view on seasonal migration wherein entire family leaves for agricultural labour work to Punjab and Gujarat every year. As the migrants are purposively selected from the population, Heckman probit model was used to estimate the variables that contribute to the decision to migrate. Qualitative methodology was used to analyse the gender perspectives on migration. Empirical results yield that compared to large and small farmers, medium farmers have higher livelihood vulnerability due to low livelihood diversification index and low crop diversification index. Probit model shows that there are significant differences in the socio-economic variables of migrating and non-migrating farmers. In Khohar village, unstable climate, poor market linkages, depleting groundwater table and influence of middlemen are the primary factors that contribute to the socio-economic instability that lead to significant differences in the livelihood variables of migrating and non-migrating farmers.

Migration is an ubiquitous reality in India. Kingsley Davis in his pioneer work in 1951 argued that Indians are less mobile (Davis, 1951). However, this has come out to be far from being true. Over the years with India's successful growth pattern and subsequent urbanisation, the number of interstate, intrastate as well as international migrants have been increasing with people shifting their livelihood base permanently or temporarily usually for better economic prospects. The high economic disparity between regions and the limited scope of opportunities available in a rural area drives labour to increasingly migrate to urban setups. Migration comes with its own set of opportunities and challenges varying as per the nature of migration, the location and other various social and economic aspects. It is a common phenomenon in India and Indians engage majorly in internal migration with the number of internal seasonal migrants estimated to be more than 100 million (Deshingkar and Akter, 2009). Over the last couple of decades, migration seems to be accelerating in India with the annual rate of growth of labor migrants rising to 4.5 percent per annum in 2001-2011 from 2.4 percent in the previous decade (Ministry of Finance, 2017). Most migration flows from rural to rural areas at 47.4% while rural to urban migration which is assumed to be quite common increased only marginally between 2001 and 2011 from 21.8% to 22.1% respectively and migration from urban to urban rose from 15.2% to 22.1% (Census of India, 2011).

Better employment opportunities and higher wages are one of the common reasons for migration apart from marriage, natural calamities and migrating for prosperity among others. Labour migration includes all individuals who are currently employed, unemployed or seeking employment in the place of destination (ILO, 2015). Migration can be of various kinds and does not necessarily result in better standards of living. The people worst affected are the ones lying at the bottom of the hierarchy, that is the seasonal migrants defined as "A worker employed in the unorganized, informal labour market, engaged for 3 months or more at a work destination, away from his/her native rural block." (Aajeevika Bureau, 2014). Roughly 70 to 80 million workers in the country are seasonal migrants, making it 15 to 20 percent of India's workforce. Female labour migration seems to be on a rise as well. It witnessed a 101 percent increase between 2001 and 2011, and female migration because of business increased by 153 per cent which is four times more than the rate for men (GoI, 2017). Migration should always be a choice; however, when it happens out of necessity, which is the case for maximum rural migrants in the country, it is responsible for some challenges and hardships the migrating families and individuals essentially face which ultimately affect their livelihood.

The state of Rajasthan has majority of its rural population actively involved in the wage labour market as its sole means for survival. It has an increasing number of migrants contributing to its economy, with around 5.79 million of them being from rural areas where grinding climatic conditions along with low rainfall and proneness to drought makes many of them move out and look for work in other locations in the country (Aajeevika Bureau, 2014). However, the increasing number of migrants and their increasing contributions to the economy are met by a simultaneous deterioration in their livelihood conditions. The seasonal migrants remain almost invisible to the society and to the government with no efforts made to improve their low and unstable wages and harsh living conditions as they continue to survive on the fringes of the economy.

In the last few decades, empirical works on the reasons and significance of migration in many developing countries has been recorded (De Haan, 1999). However, until today migration pattern of people of Khohar a small village in the Alwar district of Rajasthan has not been recorded identifying the major determinants in a gender angle. Out of the total 154 households of Khohar, about 50 migrate on an average every year. The village has a problem of acute water shortage and also witnesses large-scale seasonal migration of entire families and individuals to nearby states where the migrants work as daily wage labourers. Therefore, the present study was designed to obtain for an in-depth look view of the cause of migration and how strong a role gender plays in the situation. This will help understand the migrating trends in detail and in return, resolve the local issues effectively.

Results and Discussions

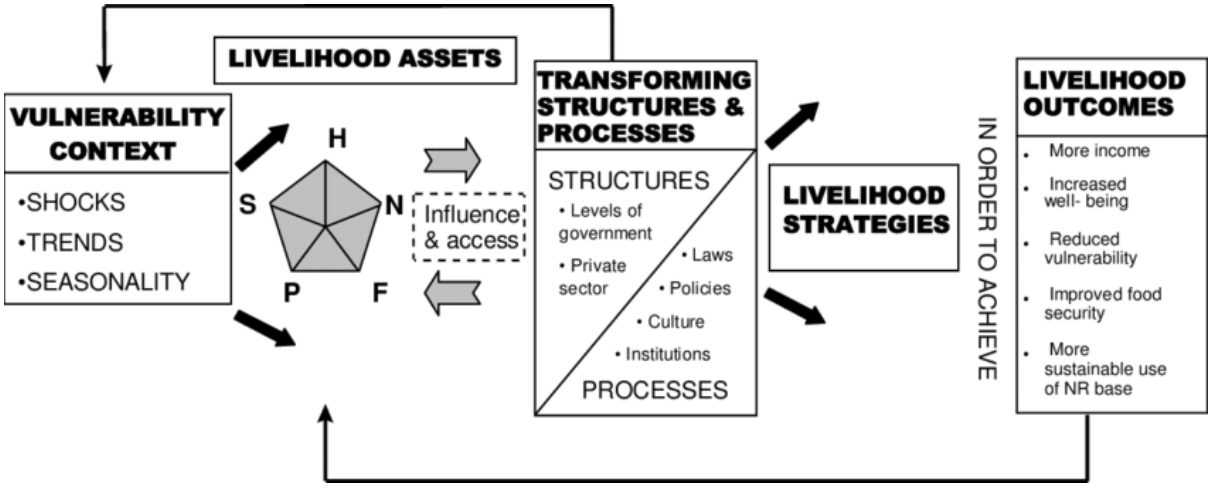
Table 1 represents the demographic and socioeconomic characteristics of sample farm households of the study area. The socioeconomic status of the villagers varies considerably between migrants and non-migrants. The education status of house hold head is the variable the major socio economic variable, that significantly varies between migrants and non-migrants. The migrants have a tendency to discontinue education and migrate, resulting in an increased migratory income of the family. Thus from childhood they receive partial education resulting in a skewed value of education variable. The land owned by migrants are very small with less access to irrigation water, therefore the agricultural income and the total income is less. None of the migrants has their own bore well, hence the total time spent in a day to collect water was more for migrants compared to non-migrants. The non-migrants are the land owners and the influential persons of village so the social participation index is high for them. As the adults and children migrate and work, the dependency ratio is almost comparable for both migrants and non-migrants.

TABLE 7.1: *Socioeconomic Characteristics of the Respondents*

Variables	**Migrants (n=47)**		**Non - Migrants (n=103)**	
	Mean	Standard Deviation	Mean	Standard Deviation
Education Status of Household Head	3.68	3.88	5.19	3.68
Total Family Members	5.02	1.56	5.81	2.26
Income from Agriculture	8173.33	15686.98	27888	55942.60
Total Annual Income	74549	75441	164161	172979
No. of Agriculture Equipment Used	0.17	0.64	1	3
Land Size	0.79	1.11	2.48	5.22
Total time spent in a day to collect water	166.77	108.06	88.50	58.92
Number of Livestock	2.91	5.64	3.65	8.51
Dependency Ratio	0.30	0.21	0.33	0.22
Social Participation Index	18.08	18.77	26.01	22.80

Gender Perspectives on Migration and its effect on livelihood

The Focused Group Discussions (FGD) yielded tangible differences between the perspectives of male and female migrants. The FGDs were made on the basis of assets component pentagon of Sustainable Livelihood pentagon (DFID, 1999).



Human Capital

Human Capital is a measure of the skills, education, capacity and attributes of labour which influence their productive capacity and earning of the Khohar population. Among adults, the men were adamant on the fact that the entire family must migrate every time, be it infants or even pregnant women and staying back home is not an option. The females on the other hand stated that sometimes the small children and those who cannot help in the fields do stay back in Khohar with the elderly of the household. One major issue with migration for the women was the education of their kids. Being away for four to five months straight interrupts their studies and they just come back to give the final exams, which they are bound to fail.

The challenges faced by the youth are very different for boys and girls too. While the main challenge for the boys was to get a decent job or employment in or around the village that could help them earn a decent living, all the girls wanted a higher secondary school in the village itself so as to complete their education. As the nearest school is almost 10 kms away and adding to the yearly migration practice, the girls usually drop out of school after 8^{th}-9^{th} grade and are unable to complete their education. The boys contrastingly do manage to complete their schooling and a few of them had even done a technical course or graduated from college, but were still unemployed. Boys and girls both realize the need to migrate with their families as they are aware of the financial constraints existing in the village. Yet they are constantly looking for opportunities to expand their horizon and escape this cycle of migration. Some of the male participants in the FGD were now venturing out into non-agricultural services like driving and stitching, diversifying the opportunities available to them. Like the limited opportunities available to them, the dreams of these girls are also limited. They only dream of fulfilling their very basic and fundamental needs like education, getting married on their own terms or going to college if they like.

Healthcare is another cause of concern for the people of Khohar. The nearest hospital is in Alwar which takes about an hour or longer to reach, that too if they find some mode of transportation for the same. There is no doctor or a Public Health Center in the village, making it increasingly difficult for the villagers to get proper and timely cure and treatment for their illnesses. The situation for migrants is worse as they live in unbearable harsh conditions in the rural areas of Punjab and Gujarat, coming back home with malaria, high fever or other diseases. The women expressed having a hospital nearby and explained how tough it is to take a pregnant woman to the hospital for delivery at odd hours in the day. The migrant women mostly suffer from low blood count or nutritional deficiency.

Natural Capital

Natural capital can be defined as the world's stocks of natural assets which include geology, soil, air, water and all living things. Migrants possess small to negligible acres of land which they are able to cultivate only in the monsoons. Their fields lie fallow the rest of the year due to irrigation issues in the village. The average land holding size of migrants is less than 0.83 bigha and for non migrants is more than 2.6 bigha. Smaller landholdings is one of the primary reasons for migration as well.

The migrants also have to put in a lot of effort in getting water for their households as the borewells in the village are majorly owned by affluent families. One of the borewells is opened for 15 to 20 minutes each day in which the entire village rushes with their pots and utensils to fill water for their daily needs. The women especially take part in this daily activity, earning their share of water from a battle they wage every day.

Forest is also a source of income for the whole community as timber is acquired from the bushy trees near the mountains and sold off by migrants and non-migrants alike. The money is utilised for the community needs like renovation of village infrastructure, temple etc.

Financial Capital

Financial capital is any economic resource measured in terms of money used by the Khohar population and businesses to buy what they need to do agriculture or to provide their services to the sector of the economy upon which their operation is based. Even though, the migrants earn a decent amount of money through agricultural wage labour, at least 2/5th of their earning is spent on medical bills as estimated by the migrating population themselves. They usually migrate at least three times in a year for cotton, wheat and rice cultivation. Table 2 below provides an estimate of the wages they earn daily.

Table 2 - Estimated wages earned by the migrants

Crop	Location	Duration	Wage earned per person

Wheat	Punjab/Palwal	15-20 days	INR 400-600 per day
Cotton	Gujarat/Punjab	4-5 months	INR 350-500 per day
Rice	Gujarat/Palwal	15 days	INR 600-700 per day

Source: FGDs and Personal Interviews

Physical Capital

Physical capital refers to a factor of production (or input into the process of production) which is mainly the capital for agriculture and other livelihood activities. The villagers in Khohar have pucca houses to live in with proper shelter over their head. However, toilets are not functioning due to lack of water. Open defecation is highly prevalent among men and women alike. The migrating women did complain about going out in the open for defecation but were also aware about the financial constraints of getting a toilet built in their homes. Even where the toilets were built, most of them were non-functional due to lack of water availability.

All the groups in the FGDs mentioned similar problems faced at the migrating destination including lack of proper housing as the families have to live on the farms, under a makeshift tent for some shade and sleep in the open fields in extreme weather conditions as well. Water and food issues also exist as the contractors sometime provide them with ration which they have to cook themselves but they need to fetch water for their daily needs from nearby streams or canals where all animals bathe and germs and mosquitoes are breeding. Thus, people get ill very often when working there, with high fever and malaria being common diseases and low blood count and nutritional deficiency common among females. The intense 12 hour shifts start at 6 in the morning and stretches up to late evenings which contributes to their ill health. The women expressed frustration regarding this and raised grave concerns about travelling all the way with their little children and not being able to take proper care of them. They were also blaming their husbands for being complacent to not look for employment elsewhere or go to an urban setup for non-agricultural daily wage work.

Social Capital

Social Capital includes the networks of relationships among people who live and work in Khohar, enabling that society to function effectively. Conducting in-depth interviews with the villagers including migrants and non-migrants also helped in understanding differences between them in detail. The women belonging to better off households who are not engaged in migration were physically healthier than the women who migrate. Sumitra Bai, a woman living with her husband in Khohar does not need to worry about employment as her two children live and work in Delhi and provide for the family. The woman cultivates a few crops in her small field but is reaping the benefits of educating her

children who were able to get away from the vicious trap and make their own living. She herself did migrate with her husband for a couple of years in the beginning of her marriage but was unable to continue, describing it as a highly tedious and challenging task. Women of Khohar lead very challenging lives with migration being a necessity for them, and the only possible means to earn a living guaranteeing survival. They have been migrating since they were children and have seen their parents do it as well. Their education was interrupted because of the frequent migration, wherein many of them dropped out of school at a young age and never went back. The same cycle continues with their kids not being able to go to school for similar reasons. All family members who are healthy and are able to participate in the fields, work together in order to earn maximum returns for their labour.

Surviving under such unbearable conditions makes the whole process of migration extremely difficult for all members of the household. However, the burden falls harder on females as they are supposed to perform all household duties, look after their children as well as work in the fields for long hours even if they don't wish to. In a study by Sandhya Mahapatro (2013), it is highlighted how increased female migration is a sign of empowerment for women and that higher migration leads to improved role of women in their households and in decision making processes as well. Khohar however presents a different side to this. Living in a patriarchal system, their migration trends are not characterized by empowerment but by forced and taxing situations, from which they can't seem to find a way out.

Table 7.3; Heckman selection model for seasonal migration

	Total Migration Select Heckman	Total Migration ln(tot_annual_inc)
edu_status_HH_head	0.02141 *	0.0234*
agri_equipments	0.14722	0.627960
land_size	0.59613	0.964413
amt_credi	0.58117	0.962029
agri_diversification_index	2.14e-05 ***	0.849314
sources_income	0.39940	0.000152 ***
dependency_ratio	0.54728	0.141791
time_spent_in_day_to_collect_water	0.00469 **	0.65630
agri_income	0.65630	0.027366 *

livestock	0.67585	0.006036 **
social_part_index	0.59268	0.023185 *

*** p<0.01, ** p<0.05, * p<0.1

Table 7.3 shows the results of Heckman two step model. From the model it can be said that the main determinants of decision to migrate are education status of the household head, agriculture diversification index and time spent in a day to collect water. On the other hand the main variables influencing the total income of migrants are education status of the household head, total sources of income, agricultural income, livestock and social participation index. Education status of the household head and agricultural diversification index have a negative impact on the migration decision while time spent in a day to collect water has a positive impact.

Conclusion

Gender analysis along with Heckman model helps us identify the factors responsible for migration in Khohar as well as factors affecting the total income earned by migrants. With the help of Heckman two step model we realize the significant differences in the socio-economic variables and livelihood asset components of migrating and non-migrating farmers.

Looking at the issues faced by the migrants in the village, adequate policy measures should be adopted to effectively solve their problems. The statistical results help us to stress on the variables which are highly significant in influencing the decision to migrate. Policies for better access to education and generating employment opportunities in the village would help these villagers stay back in Khohar and work instead of frequently migrating. As agriculture is the primary occupation in the village and water scarcity is a major problem, a district level Master Plan for small water harvesting structures like check dams or earthen tanks could be developed.

Another policy level change needs to focus on better inclusion of the migrating community all across India. These individuals are often deprived of the basic legal and social protection that could ease the process of migration and help them become recognized and a respected part of the society. This would also provide them relief from living in such unlivable conditions at their migrating workplace.

Chapter VIII
Conclusion and Recommendations

- The Rajasthan State Water Policy (2010) needs to precisely recognize the importance and relevance of check dam and the measures that can be taken to harness this potential in solving the associated water issues in the state for the minor irrigation, drinking water, etc. The state policy mentions sound watershed management through extensive soil conservation, catchment area treatment, preservation of forests and increasing the forest area and construction of check dams shall be promoted to reduce the intensity of floods. About 80% of state's irrigation sources are ground water sources, and it is quite likely that check dam has a significant share in the state's overall irrigated area. It is recommended to develop a district level Master Plan for small water harvesting structures like check dam and earthen tank.
- Precise water measurement and soil moisture checking are critical components of efficient on-farm water management practices. Irrigation flow meters can be used to help calculate the efficiency of irrigation systems, identify water loss from leaks in conveyance systems, and to accurately apply only the necessary amount of water based on soil moisture levels and weather conditions. Soil moisture monitoring is used in conjunction with weather data and crop evapotranspiration requirements to schedule irrigation. Fields need to be designed for efficient water use by grading land with laser equipment, creating furrow dykes to conserve rainwater, and by retaining soil moisture through conservation tillage. WFP benchmarks will enable actors along supply chains – from farmers through intermediate companies to final consumers – to compare the actual WFP of products against certain reference levels (Hoekstra, 2014). The benchmark values can be used to measure performance, to set WFP reduction targets and monitor progress in achieving these targets.

- The Khohar check dam can be considered small as far as size is concerned. The average length of the surveyed stop dam was 185-meter-long and 3-meter-high check dam with a capacity to hold 32 crore litres of annual rain water harvesting.
- The study confirmed that even though the radical change regarding the water level has been observed in the ground water table in 2015 and 2017 due to the impact of check dam supplemented with rainfall, over-exploitation of water by increasing area under

wheat and cotton resulted in the high vulnerable situation. Even though they haven't seen any changes in the water table, but they realize that past year the water table did go down significantly because of the impact of the check dam.

- Unanimously, all the respondents were found to be unsatisfied with the low height of the dam, which, according to them is unable to store more water for a more extended period. They wished for an increase in the depth of the dam or increase the catchment area to accumulate and retain more rainwater, which eventually will recharge the ground water in a short span of time. Due to the silt deposit over the years, the villagers also complained that the recharge wells are not functioning correctly and the height of the wall also reduced.
- Prioritizing the applicability of recharge water, discussion with different groups exhibited that it would be more useful in irrigation by timely availability of water and in the desired amount as the people preferred to cultivate cash crops like cotton and onion.
- Other beneficial areas that were put into a discussion with the respondents were water for domestic use and livestock and reduction in women's drudgery as they used to carry water from long distances for cooking, washing, bathing and drinking purposes. This may include a reduction in time and effort spent collecting water from the water source to their home. Women repeatedly said, that, stored water in check dam will help their cattle for drinking and grazing in the jungle
- For medium farmers, livelihood strategies were found to be less diverse that indicates more agrarian distress and migration in future. Accessibility to food is less for small and medium farmers with more malnourishment in this region. The livelihood vulnerability, social network and water threat component is more for the small and medium farmers. The average time required to reach the health facility centre is almost same for all the farmers. As far as the number of persons getting chronic ailments, it is maximum for small farmers but the amount spent on the treatment of diseases are very less for them. Affordability of large farmers are high so they spent more money to treat diseases.
- The cropping pattern and market linkages are the major factors that lead to the agrarian distress. Allied agricultural activities should be promoted that acts as a life saver for vulnerable communities. Cost of tube well irrigation is the major component of the total variable cost of production of the agriculture. The analysis showed that increased use

of tube-well water was not affecting the crop income significantly since the average water quality in the study area was within the normal range

- Constructing a check dam in Khohar, will not only help in curbing the future water struggle, but it will also increase the agricultural output, provide a guarantee to food security, enhance groundwater resources and potentially reduce uncontrolled migration and poverty of the village in the coming time.
- The export of agricultural products of India should take care of the virtual water imbibed in the production. So the farm output of the water-intensive crop should be for sustenance, not for import.

Chapter IX

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