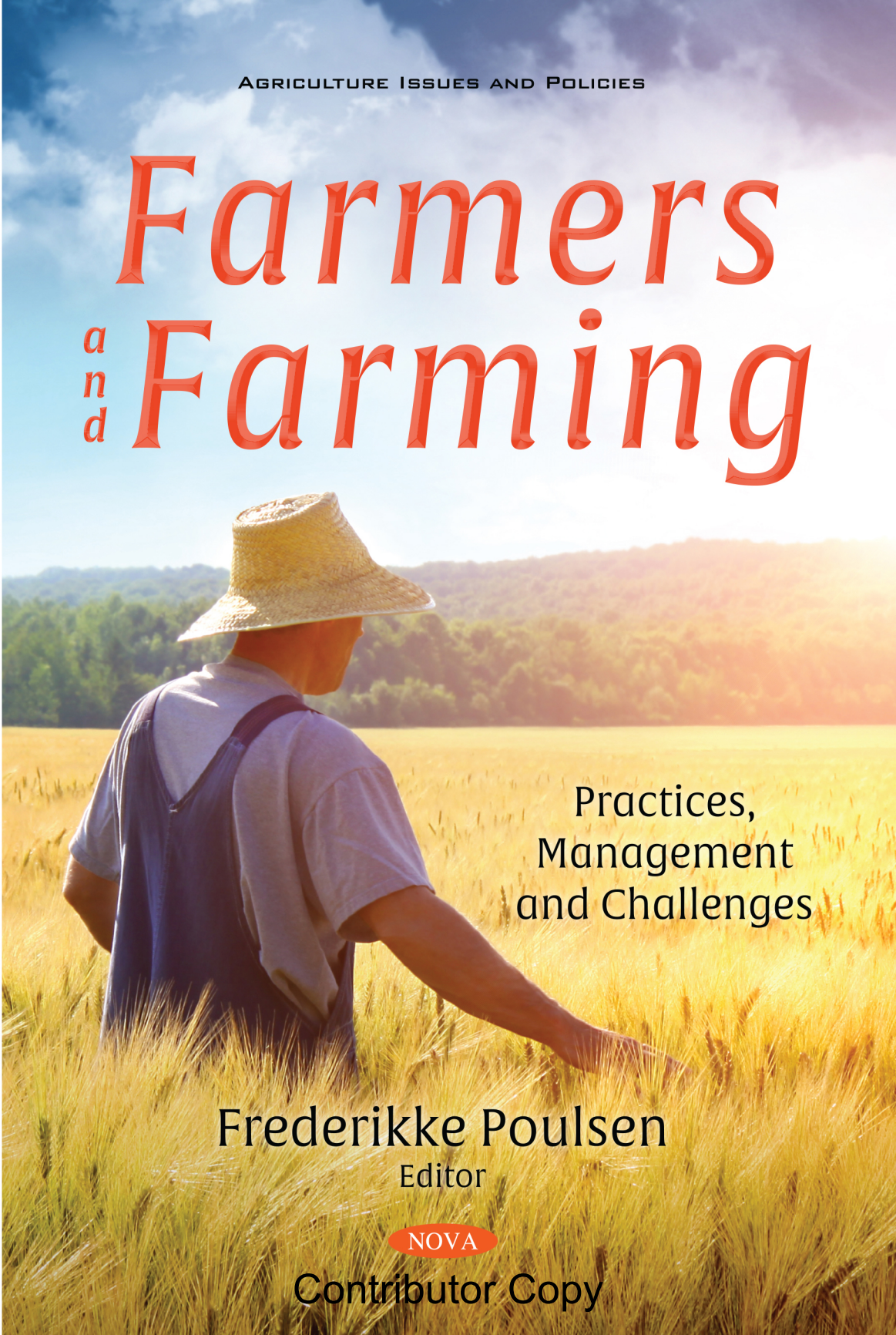
Agriculture Issues and Policies
Farmers and Farming
Practices, Management and Challenges
Frederikke Poulsen
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AGRICULTURE ISSUES AND POLICIES

FARMERS AND FARMING

PRACTICES, MANAGEMENT AND CHALLENGES

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FARMERS AND FARMING

PRACTICES, MANAGEMENT AND CHALLENGES

FREDERIKKE POULSEN
EDITOR

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CONTENTS

PREFACE

Farmers and Farming: Practices, Management and Challenges opens with a focus on livelihood, which refers to the way people make a living. Livelihoods are the means people use to support themselves, to survive and to prosper.

Next, the authors aim to analyze the socio-economic features of farmers involved in organic cultivation, exploring landholding patterns in the northern part of Karnataka state.

They also explore how gender-based farming systems analysis could be used to simulate the effects of a change in agricultural practices on gender relations, either with the aim to do no harm or with the objective to achieve more gender equality.

In closing, an overview on the potential and setbacks of intercropping in maintaining crop yields in changing climate in smallholder farmers in ESA set-up.

Chapter 1 - Livelihood refers to the way people make a living and analyzing livelihood system is the analysis of the factors involved in the way people make a living. Livelihoods are the means people use to support themselves, to survive and to prosper. Livelihoods are an outcome of how and why people organize to transform the environment to meet their needs through technology, labor, power, knowledge and social relations. In India, rural livelihood is occupation as a source of income, and livelihood in the

rural areas include agricultural work and other allied rural employments such as labor, home industry etc. A rural livelihood is defined as the capabilities, assets and activities that rural people require for a means of living. Recently, rural development has assumed global attention especially among the developing nations. It has great significance for a country like India where the majority of the population live in the rural areas. India is primarily an agriculture based economic country. Agriculture contributes nearly one-fifth of the gross domestic product in India. The majority of the population in rural areas rely on agriculture and linked occupation. Agriculture and allied activities support the livelihoods of nearly 70 percent of India's rural population. Indian agriculture is characterized by millions of marginal and small farmers, who are facing difficulties to operate high risks of farming. The risks are related to weather uncertainties, uneven access to technologies and natural resources, unreliable input supplies, stressed infrastructure in power and irrigation and uncertain marketing arrangements which are responsible for less bargaining power in input and output marketing of Indian farmers in present economic scenario. The number of small and marginal farm families for this study was 300. The data were collected through a pre-tested structured interview schedule with appropriate statistical measures for analysis and interpretation of the data. Regarding natural capital of farm families in the present study, more than half (50.3%) of farm families used ponds/well/canal for getting water for agricultural/household purpose. Majority (65.0%) of farm families benefit from community land for grazing livestock. Data regarding economic security of selected farm families revealed that less than half (45.0%) of the families were having annual income ranging between Rs. 3-4 lakh, they had livestock values in between Rs. 30,001-60,000. As regards to value of land, an overwhelming percentage (68.6%) of farm families had land estimated worth of Rs. 25,00,001- 30 lakh. Less than half (47.3%) of the families were not in debt and very few families (18.7%) were in moderate debt.

Chapter 2 - The study aims to analyze the socio-economic features of farmers involved in organic cultivation besides the study also explores to find the landholding patterns in the northern part of Karnataka state. The

study has used both primary and secondary data for fulfilling the objectives of the study with a sample size of 75 sample respondents from each district, in total consisting of 225 samples. The findings reveal that, the average family size of the sample farmers was 6.15, 6.06, and 5.38 in Bagalkot, Bijapur, and Gadag districts respectively. About literacy rate the proportion of illiterates was found to be highest in Bagalkot district (34.66 percent) when compared to Gadag (26.66) and Bijapur (25.33) district. Further, the study also reveals that the literacy rate in the districts such as Bijapur (72.23%) and Gadag (73.34) was found higher than the Bagalkot district literacy rate (65.34%). However, these three districts literacy rate is on par with Karnataka state literacy rate 66.60%. Therefore, there may not be any problem for the extension workers to educate the farmers regarding recent developments in agriculture and other enterprises to increase their level of income and productivity in farms. The findings on the source of irrigation convey that the major source of irrigation Bagalkot district was through wells (33.77%) followed by bore well (30.06%). Similarly, in Bijapur district the major source of irrigation was through other sources (40.12%) followed by bore well (34.14%), canals (20.74%), wells (4.67%) and tank (0.32%).

Chapter 3 - Conceptual lock has resulted in the failure of the agricultural extension and advisory services to properly serve women in farming systems. Women's needs as farmers are to be included in the development agenda in order to mainstreaming gender in farming systems, since women contribute a large percentage to total family income. Focusing on access is not enough ensuring women as well as men can implement what they learn requires a conceptual model in order to achieve gender equality. Integration of gender indicators are essential to make farming systems analysis more gender sensitive. Gender based farming systems analysis could be used to simulate the effects of a change in agricultural practices on gender relations, either with the aim to do no harm or with the objective to achieve more gender equality. Specific needs of the farmers can be targeted and agricultural scientists, technologists and extensionists can be benefited from the knowledge of female farmers and the designed interventions have a higher chance to be implemented

effectively. Government policies and programs should be revised to address women's practical and strategic needs for gender transformative change. One of the main tasks of a gender-responsive/transformative research and extension farming systems approaches is to capture, record, replicate, and upscale such methodologies to effect broader social change.

Chapter 4 - The smallholder farming systems in eastern and southern Africa (ESA) depend on natural rainfall for crop and livestock production. However, climate change effects increasingly influence overall productivity in ESA smallholder farms. Prolonged dry spells have become more frequent which leads to moisture scarcity and low crop yields. Many cropping systems that are common in ESA are designed to maximize efficiency and productivity under optimum conditions. Hence, it is important to investigate potential cropping systems that are resilient to the impacts of climate change and promote conservation of resources in smallholder farms. One possible practice is intercropping cereals with different legume types. This has been traditionally used by farmers and has several benefits including reduced risk of total crop failure, more soil cover to protect the soil surface from direct sun and raindrop impact, improved resource use efficiency, reduced pests, diseases and weeds infestation and increased crop yield. Although intercropping different crop species has several benefits if properly combined in space and time, the crop mixtures practiced by farmers are not fully understood by researchers/scientists. Crops respond differently to environmental stress, and they have potential to complement each other. This review aims at providing an overview on the potential and setbacks of intercropping in maintaining crop yields in changing climate in smallholder farmers in ESA set-up.

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Chapter 1

LIVELIHOOD ASSETS AND SECURITY OF SMALL AND MARGINAL FARMERS IN SELECTED DISTRICTS OF HARYANA, INDIA

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ABSTRACT

Livelihood refers to the way people make a living and analyzing livelihood system is the analysis of the factors involved in the way people make a living. Livelihoods are the means people use to support themselves, to survive and to prosper. Livelihoods are an outcome of how and why people organize to transform the environment to meet their needs through technology, labor, power, knowledge and social relations. In India, rural livelihood is occupation as a source of income, and livelihood in the rural areas include agricultural work and other allied rural employments such as labor, home industry etc. A rural livelihood is defined as the capabilities, assets and activities that rural people require for a means of living. Recently, rural development has assumed global

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attention especially among the developing nations. It has great significance for a country like India where the majority of the population live in the rural areas. India is primarily an agriculture based economic country. Agriculture contributes nearly one-fifth of the gross domestic product in India. The majority of the population in rural areas rely on agriculture and linked occupation. Agriculture and allied activities support the livelihoods of nearly 70 percent of India's rural population. Indian agriculture is characterized by millions of marginal and small farmers, who are facing difficulties to operate high risks of farming. The risks are related to weather uncertainties, uneven access to technologies and natural resources, unreliable input supplies, stressed infrastructure in power and irrigation and uncertain marketing arrangements which are responsible for less bargaining power in input and output marketing of Indian farmers in present economic scenario. The number of small and marginal farm families for this study was 300. The data were collected through a pre-tested structured interview schedule with appropriate statistical measures for analysis and interpretation of the data. Regarding natural capital of farm families in the present study, more than half (50.3%) of farm families used ponds/well/canal for getting water for agricultural/household purpose. Majority (65.0%) of farm families benefit from community land for grazing livestock. Data regarding economic security of selected farm families revealed that less than half (45.0%) of the families were having annual income ranging between Rs. 3-4 lakh, they had livestock values in between Rs. 30,001-60,000. As regards to value of land, an overwhelming percentage (68.6%) of farm families had land estimated worth of Rs. 25,00,001- 30 lakh. Less than half (47.3%) of the families were not in debt and very few families (18.7%) were in moderate debt.

Keywords: livelihood, natural, economic, capital, security

1. INTRODUCTION

India has accomplished notable socio-economic achievements after independence, but it is in its evolving phase, and population growth is a major hurdle in its growth (Chadha, 2016). India has a geographical area of over 329 million hectares which is endowed with a complex diversity of soil conditions, climate, flora and fauna. These peculiarities offer both a blessing and a challenge for agricultural development. The richness of the country is affected by its huge population, increasing population density

and corresponding demand for arable lands and ensuring food security. Several revolutions i.e., green revolution in wheat and rice, white revolution in milk, yellow revolution in oilseed and blue revolution in fisheries have improved the food basket of the country, but many technological challenges remain. First, despite the shrinking share of the agricultural sector in the economy, the majority of the labor force continues to depend on agriculture and allied activities of agriculture. Secondly about 75 percent of India's population with low purchasing power lives in rural areas and nearly 60 percent of the cultivated area is under rain-fed farming (Ramchandani, 2014).

The idea of farming appears to be ingrained in this earth for 10,000 years. Since inception, Indian agriculture is not merely an occupation, but it is the way of life which for centuries has shaped the outlook of life and livelihood of the nation. This is one sector that is closely connected to environment, which can be immensely affected by weather conditions. Any change in weather has a two-fold effect: a) impacts on crop production b) socio-economic conditions of the farmer and his household. In an agrarian society like India, most studies have pointed out that severe water and heat stress have profoundly impacted the livelihood of small and marginal land holding farmers reducing their ability to enhance assets and improve their quality of life. For a considerable period, the farmers of the developing countries have remained in topographical variation, have kept up their particular culture of farming and have managed on family-based farming. According to the World Bank (2008), agriculture is a source of livelihoods for 5.5 billion people in the developing world of which 3 billion live in rural areas. Nearly 2.5 billion of these rural people are involved in agriculture of which 1.5 billion belong to smallholder households. These resource poor farmers constitute the majority (85%) of farmers in the developing world.

Indian agriculture is the home of small and marginal farmers. Therefore, the future of sustainable agriculture growth and food security in India depends on the performance of small and marginal farmers. In India, greater part of the farming community has a place with small and marginal farmers (76.2%) who have just 29 percent for operational holding, while

71 percent of the worked region is controlled by farmers who have medium and expansive size possessions. The nourishment, feed and fuel generation should be expanded by 60 percent in the following 25 years to address the issues of the developing countries. Clearly, that majority of the farmers of this nation belong to small and marginal categories. According to Haryana census 2011, the total farming families are 16.17 lac. Among them marginal farmers are 7.78 lac (48.1%), small farmers are 3.15 lac (19.5%) and others are 5.24 lac (32.4%) (GOI, 2014).

In India, small and marginal farmers are facing many problems to operate the high-risk farming. These risks are related to weather uncertainties, uneven access to technologies and natural resources, unreliable input supplies, stressed infrastructure or irrigation, uncertain marketing arrangements, inefficient water management, lack of access to inputs, lack of timely support, lack of knowledge, lack of ability to diversify, lacking connectivity, lack of access to credit, lack of value addition at farm level etc. Due to these limiting factors, the small and marginal farmers suffer from the low productivity, instability in yield, low employment, less income and poor standard of living which are responsible for less bargaining power in input and output marketing of Indian farmers in present economic scenario. The increase in population, subdivision and fragmentation of land holdings due to breakdown of joint family system has further resulted in un-economic land holdings on which application of new agricultural practices becomes more difficult. In traditional farming practices, their costs of cultivation and risks of crop failure are so high that often the farmers cannot even recover the money spent. This summarizes the enormity of the present agricultural crisis and the challenge faced by the nation.

However, opportunities are also widely open to marginal and small farmers in terms of increasing scope of human labor-intensive enterprises such as fruits and vegetables, dairy, fishery, goat and sheep rearing etc. Within the agricultural sector, high-value segment is expected to contribute more to the wellbeing of the smallholders, as it requires more labor and generates higher returns than cereals (Joshi et al., 2006). Crop diversification possibly will be an important mechanism for employment

generation, income growth, poverty alleviation, food and nutritional security, risk aversion and sustainability of the system from judicious use of scarce natural resources. Creation of non-agricultural jobs may not happen in the short run; as such agriculture is likely to continue being a source of employment and livelihood in the medium to long term, especially for countries that depend on agriculture (Brooks et al., 2012).

1.1. Livelihood

1.1.1. Definition of Livelihood

The term "livelihood" is used rather than "job" or "source of income." In everyday language "livelihoods" refers to a "means of living." Asking someone "How do you earn your livelihood?" is the same as asking "What do you do for a living?"

In development thinking, livelihood refers to the way people make a living, and analyzing livelihood system is the analysis of the factors involved in the way people make a living.

1.1.2. Livelihoods as a Concept

The concept of livelihood is relatively new but is now widely used in poverty and rural development literature. A person's livelihood refers to their "means of securing the necessities of life." Livelihoods is defined as a set of economic activities, involving self-employment, and/or wage employment by using one's endowments (both human and material) to generate adequate resources for meeting the requirement of the self and household on a sustainable basis with dignity. The activity is usually carried out repeatedly. For instance, a fishermen's livelihood depends on the availability and accessibility of fish.

Livelihoods are the means people use to support themselves, to survive and to prosper. Livelihoods are an outcome of how and why people organize to transform the environment to meet their needs through technology, labor, power, knowledge and social relations. Livelihoods are

also shaped by broader economic and political system within which they operate.

Conceptually, 'Livelihoods' denotes the means, activities, entitlements and assets by which people make a living. One can describe a 'Livelihood' as a combination of the capabilities and resources people have (including social, human, financial, natural and material assets) and the activities they undertake in order to make a living and to attain their goal and aspirations. "Assets are not simply the resources people use in building livelihoods: they are assets that give them the capability to be and to act" (Bebbington, 1999). The Sustainable Livelihood literature focuses on the accumulation of five types of assets, often called the asset pentagon: human (education, labor, health and nutrition), social (community, family and social networks), natural (land and water), physical (roads, clinics, markets, schools and bridges) and financial (saving and credit availability). The sustainability of livelihoods becomes a function of how men and women utilize asset portfolios on both a short and long-term basis. Sustainable livelihoods are those that can cope with and recover from shocks and stresses such as drought, civil war and policy failure through adaptive and coping strategies (Jirli et al., 2008). Capability, equity and sustainability combine in the concept of sustainable livelihood.

A livelihood comprises the capabilities, assets (stores, resources, claims and access) and recovers from stress and shocks to maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation and which contributes net benefits to other livelihoods at the local and global levels and in the long and short run (Chambers and Conway, 1992).

A rural livelihood is defined as "the capabilities, assets and activities that rural people require for a means of living." A 'livelihood' is sustainable when people cope with and recover from shocks and crisis (e.g., seasonal, environmental and economic) and can maintain to enhance their capability as asset both now and in the future, while not undermining the natural resources base.

A livelihood is a means of making a living. The concept of livelihood as described by Long (1997) expresses the idea of individuals and groups

striving to make a living, attempting to meet their various consumption and economic necessities, coping with uncertainties, responding to new opportunities and choosing between different value positions. It encompasses people's capabilities, assets, income and activities required to secure the necessities of life. The analysis of prosperity and poverty from livelihood point of view to understand rural inequalities has received considerable attention during the last few decades in India and other developing countries (Sharma, 2005). The livelihoods perspective, developed originally in the 1990s (Chambers and Conway, 1991; Scoones, 1998; DFID, 1999), is still widely recognized as offering the most comprehensive framework for understanding how people live. 'Various livelihoods frameworks have been developed, of which the most commonly used and 'conceptually sophisticated' is DFID's Sustainable Livelihoods Framework (SLF) which continues to prove influential' (Pain and Lautze, 2002).

Human development is described as the expansion of capabilities. Capabilities are not reflected in inputs as in the case of income, but in human outcomes i.e., in the quality of people's lives. A certain level of essential human achievement or functioning is required for sustainable livelihood e.g., good health, education, access to satisfactory levels of resource and asset bases. In the Sustainable Livelihood Framework of DFID (1999), five livelihood capitals or assets lie at the center of sustainability. These assets represent all spheres of materials, services, and opportunities available to people to use in meeting their basic needs and in mitigating or adapting to disruptive change. These five core assets are human capital (knowledge, skill, ability to labor), social capital (networks of reciprocity, trust, membership of social organizations), natural capital (use of natural resources like land, water, wildlife, bio-diversity), physical capital (basic amenities like shelter, communication means) and financial capital (different financial resources like savings, subsidiary income) that help people to pursue their livelihoods.

It is important to highlight that one asset can generate multiple benefits. If people have secure access to land (natural capital) they may also be well-endowed with financial capital, as they can use this land not

only for direct productive activities but also as collateral for loans. Similarly, livestock may generate social capital (prestige and connectedness to the community) for owners while at the same time being used as productive physical capital. In order to develop an understanding of these complex relationships, it is necessary to look beyond the assets themselves, to think about prevailing cultural practices and the types of structures and processes that 'transform' such assets into livelihood outcomes. 'The households utilize these assets in their productive activities in order to create income and satisfy their consumption needs, maintain their asset levels and invest in their future activities' (Ellis and Freeman, 2005).

Ideally, a livelihood should keep a person meaningfully occupied in a sustainable manner with dignity. A livelihood is much more than employment. Different people have different lifestyles and ways of meeting their needs. Households perform various activities to gain and maintain their livelihoods. The nature of these livelihood activities depends on the availability of assets, resources (including climate), labor, skills, education, social capital, seasonality, agro-climate/agro-ecology and gender (Akinwale, 2010). Household sizes, age, education, vocational training, health status, households experience in farming activities were the major human resources to improve livelihoods. In other words, skills, knowledge, good health and physical capability together enable people to pursue livelihoods (Morse and McNamara, 2013).

Livelihood security is the ability of a household to meet its basic needs (or realize its basic rights). These needs include adequate food, health, shelter, minimal levels of income, basic education and community participation. If any of these basic needs is not met, the household is considered living in absolute poverty. However, simply satisfying one's basic need is not adequate to ensure that people can rise above and stay above absolute poverty or better livelihood.

Household livelihood security is described as adequate and sustainable access to income and resources to meet basic needs that include not only adequate access to food but also potable water, health facilities, educational opportunities, housing, community participation and social

integration. A Household Livelihood Security Assessment (HLSA) is a holistic and multi-disciplinary analysis. Livelihood security frameworks have become useful for community and family assessments and social program design that help in understanding complex needs of families and communities. To determine whether households are successful in pursuing their livelihood strategies, it is important to look at a number of outcome measures that capture need or well-being satisfaction. Nutritional status is often considered one of the best outcome indicators for overall livelihood security, but other important livelihood outcomes have been included in various studies such as sustained access to food, health, education, habitat, social networks and participation, physical safety, environmental protection, as well as life skills capacities. Analysis of these outcomes should not only determine what needs are currently not being met, but also what hindrances are there between needs. Livelihood and food and nutrition security usually go side by side. There is no such difference between these two concepts and the availability of enough food to each member determines the livelihood progress of that household.

Food security is fundamentally linked to questions of livelihood. If food security does not exist, other livelihood outcomes will most likely fail to be reached and efforts to secure food will be prioritized (Oxfam, 2017). Food security is a multi-dimensional concept and extends beyond the production, availability and demand for food (Pieters, et al., 2013). There has been a definite and significant paradigm shift in the concept of food security from mere macro level availability and stability to micro level household food security and from an assessment of energy intake to measures and indicators of malnutrition (Ittyerah, 2017).

Livelihood security has been interpreted in different ways by various scholars. Many definitions of livelihood security derive from the work of Chambers and Conway (1992). In their early work they defined livelihoods as the 'capabilities, assets (stores, resources, claims and access) and activities required for a means of living; a livelihood is sustainable when people can cope with and recover from stress and shocks, maintain or enhance their capabilities and assets and provide sustainable livelihood opportunities for the next generation. Livelihood security has been

understood to encompass ownership of access to resources and assets to offset risks, ease out shocks and meet contingencies.

Most livelihoods analysis take the household as its basic unit of analysis. It affects everything about the way all the household's members (male and female) live, the way they set goals, claim assets in society and are treated by institutions. Household livelihood security frameworks have become useful for community and family assessments and social program design. Livelihood security strategy views the household as a system influenced by various interrelated factors. The objectives of the study are twofold: First, to explore livelihood capabilities of rural households. Second, to assess status of livelihood security of small and marginal families.

2. METHODOLOGY

Science is a systematized body of knowledge. It is marked by careful and accurate classification of facts, discovery of scientific laws by creative imagination and self-criticism to arrive at logical conclusions. Methodology is of great importance in any scientific enquiry as the reliability and validity of the facts primarily depend upon the system of investigation. This section focuses on brief description of the study area; instrument used to collect needed information for this study, method of data collection and analysis - The procedure has been distinctly described under the following sub-heads:

2.1. Study area
2.2. Livelihood capability
2.3. Livelihood security
2.4. Tools and techniques of data collection
2.5. Data analysis

2.1. Study Area

The study was carried out in Rohtak division of Haryana state selected purposively. Data were collected during 2016- 2017. Two districts namely- Sonipat and Karnal were selected randomly. One block from each selected district was selected randomly. Two villages from each block were selected randomly (Figure 1). From the selected four villages, seventy-five small and marginal farm families were drawn randomly, thus making a total sample of 300 farm households. Some independent and dependent variables were included in the study. Independent variables included family profile, economic profile, land characteristics and communication variables. Two dependent variables i.e., livelihood capability and livelihood security were selected. Haryana is one of the twenty eight states in India, located in northern part of the country. It was carved out of the former state of East Punjab. It is ranked 22nd in terms of area with less than 1.4 percent of India's land area (GOH, 2016).

Haryana is extremely hot in summer at around 45°C (113°F) and mild in winter. The hottest months are May and June and the coldest are December and January (GOH, 2016). The climate is arid to semi-arid with average rainfall of 354.5 mm. Around 29 percent of rainfall is received during the months from July to September, and the remaining rainfall is received during the period from December to February (DOA, 2015).

Thorny, dry, deciduous forest and thorny shrubs can be found all over the state. During the monsoon, a carpet of grass covers the hills. Mulberry, eucalyptus, pine, *kikar*, *shisham* and babul are some of the trees found here. The species of fauna found in the state of Haryana include black buck, *nilgai*, panther, fox, mongoose, jackal and wild dog. More than 450 species of birds are found here (Haryana Forest Department, 2018).

Agriculture is the main occupation of the people of Haryana where they are involved in the cultivation of rice, wheat, jowar, bajra, maize, barley, pulses, sugarcane, cotton, oil seeds and potato. The world-famous basmati rice is from Haryana. Nearly 70 percent of the total population of people living here are into farming. Dairy farming is also an essential part

of the people of Haryana. Now industrialization is also expanding at a very fast rate in the city for its proximity to Delhi.

2.2. Livelihood Capability

Livelihood can be defined as the capabilities, assets and activities required for a means of living (Carney, 1998). A livelihood comprises people, their capabilities and means of living including food, income and assets. Household capabilities are knowledge, skills and abilities that the household draw on to secure its livelihood. These capabilities enable households to make optimum use of their asset base. They explore the range of assets to which different households have access. Having access to diverse resources and the capabilities to use them are important factors in determining livelihood security. Therefore livelihood capabilities for the present investigation were operationalized in terms of five livelihood capitals namely, human, social, natural, physical and financial. Important indicators for each of the five capitals were selected. The various indicators and means of measuring them are organized around the Sustainable Livelihoods Framework (SLF) developed by DFID (Carney, 1998).

2.2.1. Human Capital

The livelihood framework is centered on people and the capabilities they possess. Human capital has been defined as the acquired knowledge and skills through education, training that an individual brings to an activity (Ostrom, 1998). According to DFID (1999), human capital represents the skills, knowledge, ability to labor and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. At a household level human capital is a factor of the amount and quality of labor available. The human capital for the present study included parameters viz. age of household members, number of economically active members, number of disabled members in the family, migration of family members to earn wages, longevity of family members, education status of family, vocational training received by

family members, duration of training, possession of traditional skills, occupational knowledge etc. Each aspect was divided into three categories and scores 3 to 1 were assigned based on the capability of respondents.

2.2.2. Social Capital

Social capital refers to the social networks in which people participate and from which they can derive support for one another and with systems within their communities. It represents the social resources upon which people draw on to achieve their livelihood outcomes (Ashley et al., 2003). In the context of the sustainable livelihoods framework of DFID, it is taken to mean the social resources upon which people draw in pursuit of their livelihood objectives. These are developed through networks and connectedness that increase people's trust and ability to work together and expand their access to wider institutions, such as political or civic bodies. It also includes membership of more formalized groups and relationships of trust, reciprocity and exchanges.

The social capital for the present study comprised access to various social/government organizations, level of access, utilization of government services, relationship with family members and support provided by family members, relation with friends and support during the time of distress, institutional support during shock and risk, member of political party. Scores were assigned on a three-point continuum according to responses by respondents.

2.2.3. Natural Capital

Natural capital refers to forest, land, water, biodiversity and many environmental services available to people. Conservation of natural capital is one of the key aims of livelihoods improvement (Belcher, 2005). As mentioned in DFID framework, natural capital is the term used for the natural resource stocks from which resource flows and services useful for livelihoods are derived. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity to divisible assets used directly for production (trees, land, etc.).

The parameters of natural capital included were access of natural resources for agricultural/household purpose, benefit from the community land, utilization of forest resources etc.

2.2.4. Physical Capital

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods (DFID, 1999). Physical capital is created by people themselves. It comprises of affordable transport, secure shelter and buildings, adequate water supply and sanitation, irrigation machinery, clean affordable energy and access to information resources (communications) (Bezemer and Lerman, 2003).

The indicators selected to assess physical capital owned by the farm families were- house ownership, type, size of house, household assets, means of transport and communication, size of land, land ownership pattern, cropping pattern, source of irrigation and so on. The physical asset possession of these parameters was assessed on three-point continuum.

2.2.5. Financial Capital

Financial capital denotes the financial resources that people use to achieve their livelihood objectives. Financial capital plays an important role in our economy, it helps us to facilitate the other types of capitals to be owned and traded. Financial capital denotes the financial resources viz. in form of cash, jewelry, savings, fixed deposits, ancestral capital etc. that people use to achieve their livelihood objectives. It includes flows as well as stocks and it can contribute to consumption as well as production. It is an important livelihood building block, namely the availability of cash or equivalent that enables people to adopt different livelihood strategies (DFID, 1999).

The parameters included for assessment of financial capital comprised-subsidiary income sources of family, savings and forms of saving, livestock and agricultural assets of farm families. These parameters were quantified on three-point continuum.

Source: haryana.gov.in.

Figure 1. Map of study area.

2.3. Livelihood Security

Livelihood security has been defined as adequate and sustainable access to income and resources to meet basic needs including adequate access to food, potable water, health facilities, educational opportunities,

housing, time for community participation and social integration (Frankenberger, 1996). Livelihood security index is a measure focused directly on family and community well-being. It helps to identify intra household economic and social dynamics. Many definitions of livelihood security arise from the work of Chambers and Conway (1992), CARE (1999) and many others. For present investigation, seven components of livelihood security were included. Each of these elements was assessed for availability, accessibility, quality and status of various indicators on a five-point continuum. These elements are described as below:

2.3.1. Food Security

One widely accepted conceptual framework defines food security in terms of food availability, access and utilization (Riley et al., 1999). Food security is defined in terms of food availability, food access and food utilization. "Availability" refers to the production, distribution and exchange of food and can be understood as the amount, type and quality of food available for consumption. "Access" refers to the affordability, allocation and preference of food and can be understood as the ability to access food of the required type, quality and quantity. "Utilization" refers to the nutritional value, the social value and the safety of food. It can be understood as the ability to consume and benefit from food. The availability of food is considered necessary, but not sufficient for its access and its access is necessary but is not sufficient for its utilization (Ericksen et al., 2011). Analysis of food security assesses the quantity and quality of food available to households throughout the year either on-farm or in the market, access and utilization and distribution of food, such that the nutritional needs of all household members are met. For measuring food security food sources, number of meals eaten by households per day, food scarcity during the last 12 months, amount and quality of food eaten in the last 12 months were included. All these parameters were assessed and scored on a five-point continuum.

2.3.2. Nutritional Security

Nutritional security is a livelihood outcome closely related to food security, particularly the food utilization component. Many indicators that measure nutritional security in women and children are well-known and accepted. For present study following components of nutritional security were included food frequency pattern of farm families, household diet diversity and BMI of children (0-5 years) and adult women.

2.3.2.1. Food Frequency Pattern

Food frequency is a cost effective, widely used means of dietary assessment, to estimate subjects' average diet. Questions were asked to determine how often the subjects consumed food that fall within a defined category. It was measured on five- point continuum with scores 5 to 1 for daily, alternately, twice in a week, weekly and rarely.

2.3.2.2. Household Diet Diversity

Household diet diversity is a proxy measure of household food access and food security. A more diversified diet is an important outcome. A more diversified diet is associated with a number of improved outcomes in areas such as birth weight, child anthropometric status and improved hemoglobin concentration. For determining household diet diversity, questions on dietary diversity were asked by the person who was responsible for food preparation or any other adult who was present and type of foods that he/she or anyone else in their household ate during the last 24 hours. Score one was given if anyone in the household ate the food mentioned in the questions, score zero was given if no one in the household ate the food. Initially, eight food groups were selected but later similar groups were combined together thus making a total of five groups. The household diet diversity score was calculated by using the following formula:

HDDS (0-5)	Total number of food groups consumed by members of the household. Values for A through E will be either "0" or "1." Sum (A + B + C + D + E) of all households

$$\text{HDD} = \frac{\text{Sum (HDDS)}}{\text{Total number of households}}$$

HDD= Household Diet Diversity
HDDS = Household Diet Diversity Score

2.3.2.3. Body Mass Index (BMI) (Kg/m^2)

BMI is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity. It is defined as the weight in Kilograms divided by the square of the height in meters (Kg/m^2). The conventional components of nutritional security are child and maternal nutritional status, since these are two of the most vulnerable groups because of the long-lasting damage that even temporary malnutrition can cause in child-bearing women and children. In the present study, Body Mass Index (BMI) of children (0-5 year) and adult women of age 18 to 40 years. was computed by using the following formula:

$$\text{BMI (Kg/m}^2\text{)} = \frac{\text{Weight (Kg)}}{\text{Height (m2)}}$$

Weight: Weight was measured with a scale of 0.1 Kg (weighing machine). The machine was placed on a horizontally flat surface. Respondent was weighed barefooted and wearing minimum of clothing and without touching any other surface or object, and the reading was noted.

Height: Measurement was done with a vertical anthropometric scale, while the respondent stood with head, shoulders, buttocks, and heels touching the flat surface (wall), measurements were recorded at the nearest 0.1 cm (WHO, 2006).

2.3.3. Economic Security

Economic security is intimately related to household livelihood security. Economic security is the capacity to generate enough income to satisfy the basic needs and to maintain or increase the goods necessary for

the stability of the family economy. Economic security is defined as the ability of individuals, households or communities to cover their essential needs sustainably and with dignity. The indicators that provide insight on vulnerability of farm families included for present investigation were annual income, possession of productive and unproductive assets; household debt condition, level of satisfaction with current financial condition etc. and these indicators were assessed on five- point continuum.

2.3.4. Shelter/Water and Sanitation Security

This livelihood category is considered critical in the context of India due to high population density and lack of sanitation infrastructure, particularly in rural areas. The frequent illness can severely affect the productiveness of family members, reducing incomes and production. The indicators included in this security for present study were availability of water for drinking and cooking, kitchen facility, facility of shelter for livestock, source of lighting other than electricity, cooking fuel source and access to toilet facilities. These indicators were assessed on a five-point continuum according to responses by respondents.

2.3.5. Health Security

Several parameters of health security are considered critical in livelihood security assessment. Similarly, access to appropriate medical care is important. The health security was assessed on five-point continuum by the indicators, namely occurrence of illness in the households, availability and accessibility and affordability of health services etc.

2.3.6. Educational Security

Education is the process that liberates the mind of human beings from all forms of darkness, ignorance and sharpens it for logical thinking. It's important because educational quality, while important, is a component that is generally overlooked in livelihood assessments. Educational security refers to the capacity of individuals to obtain/receive and benefit from a basic education. It included following parameters in the present

study: overall literacy level of the households, distance of educational institutes, and accessibility of educational institutes and cost of education.

2.3.7. Access to Institutions

Household livelihood well-being is influenced by extent to which a household is integrated into a wider socio-political system. The access of individual households to such external services has an impact on livelihood security, and it is assumed that livelihood well-being is enhanced by more effective access patterns. For example, there are government representatives that serve local populations, rural extensionists and local NGO staff. Also, where a larger number of institutions are present, the resource flow to the village is assumed to be greater. In the present study, parameters included were access/availability of welfare institutes, frequency of contact with officials, frequency of receiving information related to agriculture, satisfaction of respondents with the information provided by officials etc.

2.3.7.1. Livelihood Security Index

To assess different livelihood securities, relevant indicators were selected from the standard menu indicators of CARE. Selected indicators were measured based on accessibility/availability, quality and status. Each indicator was ranked on a five- point ordinal scale and these ranges were calibrated to the situation of the villages of Haryana state. Livelihood security index was computed by calculating weighted means for each dimension on a five-point continuum.

2.4. Tools and Techniques of Data Collection

A well-structured interview schedule was prepared keeping in view the objectives of the study. Data was collected personally by researcher through pre-tested interview schedule.

2.5. Data Analysis

The collected data were systematically processed, tabulated and analyzed using following statistical tools for further analysis and meaningful interpretation with the help of computer software SPSS 19.

2.5.1. Frequency and Percentage

For the assessment of profile of respondents, livelihood capabilities, livelihood securities, frequency and percentage were calculated.

2.5.2. Weighted Mean Score

For each item, the frequencies falling under each rating were tabulated. Then the frequencies in each of the category were multiplied by the assigned scores and added. The resulting sum of each aspect was divided by the total number of respondents. In this way, the weighted mean score in each aspect were calculated.

2.5.3. Coefficient of Correlation

Pearson's co-efficient of correlation was worked out for ascertaining the relationship between independent and dependent variables using the formula:

$$r = \frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$$

Where

r = Correlation coefficient

N = Number of respondents

Σxy = Sum of product of x and y

x and y = Dependent and independent variables

Σx = Summation of overall dependent variables

Σy = Summation of overall independent variables

Σx^2 = Sum of square of dependent variables

Σy^2 = Sum of square of independent variables

3. RESULTS AND DISCUSSION

The concept of livelihood is relatively new but is now widely used in poverty and rural development literature. The term "livelihood" has been defined in a variety of ways by various authors. Considering the most common definition, a livelihood can be defined as people's capacity to maintain a living (Chambers and Conway, 1991). In the last few decades, several institutions (e.g., FAO, UNDP, DFID etc.) have developed frameworks to analyze sustainability of livelihoods. Most of these frameworks are similar. DFID's conceptual framework, however, draws attention to the measured changes in different factors that contribute to livelihoods: five capitals, institutional process and organizational structure, vulnerability of livelihoods, livelihood strategies, and outcomes (DFID, 1999). Livelihood security refers to secured ownership and access to resources and income earning activities. Livelihood security is the assessment of a household's sustainable and adequate access to income and resources to meet basic needs. Livelihood security strategy views the household as a system influenced by various interrelated factors. Livelihood security frameworks have become useful for community and family assessments and social program design that help in understanding complex needs of families and communities. To determine whether households are successful in pursuing their livelihood strategies, it is important to look at a number of outcome measures that capture need or well-being satisfaction. The majority of the people in India makes out their existence directly or indirectly from farm related economic activities because agriculture is an integral part of everyday life in Indian sub-continent, not only for it employs about 70 percent of workforce of the country, but also for it provides food to the population, raw materials for the industries, wood for fuel and shelter, herbs for medicines, and above all, means of sustenance and livelihoods (Hasnain, 2008). Agriculture

sector for developing economies like India is primary source of livelihood in both farm and non-farm sectors and sustainability in agriculture sector means boosting up the rural livelihood system.

The members of a household combine their capabilities, skills and knowledge with the different resources at their disposal to create activities that will enable them to achieve the best possible livelihood for themselves. In general, the agricultural activities in India are subject to variety of risks which not only endanger the household's livelihood and income but also undermine the viability of the agricultural sector. A number of studies have confirmed the inability of agriculture to fully support livelihood security. A huge majority of farmers in India are small and marginal, who are facing many problems in operating the high-risk farming. This section presents results of analysis and discussion of data collected from three hundred small and marginal farm families in central zone of Haryana. This section is divided into three sections as follows: section one presents analysis and discussions of the livelihood capabilities of farm families, section two deals with discussion on livelihood securities of sampled households, section three presents association of independent and dependent variables.

3.1. Livelihood capitals of farm families
3.2. Livelihood securities of farm families
3.3. Association of independent and dependent variables

3.1. Livelihood Capitals of Farm Families

3.1.1. Human Capital

The skill, knowledge, ability to labor and good health are important to pursue different livelihood strategies and achieve their livelihood objectives (DFID, 2000, Scoones, 1998). A household's human capital is comprised of those individual characteristics of its members, both qualitative and quantitative that helps them to generate income. The main

characteristics of human capital are age, education, gender, household size, dependency ratio and leadership potential (Bezemer and Lerman, 2003).

3.1.1.1. Human Capital of Farm Families

Regarding age of members in the households, Table 1 shows that majority of members in both the districts and in total were middle aged. In Sonipat district, 59.3 percent farm family members were in the age of 25-50 years followed by below 25 years (33.2%) while only 7.4 percent were above 50 years. In Karnal district, 61.1 percent household members were in the age of 25-50 years followed by below 25 years (26.9%) and above 50 years (11.9%). In a pooled sample, 60.1 percent family members fell in the age group of 25-50 years followed by below 25 years (30.2%) and above 50 years (9.6%).

As regards to economically active members in household, it can be noticed from Table 1 that in majority (86.6%) of farm families 3-4 members were economically active followed by <2 members (7.3%) and > 4 members (6.0%) in Sonipat district whereas in Karnal district, 71.3 percent of farm families reported 3-4 members economically active followed by <2 members (18.0%) and > 4 members (10.6%). Similar trend was observed in the pooled sample.

Regarding disabled members in the family, Table 1 elucidates that in pooled sample 97.0 percent were those farm families which did not have any disabled member; only 3.0 percent households in total had one disabled member. From the Table 1 it can be further observed that in 51.3 percent households in Sonipat district 2 members or less had migrated to earn wages followed by 39.3 percent where more than 2 members had migrated, while the families with no migrants at all were 9.3 percent. In case of Karnal district, more than half (54.6%) of the farm families had no migrant members followed by <2 members (30.0%) and > 2 members (15.3%) migrated members. Reddy and Jaysree (2006) also observed that households having two migrants were 48.17 percent and covered a distance up to 50 km for earning their livelihood.

Table 1. Human capital of farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	(%)	f	(%)	f	(%)
1.	Age of members in the household	(n=871)		(n=782)		(n=1653)	
	Below 25 years	289	33.2	211	26.9	500	30.2
	25 -50 years	517	59.3	478	61.1	995	60.1
	Above 50 years	65	7.4	93	11.9	158	9.6
2.	Economically active members						
	≤ 2 members	11	7.3	27	18.0	38	12.6
	3-4 members	130	86.6	107	71.3	237	79.0
	> 4members	9	6.0	16	10.6	25	8.3
3.	Disabled members in the family						
	No member	143	95.3	148	98.6	291	97.0
	One	7	4.6	2	1.3	9	3.0
	Two	0	0.0	0	0.0	0	0.0
4.	Family members migrate to earn wages						
	≤ 2 members	77	51.3	45	30.0	122	40.6
	>2 members	59	39.3	23	15.3	82	27.3
	No member	14	9.3	82	54.6	96	32.0
5.	Members died below 40 years						
	≤ 2 members	9	6.0	4	2.7	13	4.3
	> 2 members	0	0.0	0	0.0	0	0.0
	No member	141	94.0	146	97.3	287	95.7
6.	Family education status						
	Low	28	18.6	79	52.6	107	35.6
	Medium	88	58.7	50	33.3	138	46.0
	High	34	22.6	21	14.0	55	18.3
7.	Vocational training received by family members						
	≤ 2 members	11	7.3	37	24.6	48	16.0
		f	(%)	f	(%)	f	(%)
	> 2 members	13	8.6	15	10.0	28	9.3
	No member	126	84.0	98	65.3	224	74.6
8.	Duration of training	(n=24)		(n=52)		(n=76)	
	0-6 months	16	66.6	13	25.0	29	28.1
	7-12 months	5	20.8	22	42.3	27	35.5
	Above 1 year	3	12.5	17	32.7	20	26.3
9.	Traditional skills possessed						
	Highly skilled	17	11.3	0	0.0	17	5.6
	Somewhat skilled	39	26.0	46	30.6	85	28.3
	Less skilled	94	62.6	104	69.3	198	66.0
10.	Occupational knowledge						
	Excellent	30	20.0	7	4.6	37	12.3
	Good	77	51.3	51	34.0	128	42.6
	Poor	43	28.6	92	61.3	135	45.0

Table 1 further unveils that in huge majority (95.7%) of farm families, no member died below 40 years of age, thus having good longevity. Singh et al. (2009) reported that majority of households had more than 4 members were economically active and 49 percent of the respondents had medium level of human capital followed by high (24.39%) and low (20.12%) categories respectively. The data regarding family education of the farm families in Table 1 indicate that in Sonipat district, 58.7 percent of the farm families were having medium family education status followed by high and low education status (22.6% and 18.6%) respectively. But in Karnal district, 52.6 percent of the sample households were having low family education status followed by medium and high education status (33.3% and 14.0% respectively). In pooled sample, 46.0 percent of the farm families were having medium family education status followed by low and high education status (35.6% and 18.3% respectively).

Majority (74.6%) of farm family members never received any vocational training. In 16.0 percent families, two or less than two members received vocational training while in 9.3 percent families, more than two members received vocational training.

As regards to duration of training, data in Table 1 clearly points out that out of those who received training in Sonipat district, majority (66.6%) of farm family members received vocational training of 0-6 months duration followed by 7-12 months (20.8%) and above 1 year (12.5%), while in Karnal district, little less than half (42.3%) of farm family members received training of 7-12 months followed by above 1 year (32.7%) and 0-6 months (25.0%). In pooled sample, 35.5 percent of sample household members received training of 7-12 months duration followed by 0-6 months (28.1%) and above 1 year (26.3%).

Data pertaining to traditional skills possessed by farm families presented in Table 1 reveals that 66.0 percent of farm families perceived as having less traditional skills followed by somewhat skilled (28.3%) and highly skilled (5.6%). Regarding occupational knowledge, in Sonipat district 51.3 percent of farm families had good knowledge regarding their occupation followed by poor (28.6%) and excellent (20.0%), while in

Karnal district, more than half (61.3%) of the sample households had poor knowledge followed by good (34.0%) and excellent (4.6%).

Thus, it is clear from Table 1 that majority of farm families' members belonged to 25-50 years of age; 3-4 members were economically active with good health and longevity, medium family education status. But very few members received vocational training, possessed less traditional skills and poor occupational knowledge.

3.1.1.2. Mean Human Capital Scores of Farm Families

Mean human capital scores were computed by multiplying weights of each cell with the frequency and dividing by number of respondents. These ranged between 3 to 1 and accordingly divided into three categories of high, medium and low.

Table 2. Mean human capital scores of farm families

Sr. No.	Variables	Sonipat WMS	Karnal WMS
1.	Age of members in the household	2.51	2.49
2.	Economically active members	1.98	1.92
3.	Disabled members in the family	2.95	2.98
4.	Family members migrate to earn wages	2.3	1.61
5.	Members died below 40 years	2.94	2.97
6.	Family education status	2.04	1.61
7.	Vocational training received by family members	1.24	1.45
8.	Duration of training	1.45	2.07
9.	Traditional skills possessed	1.48	1.31
10.	Occupational knowledge	1.91	1.43
	Overall	2.08	1.97

WMS: Weighted Mean Score
Low: 1.00 - 1.66
Medium: 1.67- 2.33
High: 2.34 – 3.00.

Table 2 shows data regarding mean human capital scores of both the districts. The human capital scores in Sonipat district in terms of age of members in the household (WMS- 2.51), disabled members in the family (WMS- 2.95), members died below 40 years of age in the family (WMS- 2.94) were found to be of high level. Medium scores were obtained for parameters like economically active members (WMS- 1.98), family

members migrate to earn wages (WMS, 2.3), family education status (WMS, 2.04) and occupational knowledge (WMS, 1.91), while vocational training received by family members (WMS, 1.24), duration of training (WMS, 1.45) and traditional skills possessed by family members (WMS, 1.48) were found to be low. Similarly, in Karnal district, human capital regarding age of members in the household (WMS- 2.49), disabled members in the family (WMS- 2.98) and members died below 40 years (WMS- 2.97), scored high while economically active members (WMS- 1.92) and duration of training (WMS- 2.07), fell in medium category. However, family members migrate to earn wages (WMS- 1.61), family education status (WMS- 1.61), vocational training received by family members (WMS, 1.45), traditional skills (WMS, 1.31) and occupational knowledge (WMS, 1.43) were found to be low in Karnal district.

Thus it can be concluded from Table 2 that human capital in both the districts in terms of health and longevity were high, but they scored medium too low for training, education and skills.

3.1.2. Social Capital

Social capital in the context of the livelihood framework is taken to mean the social resources upon which people draw in the pursuit of livelihood objectives (Messer and Townsley, 2003). These are developed through networks and connectedness, either vertical (patron/client) or horizontal (between individual with shared interest) that increases people's trust and ability to work together and expand their access to wider institutions. For instance, political or civic bodies, membership of more formalized groups which often entails adherence to mutually agreed or commonly accepted rules, norms, sanctions, and relationships of trust and reciprocity (UNDP, 1998).

3.1.2.1. Access and Utilization of Government Services by Farm Families

Regarding access to social organizations, the findings in Table 3 depict that a considerable percentage of respondents in aggregate had access to bank (93.6%), *anganwadi* (87.0%), village *panchayat* (83.0%), public

distribution system (67.3%) and CHC/PHC (60.3%). Twigg (2013) also observed that more members a household has the more possibilities it has to social networks to promote positive livelihoods.

Table 3. Access and utilization of government services by farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	(%)	f	(%)	f	(%)
1.	Access to government/social organization*						
	Anganwadi	126	84.0	135	90.0	261	87.0
	Panchayat	112	74.6	137	91.3	249	83.0
	CHC/PHC	84	56.0	97	64.6	181	60.3
	Bank	133	88.6	148	98.6	281	93.6
	Public Distribution System	93	62.0	109	72.6	202	67.3
2.	Level of access						
	Easily accessible	28	18.7	86	57.3	114	38.0
	Somewhat accessible	109	72.7	64	42.6	173	57.6
	Not accessible	13	8.6	0	0.0	13	4.3
3.	Awareness about government schemes						
	High	129	86.0	138	92.0	267	89.0
	Medium	14	9.3	9	6.0	23	7.6
	Low	7	4.6	3	2.0	10	3.3
4.	Utilization of government services/schemes*						
	MNREGA	78	52.0	64	42.6	142	47.3
	Sukanya Samriddhi Yojana	12	8.0	5	3.3	17	5.6
	Atal pension Yojana	41	27.3	36	24.0	77	25.6
	PM Jan Dhan Yojana	63	42.0	47	31.3	110	36.6
	Ujjvala Yojana	26	17.3	38	25.3	64	21.3
	Fasal Bima Yojana	34	22.6	59	39.3	93	31.0
	Kisan Credit Card	128	85.3	143	95.3	271	90.3
	Agricultural Extension Services	54	36.0	29	19.3	83	27.6
	Mid-Day Meal	127	84.6	113	75.3	240	80.0
	Skill India	18	12.0	23	15.3	41	13.6
	DRDA	8	5.3	0	0.0	8	2.6
5.	Level of utilization						
	Most often	34	22.6	29	19.3	63	21.0
	Often	109	72.7	98	65.3	207	69.0
	Never	7	4.6	23	15.3	30	10.0

* Multiple response.

As regards to level of access of government services, majority of farm families (72.7%) in Sonipat district reported these as somewhat accessible

followed by easily accessible (18.7%) whereas in Karnal district, majority (57.3%) reported easily accessible and somewhat accessible (42.6%). In pooled sample, more than half (57.6%) of the farm families reported that government/social organizations were somewhat accessible to them followed by easily accessible (38.0%) and not accessible (4.3%).

Regarding awareness about government schemes, it is clear from Table 3 that in total sample, 89.0 percent of the farm families had high awareness about government schemes followed by medium (7.6%) and low (3.3%). Similar trend was observed in both the districts.

As far as utilization of government services was concerned, it is clear from Table 3 that in both the districts, a good percentage of farm families utilized *Kisan* Credit Card (90.3%), Mid- Day Meal (80.0%), and MNREGA (47.3%). About one-third to one-fourth were using PM *Jan Dhan Yojana* (36.6%), *Fasal Bima Yojana* (31.0%), Agricultural Extension Services (27.6%), *Atal* Pension *Yojana* (25.6%) and *Ujjavala Yojana* (21.3%), while some were using skill India (13.6%), *Sukanya Samriddhi Yojana* (5.6%) and DRDA (2.6%) respectively.

About level of utilization, it is apparent from the Table 3 that in Sonipat district, an overwhelming percentage (72.7%) of farm families had often utilization of government services followed by most often (22.6%) and never (4.6%). In Karnal district, it was found that farm families (65.3%) often utilized government services followed by most often (19.3%) and never (15.3%). Similar data was observed in pooled sample.

From Table 3, it can be concluded that majority of families accessed the government services, had high awareness about government schemes and often utilized these schemes.

3.1.2.2. Social Support System of Farm Families

Social support system included relations of trust, reciprocity and exchange between individuals, connectedness, networks and groups.

As regards to relation with family members, Table 4 reveals that majority of farm families in Sonipat (85.3%), Karnal (74.6%) and in aggregate (80.0%) had very strong relation with their family members. Table 4 further reveals that 98.7 per cent families in Sonipat and 64.6

percent in Karnal got frequent help from their family members at the time of distress.

Table 4. Social support system of farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	(%)	f	(%)	f	(%)
1.	Relation with family members						
	Very strong	128	85.3	112	74.6	240	80.0
	Strong	22	14.7	38	25.3	60	20.0
	Not so strong	0	0.0	0	0.0	0	0.0
2.	Family members help in the time of distress						
	Frequently	148	98.7	97	64.6	245	81.6
	Sometimes	2	1.3	53	35.3	55	18.3
	Never	0	0.0	0	0.0	0	0.0
3.	Relation with friends						
	Very strong	32	21.3	44	29.3	76	25.3
	Strong	118	78.7	106	70.7	224	74.6
	Not so strong	0	0.0	0	0.0	0	0.0
4.	Friends help in the time of distress						
	Frequently	76	50.7	68	45.3	144	48.0
	Sometimes	70	46.7	82	54.6	152	50.7
	Never	4	2.6	0	0.0	4	1.3
5.	Institutions support during shock and risk						
	Frequently	5	3.3	0	0.0	5	1.6
	Sometimes	47	31.3	23	15.3	70	23.3
	Never	98	65.3	127	84.6	225	75.0
6.	Member of political party						
	No membership	128	85.3	136	90.7	264	88.0
	Member	22	14.7	14	9.3	36	12.0
	Office bearer	0	0.0	0	0.0	0	0.0
7.	Social conflicts						
	Frequently	0	0.0	0	0.0	0	0.0
	Sometimes	17	11.3	9	6.0	26	8.6
	Never	133	88.6	141	94.0	274	91.3

It can be seen from the Table that majority of families in Sonipat (78.7%) and Karnal (70.7%) had strong relationship with friends while about one-fourth respondents in both the districts had very strong relationship with friends (21.3% and 29.3% respectively). Similar trend was observed in pooled sample. As far as friends help in the time of

distress was concerned, half (50.7%) of the families reported that their friends helped them frequently followed by sometimes (46.7%) and never (2.6%) in Sonipat. In Karnal district, 54.6 percent sample households' friends sometimes helped them and 45.3 percent helped frequently in the time of distress.

The Table also shows the data regarding institutional support during shock and risk. 65.3 percent farm families reported that institutions never support during shock and risk, followed by sometimes (31.3%) and frequently (3.3%) in Sonipat. In Karnal district also, majority of (84.6%) families never received any support from institutions during shock and risk.

A huge majority of respondents in Sonipat (85.3%) and Karnal (90.7%) districts reported that they had no membership of any political party. In aggregate, 88.0 percent families had no membership and 12.0 percent were members of some political party. Majority of the farm families (91.3%) were those who never faced any kind of social conflict and rest i.e., 8.6 percent families faced social conflicts sometimes. Djoudi et al. (2013) revealed that lack of social capital with respect to the rural respondents decreased their adaptive capacity and further increased their vulnerability.

It can be concluded from Table 4 that majority of families had very strong relation with their family members and friends, who frequently helped during distress, but government/social institutions never helped during shock and risk. Majority of members had no political membership and they never faced any social conflict.

3.1.2.3. Mean Social Capital Scores of Farm Families

Table 5 shows the data regarding mean scores of social capital of farm families. In both the districts- Sonipat and Karnal, social capital in terms of awareness about government schemes (WMS- 2.81, 2.9 respectively), family support (WMS- 2.98, 2.64), friends support (WMS- 2.48, 2.45 respectively), for social conflicts (WMS- 2.88, 2.94 respectively) was found of high level. These were minimum social conflicts, hence high scores. However, level of utilization of government schemes (WMS- 2.18,

2.04 respectively) was found to be in medium category and institutional support during shock and risk (WMS- 1.38, 1.15 respectively), membership of political party (WMS- 1.14, 1.09 respectively) fell under low category.

Table 5. Mean social capital scores of farm families

Sr. No.	Variables	Sonipat WMS	Karnal WMS
1.	Level of access	2.1	2.57
2.	Awareness about government schemes	2.81	2.9
3.	Level of utilization	2.18	2.04
4.	Family support	2.98	2.64
5.	Friends support	2.48	2.45
6.	Institutions support during shock and risk	1.38	1.15
7.	Member of political party	1.14	1.09
8.	Social conflicts	2.88	2.94
	Overall	2.24	2.22

WMS: Weighted Mean Score
Low: 1.00 - 1.66
Medium: 1.67- 2.33
High: 2.34 – 3.00.

Thus, it can be concluded from Table 5 that social capital in terms of access and utilization of schemes, family and friends support was found high but it was low regarding institutional support and political membership.

3.1.3. Natural Capital

Natural capital is the natural resources stocks from which resources flows and services useful for livelihoods are derived. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity to divisible assets used directly for production (trees, land, etc.). It includes the natural resources stocks from which resource flows are useful for livelihoods. (e.g., land, water, wildlife, biodiversity, environmental resources) (DFID, 1999).

3.1.3.1. Natural Capital Used by Farm Families

As regards to accessing natural resources, more than half (58.0%) farm families in Sonipat district and less than half (42.6%) farm families in Karnal district used ponds/well/canal for agricultural/household purpose. In pooled sample, majority of the farm families i.e., 50.3 percent accessed ponds/well/canal for agriculture/household purposes followed by grassland (15.6%) and trees/wood (6.7%).

Table 6. Natural capital used by farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	(%)	f	(%)	f	(%)
1.	Access natural resources for agricultural/household purpose*						
	Ponds/well/canal	87	58.0	64	42.6	151	50.3
	Grassland	19	12.6	28	18.6	47	15.6
	Trees/wood	8	5.3	12	8.0	20	6.7
2.	Benefit from the community land*						
	Grazing livestock	89	59.3	106	70.7	195	65.0
	Collecting firewood	11	7.3	8	5.3	19	6.3
	For household purpose	54	36.0	39	26.0	93	31.0
3.	Utilization of forest resources						
a)	Fuel wood						
	Frequently	0	0.0	0	0.0	0	0.0
	Occasionally	8	5.3	3	2.0	11	3.6
	Never	142	94.6	147	98.0	289	96.3
b)	Fodder						
	Frequently	0	0.0	0	0.0	0	0.0
	Occasionally	19	12.6	23	15.3	42	14.0
	Never	131	87.3	127	84.6	258	86.0
c)	Fruit/vegetables						
	Frequently	0	0.0	0	0.0	0	0.0
	Occasionally	7	4.6	12	8.0	19	6.3
	Never	143	95.3	138	92.0	281	93.6

* Multiple response.

Table 6 further pin-points that 59.3 percent farm families in Sonipat used community land for grazing livestock followed by household purpose (36.0%) and collecting firewood (7.3%) whereas in Karnal district also majority (70.7%) of farm families used community land for grazing

livestock followed by household purpose (26.0%), collecting firewood (5.3%). Majority of the farm families in total reported benefit from community land for grazing livestock (65.0%) for household purpose (31.0%) and for collecting firewood (6.3%).

Regarding utilization of forest resources, huge majority of farm families did not use different forest resources like fuel wood, fodder, fruits and vegetables to meet their household purposes and data shows that only 3.6 percent of farm families used fuel wood from forest occasionally, 14.0 percent used fodder occasionally and only 6.3 percent used fruits and vegetables occasionally from community resources. On the contrary, Islam (2012) conducted a study in Bundu block (Ranchi) and results inferred that most utilized forest product of the respondents in the study area was recorded to be fuel wood which was ranked 1, followed by fodder, vegetable, fruit, timber, fiber/floss, cottage industry products/handicrafts, oilseed, medicine and animals/birds/insects etc. Sarker et al. (2009) referred that five capital assets are considered to be essential for the livelihood; natural capital plays a crucial role in the livelihoods of rural people. It is significant because the poor people around the world are primarily dependent on natural resources.

It can be concluded from Table 6 that most of the families accessed ponds/well/canal and grazed their livestock on community land, but they never utilized any forest resources i.e., fuel wood, fodder and fruits and vegetables.

3.1.3.2. Mean Natural Capital Scores of Farm Families

Data presented in Table 7 indicate the mean natural capital scores of farm families. In both the districts, access to natural resources for agricultural/household purpose (WMS- 2.69, 2.5), were found to be high while benefit from the community land (WMS- 1.49, 1.36), and utilization of forest resources (WMS- 1.07, 1.08) were found to be low in both the districts.

Table 7. Mean natural capital scores of farm families

Sr. No.	Variables	Sonipat WMS	Karnal WMS
1.	Access natural resources for agricultural/household purpose	2.69	2.5
2.	Benefit from the community land	1.49	1.36
3.	Utilization of forest resources	1.07	1.08
	Overall	1.75	1.64

WMS: Weighted Mean Score
Low: 1.00 - 1.66
Medium: 1.67- 2.33
High: 2.34 – 3.00.

Thus, it can be seen from Table 7 that the farm families of Sonipat district used more natural capital than Karnal district per overall mean score (1.75 and 1.64 respectively). Singha and Talukdar (2011) revealed that a sizable proportion of the respondents had shown medium level of utilization of forest resources in Golaghat Forest Division of Assam.

3.1.4. Physical Capital

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods. Infrastructure consists of changes to the physical environment that help people to meet their basic needs and to be more productive while the producer goods are the tools and equipment that people use to function more productively. The following components of infrastructure are usually essential for sustainable livelihoods: affordable transport, secure shelter and buildings, adequate water supply and sanitation, clean affordable energy and access to information (communications) (DFID, 1999).

3.1.4.1. Physical Capital of Farm Families

A perusal of data in Table 8 indicates that all the selected farm families in both the districts had their own house (100.0%). As regards to type of house, it was noticed from the Table 8 that majority (62.0%) of the farm families had semi-*pucca* type house and *pucca* (38.0%) in Sonipat district.

About 77.3 percent of the farm families were having *pucca* type house and 22.7 percent were having semi-*pucca* house in Karnal district.

Table 8 further reveals that as regards size of house, majority (65.3%) of farm families were having medium size of house followed by small house (34.7%) in Sonipat district, whereas in Karnal district 48.7 percent of the farm families were having small size of house followed by medium size of house (42.7%) and large size of house (8.7%) respectively. Hoque (2015) also reported that 100 percent of the sample respondents in the char areas of Barpeta and Jorhat districts have their own house. Majority had high material possession, high transport and communication means. Table 8 clearly depicts that majority of the farm families (70.0%) had high material possession (household assets), followed by medium (23.6%) and low (6.3%).

Data regarding means of transportation and communication shows that in Sonipat district, 52.7 percent of the farm families had medium transportation and communication means followed by high (38.6%) and low (8.7%). While in Karnal district, 62.7 percent of the sample households had high transportation and communication means followed by medium and low (23.3% and 14.0%, respectively). In pooled sample, 50.7 percent of the farm families were having high transportation and communication means followed by medium and low (38.0% and 11.3% respectively).

A glance at the Table 8 further shows that most of the sample households in both the study areas (82.6%, 88.0%) were having more than 2.5-5 acre of land followed by 1-2.5 acre in both the districts (14.7%, 12.0%) respectively.

As regards to land ownership pattern of farm families, although all the sample households were having their own land in both the districts, 27.3 percent of the respondents were also having rented farmland for farming and 25.3 percent of the farm families did shared and joint farming in Sonipat district while in Karnal district 28.0 percent of the families were having rented farmland and 17.3 percent of the farm families did shared and joint farming for increasing their farm income.

Table 8. Physical capital of farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	(%)	f	(%)	f	(%)
1.	House ownership						
	Own	150	100.0	150	100.0	300	100.0
	Rented	0	0.0	0	0.0	0	0.0
2.	Type of house						
	Kutcha	0	0.0	0	0.0	0	0.0
	Semi-*pucca*	93	62.0	34	22.7	127	42.3
	Pucca	57	38.0	116	77.3	173	57.7
3.	Size of house						
	Small (≤ 100 sq m)	52	34.7	73	48.7	125	41.6
	Medium (200-400 sq m)	98	65.3	64	42.7	162	54.0
	Large (≥ 400 sq m)	0	0.0	13	8.7	13	4.3
4.	Household assets						
	Low	14	9.3	5	3.3	19	6.3
	Medium	23	15.3	48	32.0	71	23.6
	High	113	75.3	97	64.7	210	70.0
5.	Transport and communication means						
	Low (0-5)	13	8.7	21	14.0	34	11.3
	Medium (6-10)	79	52.7	35	23.3	114	38.0
	High (11-15)	58	38.6	94	62.7	152	50.7
6.	Size of land						
	Less than 1 acre	4	2.7	0	0.0	4	1.3
	1-2.5 acres	22	14.7	18	12.0	40	13.3
	More than 2.5-5 acres	124	82.6	132	88.0	256	85.3
7.	Land ownership pattern*						
	Own land	150	100.0	150	100.0	300	100.0
	Share and joint farming	38	25.3	26	17.3	64	21.3
	Rented farmland	71	27.3	42	28.0	113	37.6
8.	Access to irrigation						
	Fully irrigated	142	94.6	147	98.0	289	96.3
	Semi-irrigated	8	5.3	3	2.0	11	3.6
	Dry land	0	0.0	0	0.0	0	0.0
9.	Source of irrigation*						
	Tube well	135	90.0	142	94.6	277	92.3
	Canal	102	68.0	140	93.3	242	80.6
	Rain fed	0	0.0	0	0.0	0	0.0

* Multiple response.

As far as access to irrigation was concerned, findings in Table 8 depict that 94.6 percent of farm families in Sonipat and majority (98.0%) of farm families in Karnal reported fully irrigated area. It is obvious from the Table 8 that a great majority of the sample households (90.0%) used tube well as

irrigation source in Sonipat district but in Karnal district main irrigation source was tube well (94.6%) as well as canal (93.3%). Sinha (2011) indicates that majority of household (89.7%) families had their own house and 100 percent had their own land and they used tube well for irrigation. Yadav (2016) also observed that majority of The respondents had *pucca* house of medium size, had high material possession and high transportation and communication means, most of the respondents had owned, irrigated 3-5 acre of land.

Thus, it can be concluded from Table 8 that all selected families had their owned, *pucca* and semi-*pucca* house with medium size, having high household assets, high transport and communication means, were small farmers having fully irrigated land with tube well.

3.1.4.2. Mean Physical Capital Scores of Farm Families

Table 9 indicates the data regarding mean physical capital scores of Sonipat and Karnal districts.

Table 9. Mean physical capital scores of farm families

Sr. No.	Variables	Sonipat WMS	Karnal WMS
1.	House ownership	2.0	2.0
2.	Type of house	2.38	2.77
3.	Size of house	1.65	1.6
4.	Household assets	2.66	2.61
5.	Transport and communication means	2.3	2.49
6.	Size of land	2.8	2.88
7.	Land ownership pattern	2.43	2.56
8.	Access to irrigation	2.94	2.98
9.	Source of irrigation	2.57	2.50
	Overall	2.41	2.79

WMS: Weighted Mean Score
Low: 1.00 - 1.66
Medium: 1.67- 2.33
High: 2.34 – 3.00.

It is clear from Table 9 that physical capital score in terms of type of house (WMS- 2.38, 2.77), household assets (WMS- 2.66, 2.61), size of land (WMS- 2.8, 2.88), land ownership pattern (WMS- 2.43, 2.56), access

to irrigation (WMS- 2.94, 2.98), source of irrigation (WMS- 2.57, 2.50), were found to be high in both Sonipat and Karnal districts. Scores for house ownership was found medium in both the districts (WMS- 2.0, each), but transport and communication means were found high in Karnal (WMS- 2.49), but medium in Sonipat (WMS- 2.3) respectively.

3.1.4.3. Cropping Pattern of Farm Families

During survey in both the districts (Sonipat and Karnal), mainly three types of cropping patterns were observed i.e., single, double and multiple cropping. Among majority (82.3%) of the farmers in both the districts and in total sample, double cropping pattern was used, followed by single (10.3%) and multiple (7.3%) cropping.

Regarding cropping intensity, it was recorded that 71.0 percent of the farmers fell under medium category of cropping intensity followed by low (23.3%) and high (5.6%).

From Table 10, it can be further seen that in both the districts, 100 percent of the respondents grow wheat, while majority of the respondents also grow paddy in both Sonipat and Karnal districts (78.0% and 82.6%). Under cash crops, 25.3 percent of the farmers in Sonipat and 30.0 percent in Karnal district grow fruits and vegetables, while some farmers also grow sugarcane (14.6%, 19.3%) and sunflower (8.0%, 10.6%) in Sonipat and Karnal districts. Sharma (2002) and Baba (2006) also found that large majority of households grow maize, wheat, paddy, potato, cauliflower. Vegetables occupied second place in the area after cereals.

A perusal of data (Table 10) evinced production of crops grown by farm families. In Sonipat, 80.3 percent of families obtained yield of paddy more than 19-23 quintal/acre followed by 15-19 quintal/acre (14.5%), while about five percent respondents obtained higher yield of more than 23-27 quintal/acre. In Karnal district, majority of families (82.2%) obtained yield more than 19-23 quintal/acre followed by more than 23-27 quintal/acre (10.5%) and 15-19 quintal/acre (7.2%) for paddy.

Table 10. Cropping pattern of farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	%	f	%	f	%
1.	Cropping pattern						
	Single cropping	13	8.6	18	12.0	31	10.3
	Double cropping	127	84.7	120	80.0	247	82.3
	Multiple cropping	10	6.7	12	8.0	22	7.3
2.	Cropping intensity						
	Low (< 100%)	43	28.6	27	18.0	70	23.3
	Medium (100% to 200%)	101	67.3	112	74.6	213	71.0
	High (>200%)	6	4.0	11	7.3	17	5.6
3.	Crops grown*						
I.	Grain crops*						
i.	Paddy	117	78.0	124	82.6	241	80.3
		f	%	f	%	f	%
ii.	Wheat	150	100.0	150	100.0	300	100.0
II.	Cash crops*						
i.	Sunflower	12	8.0	16	10.6	28	9.3
ii.	Fruits and vegetables	38	25.3	45	30.0	83	27.6
iii.	Sugarcane	22	14.6	29	19.3	51	17.0
4.	Yield						
I.	Grain crops						
i.	Paddy	(n = 117)		(n = 124)		(n = 241)	
	15-19 qtl/acre	17	14.5	9	7.2	26	10.8
	More than 19-23 qtl/acre	94	80.3	102	82.2	196	81.3
	More than 23-27 qtl/acre	6	5.1	13	10.5	19	7.8
ii.	Wheat	(n = 150)		(n = 150)		(n = 300)	
	10-14 qtl/acre	7	4.7	-	-	7	2.3
	More than 14-18qtl/acre	128	85.3	139	92.7	267	89.0
	More than 18-23 qtl/acre	15	10.0	11	7.3	26	8.7
II.	Cash crops						
i.	Sugarcane	(n = 22)		(n = 29)		(n = 51)	
	110-180 qtl/acre	3	13.6	-	-	3	5.8
	181-250 qtl/acre	13	59.0	17	58.6	30	58.8
	251-320 qtl/acre	6	27.3	12	41.3	18	35.3

* Multiple response.

As regards to production of wheat, majority of farmers in Sonipat (85.3%) as well as in Karnal (92.7%) obtained more than 14-18 quintal/acre yield followed by more than 18-23 quintal/acre (10.0% and 7.3% respectively). In sugarcane, more than half of farmers in Sonipat

(59.0%) as well as in Karnal (58.6%) obtained 181-250 quintal/acre yield and 251-320 quintal/acre (27.3% and 41.3% respectively). On the contrary, Hazell et al. (2009) stated that productivity growth of major food crops has declined quite significantly. However, funding has shifted from public to private research, particularly in biotechnology. This change is reportedly disadvantageous to small farmers because private research companies lack incentives to address small farmers' concerns. Also, the impacts of both environmental degradation and climate change are usually more severe for small farmers than for large farmers because small farmers have less access to human, social and financial capital than large farmers. According to Department of Agriculture, in 2015-16, the average yield of paddy in Haryana was 10-12 qtl/acre, of wheat was 18-21qtl/acre, while that of sugarcane was 315-326 quintal/acre, respectively. Paudel et al. (2017) reported that smallholder subsistence farming with a mixed crop-livestock production system is a common source of livelihood, but the level of agricultural dependency and its importance to overall household income varies across the area. Besides agriculture, salaried jobs, tourism related business, outmigration for non-farm jobs, and wage labor are the major sources of household income within the Nepal.

It is concluded from Table 10 that majority of the families used double cropping pattern and had medium cropping intensity. All the selected families grew wheat, rice and sugarcane as cash crop.

3.1.5. Financial Capital

Financial capital comprises the important availability of cash or equivalent that enables people to adopt different livelihood strategies (Kolmair and Gamper, 2002). Sources of financial capital include household saving, credit (borrowing), and remittances from family members working outside the home (Bezemer and Lerman, 2003). Reduction in financial capital results in lower adaptive capacity, hence increased vulnerability. Other stressors that act on financial capital include the rising costs of goods, services and labor, the removal of agricultural subsidies and lack of availability of loans (Wilk et al., 2013).

3.1.5.1. Financial Capital of Farm Families

The findings in Table 11 depict that majority of the selected farm families had livestock for subsidiary source of income in Sonipat (60.6%), Karnal (84.6%) and aggregate (72.6%). More than half of the sample households (63.0%) were having their income from pension/government aid/other remittances. Further, majority (58.7%) of the sample households in total had their income from service/business in addition to farming.

It can be observed from Table 11 that considerable percentage (52.0%) of the farm families in Sonipat district perceived themselves in higher income level category while in Karnal 62.0 percent of the sample households considered themselves in middle income level. Bhullar et al. (2010) reported that dairy farming is emerging as a major contributor to the income, employment and economic viability of marginal and small farmers along with the off-farm income.

The survey data regarding saving of households reveals that in total sample, 70.3 percent of the households had savings up to Rs. 40,000, followed by 22.6 percent who had savings from Rs. 40,001 to 80,000 and only 14.0 percent of the farm families had savings above Rs. 80,001. Similar trend was recorded in both the districts. In case of forms of savings, rural families saved their money in different forms like banks, fixed deposit, jewelry, life insurance etc. Majority of the farm families (82.0%) saved their money in the form of fixed deposit, 18.7 percent had life insurance and only 7.0 percent of the farm families saved their money in the form of jewelry. Shrinivasan (2015) also observed that average monthly savings of marginal and small farmers was INR 1500 and INR 469 respectively, their average investment in productive assets ranged from INR 422 to INR 540.

A glance at the Table 11 also shows that 71.3 percent of the farm families possessed up to 4 livestock while 28.7 percent had more than 4 livestock in Sonipat district, whereas in Karnal district, 66.0 percent of the farm families owned more than 4 livestock and 34.0 percent sample households had up to 4 livestock. The findings are in line with Pal et al. (2009) and Bijalwan et al. (2011) who observed that majority of the respondents possessed up to 5 livestock, followed by more than 5

livestock. Holding good number of livestock could be attributed to the fact that livestock rearing was the most preferred secondary occupation. Livestock support agriculture and allied activities besides providing nutritional, social, economic, religious and recreational benefits to the people. Pradeepa (2014) reported that majority of households had up to 6 livestock and their other subsidiary income sources were pension, livestock, service etc.

Table 11. Financial capital of farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	(%)	f	(%)	f	(%)
1.	Subsidiary income sources*						
	Services/Business	82	54.7	94	62.7	176	58.7
	Livestock	91	60.6	127	84.6	218	72.6
	Pensions/government aid/other remittances	73	48.6	116	77.3	189	63.0
2.	Self-perceived economic status						
	Lower income level	40	26.7	12	8.0	52	17.3
	Middle income level	32	21.3	93	62.0	125	41.7
	Higher income level	78	52.0	45	30.0	123	41.0
3.	Saving of households (Rs.)						
	Up to Rs. 40,000	123	82.0	88	58.7	211	70.3
	Rs. 40,001-80,000	25	16.6	43	28.7	68	22.6
	Above Rs. 80,001	2	1.3	19	12.6	21	14.0
4.	Forms of saving*						
	Saving account/Fixed deposit	119	79.3	127	84.7	246	82.0
	Jewelry	8	5.3	13	8.7	21	7.0
	Life Insurance	24	16.0	32	21.3	56	18.7
5.	Livestock possession						
	No livestock	0	0.0	0	0.0	0	0.0
	Up to 4 livestock	107	71.3	51	34.0	158	52.6
	More than 4 livestock	43	28.7	99	66.0	142	47.3
6.	Agricultural assets						
	Low (0-5)	67	44.6	36	24.0	103	34.3
	Medium (6-10)	78	52.0	112	74.6	190	63.3
	High (11-15)	5	3.3	2	1.3	7	2.3

* Multiple response.

In Sonipat district, little more than half (52.0%) of farm families had medium possession of agricultural assets followed by low (44.6%) and high (3.3%) while in Karnal majority (74.6%) of farm families had medium followed by low (24.0%) and high (1.3%). In pooled sample also, an overwhelming majority i.e., 63.3 percent of the farm families had medium agricultural assets followed by low (34.3%) whereas very few respondents had high level of agricultural assets (2.3%). Chaudhary and Panjabi (2005) also revealed that more than half (59.3%) of the respondents had medium possession of farm implements followed by low (33.3%) and high (7.3%). The average number of farm implements possessed by the respondents was found to be 9.92. Farming and allied activities being major source of livelihood of the respondents, the possession of farm implements was necessary.

Thus, it can be concluded from Table 11 that majority of farm families had subsidiary income sources. They perceived themselves in middle-income and higher-income level, and had some savings in saving account/fixed deposit. Less than half of the farm families had more than 4 livestock and medium agricultural assets.

3.1.5.2. Mean Financial Capital Scores of Farm Families

Mean financial capital scores of farm families have been presented in Table 12. It is clear from Table 12 that in Sonipat district, most of the parameters of financial capital fell in medium category i.e., subsidiary income sources (WMS-2.03), self-perceived economic status (WMS-2.25), livestock possession (WMS-2.28) and agricultural assets (WMS-1.58). However, form of saving was found to be of high level (WMS-2.73) while total savings of households were of low level (WMS-1.19). Similar trend was observed in Karnal district except that self-perceived economic status (WMS-2.22) and livestock possession (WMS-2.66) were high in Karnal while these were found medium in Sonipat district.

Overall mean score of financial assets was found medium in both the districts, Karnal having higher score (2.15) as compared to Sonipat.

Table 12. Mean financial capital scores of farm families

Sr. No.	Variables	Sonipat WMS	Karnal WMS
1.	Subsidiary income sources	2.03	2.10
2.	Self-perceived economic status	2.25	2.22
3.	Saving of households	1.19	1.54
4.	Forms of saving	2.73	2.66
5.	Livestock possession	2.28	2.66
6.	Agricultural assets	1.58	1.77
	Overall	2.01	2.15

WMS: Weighted Mean Score
Low: 1.00 - 1.66
Medium: 1.67- 2.33
High: 2.34 – 3.00.

3.1.5.3. Overall Level of Livelihood Capitals of Farm Families

Data in Table 13 (Figure 2) shows overall level of the five livelihood capitals of farm families in Sonipat and Karnal district. In Sonipat district, WMS of physical capital of farm families worked out to be 2.41, which indicate high ownership of physical capital but social capital (WMS, 2.24), human capital (WMS, 2.08) financial capital (WMS, 2.01) and natural capital (WMS, 1.75) fell in medium category. In contrast, mean score of physical capital of sample households in Karnal district was recorded to be very high (WMS, 2.79) while social capital, financial capital and human capital were calculated to be of medium category (2.22, 2.15, 1.97). The mean score of the natural capital of the farm families in Karnal district was 1.64. Khoshnodifar et al. (2012) and Tagel (2012) noted that farmers' capacity to cope with drought and food insecurity depends on ownership of access to a wide variety of resources. These include land ownership, income, farm size, educational level, gender, access to insurance, housing quality, health, access to technology, access to credits, social networking (social capital) and public support program.

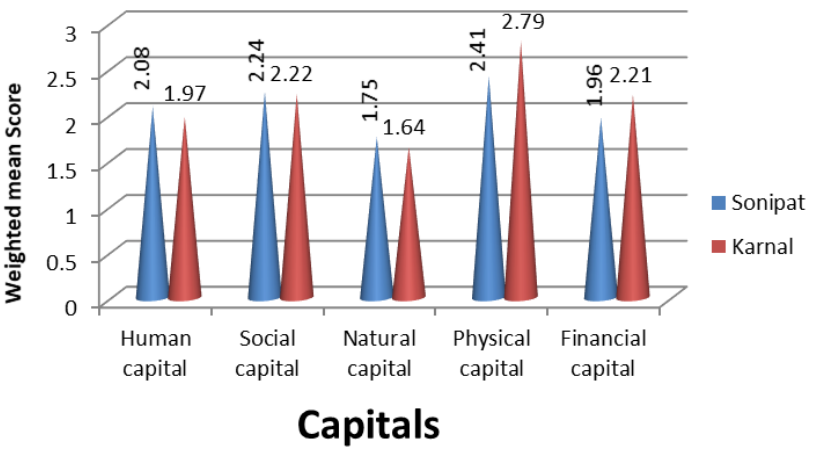
Ahmad and Sultana (2014) found that in Khoshbagh, human capital (30.3%) was higher than Majhardiar (25.3%). Educational facility was more in Khoshbagh due to its proximity to Berhampur and Lalbagh towns. In Khoshbagh, natural capital (21.1%) was lower than Majhardiar (22.7%) due to non-availability of common property resources and small size of

land holding. Physical capital was above 50 percent in both the villages. Nearly one third households of Khoshbagh had access to financial (32.4%) and social (33.3%) capital. These were slightly lower in Majhardiar i.e., 30.7 percent (financial) and 30 percent (social).

Table 13. Overall level of livelihood capitals of farm families

Sr.no	Variables	Sonipat (WMS)	Karnal (WMS)
1.	Human capital	2.08	1.97
2.	Social capital	2.24	2.22
3.	Natural capital	1.75	1.64
4.	Physical capital	2.41	2.79
5.	Financial capital	2.01	2.15

WMS: Weighted Mean Score
Low: 1.00 - 1.66
Medium: 1.67- 2.33
High: 2.34 – 3.00.



Source: Authors' calculations based on household survey data.

Figure 2. Overall level of livelihood capitals of farm families.

Thus, it can be concluded from Table 13 (Figure 2) that most of the capitals in both the districts were found medium level except physical capital which was high. Natural capital was low in one district and medium in another district.

3.2. Livelihood Securities of Farm Families

3.2.1. Food Security

Food security is the access of all people at all times to enough food so as to live an active and healthy life. Food security indicators for the present investigation included- sources of food, food shortage faced by farm families, number of meals and amount and quality of food eaten by sample households. Responses were obtained on a five-point continuum for each aspect. Omonona and Agoi (2007) reported that food access is influenced by the food availability through the behavior of prices. Accessibility also depends on their household production and ability to purchase food from the market. The purchasing power of the people in turn is determined by the entitlement of the households and entitlement defines the economic activities carried by the people to generate income and ensuring the objective of food security.

3.2.1.1. Food Security of Farm Families

It can be observed from Table 14 that about 64.6 percent of farm families had food mainly from their own farm production and own farm production as well as market (35.3%) in Sonipat district. In Karnal district too, majority of farm families had their own farm production (74.7%) and own farm production as well as market as the main food source of 25.3 percent farm families. As far as number of meals the household normally had per day, most of the farm families in Sonipat district said they had two meals (breakfast and dinner) in a day (61.3%) followed by three meals (21.3%), lunch and dinner (12.6%), breakfast and lunch (4.7%). On the contrary in Karnal district, it was found that 44.7 percent of farm families had three meals in a day followed by lunch and dinner (32.0%), breakfast and dinner (16.0%) and breakfast and lunch (7.3%) respectively.

Data regarding food scarcity faced by farm families during last 12 months indicates that majority (59.3%) of farm families never faced any food scarcity followed by once or twice per annum (31.3%) and once/twice a month (9.3%) while in Karnal district a good percentage (74.7%) of

sample households reported no food shortage and 25.3 percent farm families experienced food shortage once or twice during the year.

Table 14. Food security of farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	%	f	%	f	%
1.	Sources of food						
	Own farm production	97	64.6	112	74.7	209	69.7
	Own farm production + market	53	35.3	38	25.3	91	30.3
	Market only	0	0.0	0	0.0	0	0.0
	Exchange work for food	0	0.0	0	0.0	0	0.0
	Food assistance	0	0.0	0	0.0	0	0.0
2.	Number of meals the household normally has per day						
	Breakfast-lunch-dinner	32	21.3	67	44.7	99	33.0
	Breakfast and dinner	92	61.3	24	16.0	116	38.7
	Lunch and dinner	19	12.6	48	32.0	67	22.3
	Breakfast and lunch	7	4.7	11	7.3	18	6.0
	Only breakfast	0	0.0	0	0.0	0	0.0
3.	Food scarcity experienced during the last 12 months						
	Never	89	59.3	112	74.7	201	67.0
	Once or twice/annum	47	31.3	38	25.3	85	28.3
	Once/twice a month	14	9.3	-	-	14	4.7
	Once/twice a week	0	0.0	0	0.0	0	0.0
	Every day	0	0.0	0	0.0	0	0.0
4.	Amount and quality of food eaten in the last 12 months						
	Enough food to eat	82	54.6	119	79.3	201	67.0
	Enough quantity but not quality	68	45.3	27	18.0	95	31.6
	Sometimes not enough	0	0.0	4	2.6	4	1.3
	Often not enough to eat	0	0.0	0	0.0	0	0.0
	Always not enough	0	0.0	0	0.0	0	0.0

Further Table 14 shows that more than half (54.6%) of the sample households had enough food to eat and enough quantity but not quality (45.3%) in Sonipat district, whereas, in Karnal district, majority (79.3%) of sample households had enough food to eat followed by enough quantity but not quality (18.0%) and sometimes not enough to eat (2.6%). In pooled sample, similar data was observed. On the contrary, Tango International (2006), in a study to determine livelihood matrix for Kanai Nagar

community in the Mongla region of Bangladesh, reported that despite rapid gains in food self-sufficiency, many rural households remained food insecure. They had poor access to land and diversified livelihood opportunities and insufficient incomes which led to limited purchase of food. Anonymous (2009) also observed that over 10 million people suffer from chronic food insecurity and poor nutrition and estimated that at any one time, about two million people in the country require food assistance. Chikopela (2014) conducted a study in Nankanga camp of Kafue district, Zambia and reported that most of the respondents (54.3%) said they had two meals a day while 27 percent experienced food shortage between November and March, and they had adequate food just after the harvest in May. Sajjad and Nasreen (2014) conducted a study on food security status in Vaishali district of Bihar. The findings revealed that 75 percent of the sampled households had low food security. Within farmers' categories, most of the large farmers had high food security. Medium farmers experienced moderate food security while semi-medium, small and marginal farmers were having low food security. Bivariate regression analyses between food security and its components of all the farmers showed that food availability has a major impact on food security as 93 percent variation in food security is explained by variation in food availability. Anonymous (2017) also observed that over 10 million people suffer from chronic food insecurity and poor nutrition and estimated that at any one time, about two million people in the country require food assistance.

It can be concluded from Table 14 that majority of farm families got food from their own farm, had two meals a day, never faced food scarcity and had enough to eat.

3.2.2. Nutrition Security

Nutrition security is more than just food security. It is the outcome of good health. The indicators included for assessment of nutrition security of the respondents in the present study comprised food frequency pattern and household diet diversity. Weingartner (2012) defined nutrition security as a condition when all people at all times consume food of sufficient quantity

and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life, coupled with a sanitary environment, adequate health care.

3.2.2.1. Food Frequency Pattern of Households in Sonipat District

Assessment of food frequency is a cost effective, widely used means of dietary assessment to estimate subjects' average diet. Questions were asked to determine how often the subjects consumed food that fall within a defined category.

Table 15. Food frequency pattern of households in Sonipat district

S. No.	Food groups	Daily	Alternately	Twice in a week	Weekly	Rarely	WMS	Rank
1.	Cereals	150 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5.00	I
2.	Pulses	62 (41.3)	39 (26.0)	35 (23.3)	14 (9.3)	0 (0.0)	3.99	III
3.	Vegetables	64 (42.6)	0 (0.0)	77 (51.3)	9 (6.0)	0 (0.0)	3.79	IV
4.	Fruits	4 (2.6)	0 (0.0)	42 (28.0)	78 (52.0)	26 (17.3)	2.18	V
5.	Milk and milk products	146 (97.3)	4 (2.6)	0 (0.0)	0 (0.0)	0 (0.0)	4.97	II

Data on frequency of food pattern of sample households in Sonipat district presented in Table 15 reveals that cereals was consumed daily by all the sample households.

As far as consumption of pulses was concerned, 41.3 percent sample households consumed pulses daily followed by alternately (26.0%), twice in a week (23.3%) and rest i.e., 9.3 percent farm families consumed pulses on weekly basis.

Regarding vegetables, 51.3 percent of farm families consumed vegetables twice in a week followed by daily (42.6%) and weekly (6.0%). Consumption of fruits was only on weekly basis by more than half (52.0%) of the farm families followed by twice in a week (28.0%), rarely (17.3%) and daily (2.6%). Consumption of milk and milk products was on daily basis by 97.3 percent farm families and rest i.e., 2.6 percent of farm families consumed milk and milk products alternately.

Weighted Mean Score (WMS) and ranks I to V were assigned according to consumption pattern of food groups. Cereals were found to be having highest consumption (WMS, 5.00) and ranked I followed by consumption of milk and milk products (WMS, 4.97), pulses (WMS, 3.99), vegetables (WMS, 3.79) and fruits (WMS, 2.18) which were ranked II, III, IV, V respectively.

It can be concluded that farm families in Sonipat district consumed cereals, milk and milk products and pulses almost daily, but they lagged behind in consumption of fruits.

3.2.2.2. Food Frequency Pattern of Households in Karnal District

Table 16 displays food frequency pattern of sample households in Karnal district. It can be seen from table that cereals were consumed daily by all the sample households. As far as consumption of pulses was concerned, 44.6 percent farm families consumed pulses alternately followed by daily (36.0%), twice in a week (17.3%) and very few (2.0%) farm families consumed pulses on weekly basis.

Table 16. Food frequency pattern of households in Karnal district

S. No.	Food groups	Daily	Alternately	Twice in a week	Weekly	Rarely	WMS	Rank
1.	Cereals	150 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5.00	I
2.	Pulses	54 (36.0)	67 (44.6)	26 (17.3)	3 (2.0)	0 (0.0)	4.14	IV
3.	Vegetables	103 (68.6)	18 (12.0)	25 (16.7)	4 (2.6)	0 (0.0)	4.46	III
4.	Fruits	17 (11.3)	0 (0.0)	29 (19.3)	63 (42.0)	41 (27.3)	2.26	V
5.	Milk and milk products	119 (79.3)	31 (20.6)	0 (0.0)	0 (0.0)	0 (0.0)	4.79	II

It can be visualized from the Table 16 that the frequency of consumption of vegetables was on daily basis by majority (68.6%) of households followed by twice in a week (16.7%), alternately (12.0%) and weekly (2.6%) respectively. Consumption of fruits was on weekly basis by 42.0 percent farm families followed by rarely (27.3%), twice in a week (19.3%) and daily (11.3%). Further exploration of Table 16 reveals that

milk and milk products were consumed by majority (79.3%) of sample households and rest 20.6 percent consumed alternately. Vatsala et al. (2017) conducted a study in Mysuru district situated in Karnataka state of South India regarding nutritional and food security status of women. They opined that all the respondents consumed rice on everyday basis since that was the major staple food followed by *ragi* and wheat. Milk consumption represented a higher intake. Butter milk and curd were the other milk products that were found to be used most often by all the subjects on a daily basis. Vegetables like bitter gourd, brinjal and cluster beans had a very low average consumption rate. Others such as beans, cucumber and cauliflower were found to be used more frequently. Tomato was found being consumed by almost all the study population. Fruit consumption was found to be moderate and among fruits, banana was more commonly consumed.

Weighted Mean Score (WMS) and ranks highlight that consumption of cereals were found to be maximum (WMS, 5.00) and ranked I followed by consumption of milk and milk products (WMS, 4.79), vegetables (WMS, 4.46), pulses (WMS, 4.14) and fruits (WMS, 2.26) which were ranked II, III, IV, V respectively.

It is concluded from Table 16 that in Karnal district, farm families eat cereals, vegetables, milk and milk products daily but very few families take pulses and fruits daily.

3.2.2.3. Household Diet Diversity

Household diet diversity was calculated with the help of 24-hour recall method. Initially responses were obtained on eight food groups i.e., any cereals, any root vegetables, any vegetables, any fruits, any egg/egg products, food made from beans, peas, milk and butter milk, any food made from milk (butter, ghee etc.). However, for computation purpose, similar groups were combined together to form one group. Finally five food groups were included and scored as mentioned in methodology.

Table 17. Household diet diversity

Sr. No.	Food groups eaten during last 24 hours	Sonipat (n=150)		Karnal (n=150)	
		f	%	f	%
1.	Any cereals (*chapatti*, bread, biscuits, rice, food made by millets, maize, rice, wheat)	150	100.0	150	100.0
2.	Any vegetable	89	59.3	73	48.6
3.	Any fruits	28	18.6	42	28.0
4.	Any food made from beans, peas, lentils, nuts, pulses, egg	77	51.3	85	56.6
5.	Milk and milk products, butter, ghee	149	99.3	150	100.0
	Diet diversity scores	2.75		3.07	

Data presented in Table 17 shows that in both Sonipat and Karnal districts 100 percent of farm families consumed cereals. About half of the respondents in Sonipat (59.3%) and Karnal district (48.6%) had consumed any vegetables and beans, peas, lentils, nuts, pulses, egg (51.3% and 56.6% respectively). Almost all the respondents in both the districts had also consumed milk and milk products. However, only 18.6 percent farm families in Sonipat district and 28.0 percent consumed any fruits during last 24 hours. Overall diet diversity scores in Sonipat and Karnal was 2.75 and 3.07 respectively out of maximum 5. Shyamalie (2008) also reported that cereals, fat & oil and sugar were the most common food groups consumed, with a median value of three times per day. Roots and tubers, particularly pulses were also found to be commonly consumed by the people. Pradeepa (2014) reported that food pattern of farm households under both rainfed and irrigated situations were mainly cereals and milk products.

Vatsala et al. (2017) conducted an investigation in Mysuru district, Karnataka for dietary assessment which was calculated by two methods-food frequency and 24-hour recall method and findings of the study revealed that diets were deficient in protein, dietary fiber and iron.

Thus, it can be concluded from Table 17 that majority of the respondents consumed cereals, milk and milk products, vegetables, beans, lentils, nuts, pulses etc. But very few respondents consumed fruits.

3.2.2.4. Body Mass Index (BMI) of Children and Women of Selected Farm Families

BMI is a relative measure of whether an individual weight is at a healthy level for their height. BMI is the most widely used measure to categorize individuals as underweight, normal weight, overweight and obese. The distribution of BMI is presented in Table 18. Data in Table 18 depicts that in Sonipat district, 62.5 percent of children had normal BMI (18.5 to 24.9). However, 20.8 percent children were underweight having low BMI (less than 18.5) while 16.7 percent of children fell under high BMI (25 to 29.9). In Karnal district, large majority (94.2%) of children had normal BMI (18.5 to 24.9), while only 5.7 percent of children fell under low BMI category (underweight). None of the children in Sonipat as well Karnal district were obese.

Table 18. Body Mass Index (BMI) of children and women of selected farm families

Sr. No.	Variables	Sonipat		Karnal		Total	
		f	%	f	%	f	%
1.	Children (up to 5 years)	(n=24)		(n=35)		(n=59)	
	Less than 18.5: (underweight)	5	20.8	2	5.7	7	11.8
	18.5 to 24.9: (normal weight)	15	62.5	33	94.2	48	81.3
	25 to 29.9 (overweight)	4	16.7	0	0.0	4	6.8
	30 and above (obese)	0	0.0	0	0.0	0	0.0
2.	Women (18-40 years)	(n=164)		(n=159)		(n=323)	
	Less than 18.5: (underweight)	52	31.7	27	16.9	79	24.4
	18.5 to 24.9 (normal weight)	88	53.6	93	58.4	181	56.0
	25 to 29.9 (overweight)	21	12.8	32	20.1	53	16.4
	30 and above (obese)	3	1.8	7	4.4	10	3.1

In case of women, in both the districts it was found that more than half of the adult women (53.6%) categorized as medium BMI (18.5 to 24.9) in Sonipat district while 31.7 percent were categorized in low BMI (less than 18.5). 12.8 percent of women had high BMI range (25 to 29.9) and only 1.8 percent of women were having very high BMI (30 and above) or obese. In Karnal district, more than half of the women (58.4%) were in normal BMI category (18.5 to 24.9) followed by 20.1 percent who had high BMI

range (25 to 29.9). 16.9 percent women were categorized under low BMI range (less than 18.5) and only 4.4 percent of women were categorized as obese having very high BMI (30 and above). Mittal (2013) conducted a study on nutritional status and morbidity patterns among non-pregnant non-lactating rural women of reproductive age group (18-40 Years) in village 'Badshahpur' in Gurgaon, Haryana and reported that more than half of the samples (women) fell under normal BMI range, i.e., 18.5-24.9, 25.0 percent were underweight having a BMI <18.5 and rest were overweight. In a study conducted by Vatsala et al. (2017) on nutritional and food security status of women in Mysuru district, Karnataka stated that a majority (57.2%) of adult women were in normal range, followed by underweight (29.6%).

It can be concluded from Table 18 that majority of women and children had normal BMI, and one-tenth children and one-fourth women were underweight.

3.2.3. Economic Security

Economic security is the capacity to generate sufficient income to satisfy the basic needs and to maintain or increase the goods which is necessary for the stability of the family economy. The recommended indicators that can provide insight on economic security included- annual household income, possession of productive and unproductive assets, households' debt condition and their level of satisfaction with their current financial condition.

3.2.3.1. Economic Security of Farm Families

The findings in the Table 19 depict that a considerable percentage (48.0%) of farm families were having annual income ranging between Rs.2,00,001-3 lakh followed by Rs. 3,00,001-4 lakh (38.0%) and above 4 lakh (14.0%) whereas in Karnal district, 52.0 percent of sample households had annual income ranging between Rs. 3,00,001-4 lakh followed by Rs. 2,00,001-3 lakh (28.7%) and above Rs. 4 lakh (19.3%) respectively.

Table 19. Economic security of farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	%	f	%	f	%
1.	Household annual income						
	Up to Rs. 1 lakh	0	0.0	0	0.0	0	0.0
	Rs. 1,00,001-2 lakh	0	0.0	0	0.0	0	0.0
	Rs. 2,00,001-3 lakh	72	48.0	43	28.7	115	38.3
	Rs. 3,00,001-4 lakh	57	38.0	78	52.0	135	45.0
	Above Rs. 4 lakh	21	14.0	29	19.3	50	16.6
2.	Possession of productive assets						
a)	Livestock						
	Up to Rs. 30,000	4	2.7	11	7.3	15	5.0
	Rs. 30,001-60,000	46	30.7	98	65.3	144	48.0
	Rs. 60,001-90,000	83	55.3	32	21.3	115	38.3
	Rs. 90,001-1,20,000	17	11.3	9	6.0	26	8.7
	Above Rs. 1,20,000	0	0.0	0	0.0	0	0.0
b)	Land						
	Up to Rs. 20 lakh	0	0.0	0	0.0	0	0.0
	Rs. 20,00,001- 25 lakh	34	22.6	26	17.3	60	20.0
	Rs. 25,00,001- 30 lakh	89	59.3	117	78.0	206	68.6
	Rs. 30,00,001- 35 lakh	18	12.0	5	3.3	23	7.7
	Rs. 35,00,001- 40 lakh	9	6.0	2	1.3	11	3.6
3.	Possession of unproductive assets						
a)	Gold						
	Up to 50 gm	13	8.6	5	3.3	18	6.0
	51-100 gm	88	58.6	67	44.6	155	51.7
	101-150 gm	49	32.7	53	35.3	102	34.0
	151-200 gm	0	0.0	25	16.7	25	8.3
	Above 201gm	0	0.0	0	0.0	0	0.0
b)	Value of residential property						
	Up to Rs.3 lakh	86	57.3	98	65.3	184	61.3
	Rs. 3,00,001- 6 lakh	52	34.7	43	28.7	95	31.7
	Rs. 6,00,001- 9 lakh	12	8.0	9	6.0	21	7.0
	Rs. 9,00,001- 12 lakh	0	0.0	0	0.0	0	0.0
	Above Rs. 12 lakh	0	0.0	0	0.0	0	0.0
4.	Household currently in debt						
	No	59	39.3	83	55.3	142	47.3
	Yes, a little	77	51.3	25	16.7	102	34.0
	Moderate amount	14	9.3	42	28.0	56	18.7

Table 19. (Continued)

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	%	f	%	f	%
	High amount	0	0.0	0	0.0	0	0.0
	Unmanageable	0	0.0	0	0.0	0	0.0
5.	Level of satisfaction with current financial condition						
	Satisfied	13	8.6	59	39.3	72	24.0
	Somewhat satisfied	24	16.0	12	8.0	36	12.0
	Don't know	19	12.7	26	17.3	45	15.0
	Somewhat dissatisfied	53	35.3	21	14.0	74	24.6
	Dissatisfied	41	27.3	32	21.3	73	24.3

Possessions of productive assets were categorized in two heads- livestock and land. A glance at the Table 19 shows that in Sonipat district, 55.3 percent of sample households had livestock values in between Rs. 60,001-90,000 followed by Rs. 30,001-60,000 (30.7%), Rs. 90,001-1,20,000 (11.3%) and up to Rs.30,000 (2.7%). In Karnal district, majority (65.3%) of the sample households had livestock of worth Rs. 30,001-60,000 followed by Rs. 60,001-90,000 (21.3%), up to Rs. 30,000 (7.3%) and Rs. 90,001-1,20,000 (6.0%) in form of productive assets.

As regards to value of land, it can be seen from the Table 19 that an overwhelming percentage (68.6%) of farm families had land estimated worth of Rs.25,00,001- 30 lakh followed by Rs. 20,00,001- 25 lakh (20.0%). Few farm families had land worth of Rs. 30,00,001- 35 lakh (7.7%) and Rs. 35,00,001- 40 lakh (3.6%) in the form of productive assets.

As far as possession of unproductive assets was concerned, it was categorized in two heads- gold and value of residential property. It can be seen from the Table 19 that in pooled sample, 51.7 percent of farm families had gold jewelry of 51-100 gm followed by 101-150 gm (34.0%). Less than ten percent farm families had 151-200 gm (8.3%).

Table 19 clearly predicts that majority (61.3%) of farm families had residential property of worth up to Rs. 3 lakh followed by more than Rs. 3,00,001- 6 lakh (31.7%) and more than Rs. 6,00,001- 9 lakh (7.0%). Similar data was observed in both the districts. Shyamalie (2008) in a comparative study of hills of India and Sri Lanka found that except

savings, level of productive and unproductive assets and other indicators obtained low scores in both study districts. The score of productive assets was slightly higher in Kangra. However, the composite index score of the overall economic security in Kangra (2.04) showed a lower value than the sample of Nuwara Eliya district (2.15), indicating greater vulnerability of women in Kangra district to economic insecurity.

Table 19 further pin-points that less than half (47.3%) of the farm families reported that they were not in debt, 34.0 percent of farm families were in little debt, only 18.7 percent farm families had moderate amount of debt. None of the farm families had high and unmanageable debt. Shrinivasan (2015) observed that the average loan amount outstanding for a farm household in India was INR 47,000, which is an extremely heavy burden on farmers.

For measuring the level of satisfaction of farm families, their self-opinion was recorded and on the basis of this, Table 19 brings to the light that about 35.3 percent of selected farm families in Sonipat district were somewhat dissatisfied with their current financial condition followed by dissatisfied (27.3%), somewhat satisfied (16.0%), don't know (12.7%). Only 8.6 percent of families were satisfied with their current financial condition. In Karnal district, about 39.3 percent of farm families were satisfied followed by dissatisfied (21.3%), don't know (17.3%), somewhat dissatisfied (14.0%) and somewhat satisfied (8.0%) with their current financial condition.

It can be concluded from Table 19 that most of farm families were having annual income Rs. 3,00,001-4 lakh, had land and livestock as productive assets and gold and residential property as unproductive assets. Less than half of the families were not in debt and some of them were fully satisfied with their current financial condition.

3.2.4. Shelter/Water and Sanitation Security

3.2.4.1. Shelter/Water and Sanitation Security of Farm Families

Data regarding shelter/water and sanitation security of selected farm families has been presented in Table 20. Results indicate that less than half

(47.0%) of the farm families used piped water at home for drinking and cooking followed by community hand pump (33.3%) and community tap (17.6%). Very few households used hand pump and canal/well (1.3% and 0.7%). Shyamalie (2008) also reported that 68 percent of the sample households in Kangra district were having facility of drinking water through common tap which is generally shared by about 5 – 6 households. Whereas, rest of the households were having their own water tap in the house for domestic purposes.

District wise analysis regarding availability of kitchen indicates that 42.0 percent of farm families of Karnal district had separate kitchen without water and ventilation followed by separate kitchen with water (33.3%). Only 10.7 percent households had separate kitchen with water and ventilation, while 8.7 percent had open kitchen and 5.3 percent were having kitchen in the living room. In Sonipat district, 39.3 percent of the farm families had separate kitchen with water, 26.7 percent had separate kitchen without water and ventilation, 14.6 percent had open kitchen, 11.3 percent farm families had kitchen within the area of living room and very few (8.0%) had separate kitchen with water and ventilation.

In case of availability of shelter for livestock, majority (64.0%) of farm families in both the districts had shelter for livestock outside home, followed by 21.7 percent who had shelter for livestock near the house where they lived, 10.7 percent of farm families had livestock within their homes. Very few had far from home and separate shelter in field (2.3% and 1.3% respectively).

Almost all the farm families had electricity in their house but during the power cut they used other source for lighting. Little less than half (48.7%) of the farm families in Sonipat district used inverter followed by solar lantern (34.6%) and torch (10.7%) whereas in Karnal district, 46.7 percent of the farm families used solar lanterns followed by inverter (36.0%) and kerosene lantern (11.3%) respectively.

Table 20. Shelter/water and sanitation security of farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	(%)	f	(%)	f	(%)
1.	Availability of water for drinking and cooking						
	Piped water at home	61	40.6	80	53.3	141	47.0
	Community tap	30	20.0	23	15.3	53	17.6
	Hand pump	4	2.7	0	0.0	4	1.3
	Community hand pump	53	35.3	47	31.3	100	33.3
	Canal/well	2	1.3	0	0.0	2	0.7
2.	Availability of kitchen						
	Separate kitchen with water and ventilation	12	8.0	16	10.7	28	9.3
	Separate kitchen with water	59	39.3	50	33.3	109	36.3
	Separate kitchen without water and ventilation	40	26.7	63	42.0	103	34.3
	In the living room	17	11.3	8	5.3	25	8.3
	Open	22	14.6	13	8.7	35	11.7
3.	Availability of shelter for livestock						
	Separate shelter in field	0	0.0	4	2.7	4	1.3
	Far from home	0	0.0	7	4.7	7	2.3
	Near the home	40	26.7	25	16.6	65	21.7
	Outside home	89	59.3	103	68.7	192	64.0
	Within the home	21	14.0	11	7.3	32	10.7
4.	Source of lighting other than electricity						
	Inverter	73	48.7	54	36.0	127	42.3
	Solar lantern	52	34.6	70	46.7	122	40.6
	Torch	16	10.7	9	6.0	25	8.3
	Kerosene lantern	9	6.0	17	11.3	26	8.7
	Candle	0	0.0	0	0.0	0	0.0
5.	Source of cooking fuel						
	LPG	9	6.0	12	8.0	21	7.0
	Electricity stove	2	1.3	0	0.0	2	0.7
	Wood	14	9.3	5	3.3	19	6.3
	Dung	119	79.3	133	88.6	252	84.0
	Crop residue	6	4.0	0	0.0	6	2.0
6.	Access to toilet facilities						
	Flush toilet	11	7.3	0	0.0	11	3.7
	Pit flush toilet	37	24.6	43	28.6	80	26.7
	Improved pit	59	39.3	65	43.3	124	41.3
	Traditional pit	24	16.0	0	0.0	24	8.0
	Open field	19	12.6	42	28.0	61	20.3

With regards to source of cooking fuel, majority of families in both the districts i.e., in Sonipat (79.3%) and in Karnal (88.6%) used dung as a cooking fuel. Chhachhiya (2015) also reported that more than half of the households were having facility of drinking water through tap and majority of the households were still using cow dung cake.

Only some farm families used wood (9.3%), LPG (6.0%), crop residue (4.0%) and electric stove (1.3%) in Sonipat, while in Karnal too, few households used LPG (8.0%) and wood (3.3%) as cooking fuel.

It was also observed in pooled sample that most of the households i.e., 41.3 percent of households had improved pit toilet followed by pit flush toilet (26.7%). Few households had traditional pit (8.0%) and flush toilet (3.7%) while about one fifth 20.3 percent still used open field. Similar data was observed in both the districts.

It can be concluded from Table 20 that most of farm families were having piped water at home for drinking and cooking. Only one-third of them had separate kitchen with or without water. They used inverter and solar lantern as source of lighting.

3.2.5. Health Security

Health is an important factor which influences the livelihood of household. Security of a household in terms of health is defined as the availability and accessibility of health services. For measuring health security, parameters selected were occurrence of illness, availability, accessibility of health services and affordability of household for professional treatment.

3.2.5.1. Health Security of Farm Families

Data in Table 21 elucidated that in Sonipat district, half (51.3%) of the farm families faced illness once or twice in a week followed by once or twice in a year (21.3%), few times in a month (18.7%) and 8.6 percent farm families members did not face any illness. While in Karnal district too, majority of farm families (64.6%) reported that they suffered illness once or twice in a week followed by once or twice in a year (16.7%), a few times in a month (12.6%). 2.7 percent of households' members reported

that they faced almost everyday illness. Only 3.3 percent of farm families never face any illness during last 12 months. Kabir et al. (2016) identified illness as a major constraint in ability of slum households to have secured livelihoods in Dhaka (Bangladesh). Illness had negative effect on human and social capital of households thus pointing to their vulnerable livelihood. There was a need to address the problem with action required on three fronts; reduce the risk of morbidity as it was significantly associated with poverty, stemming from poor habitat and living conditions and poor nutrition. Provision of quality, accessible and affordable health care for adults was required.

Regarding availability and accessibility of primary health services, Table 21 depicts that in Sonipat district 44.6 percent of farm families reported that they had availability of primary health centers within 1-2 Km followed by 4-6 Km (29.3%) and 2-4 Km (26.0%). In Karnal district, 42.0 percent of farm families reported that they have primary health centers within the area of 2-4 Km followed by 1-2 Km (40.7%) and within 1 Km (14.6%). Only 2.6 percent of farm families had primary health centers at a distance of 4-6 Km from their living area. Shyamalie (2008) also reported that access to health services gained a better score for women in Kangra district (3.69), compared to women of NuwaraEliya district (1.75). Sakamma (2013) concluded that the households of high women empowered irrigated situation have more availability of primary health services (52.2%) and are also having good accessibility both in terms of time as well as distance.

Further exploration of availability and accessibility of government/private hospital reveals that in Sonipat district, 46.7 percent respondents reported that availability of government hospital was within 6-8 Km from their village followed by 4-6 Km (34.0%) and beyond 8 Km (19.3%). Similarly, in Karnal district, it was found that majority of the respondents' (72.0%) reported that availability of government and private hospitals was at 6-8 Km distance from their village.

Table 21. Health security of farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	%	f	%	f	%
1.	Occurrence of illness in the household during last 12 months						
	Never	13	8.6	5	3.3	18	6.0
	Once or twice in a year	32	21.3	25	16.7	57	19.0
	A few times a month	28	18.7	19	12.6	47	15.6
	Once or twice in a week	77	51.3	97	64.6	174	58.0
	Almost everyday	0	0.0	4	2.7	4	1.3
2.	Availability and accessibility of primary health services						
	0-1 Km	0	0.0	22	14.6	22	7.3
	>1-2 Km	67	44.6	61	40.7	128	42.6
	>2-4 Km	39	26.0	63	42.0	102	34.0
	>4-6 Km	44	29.3	4	2.6	48	16.0
	Beyond 6 Km	0	0.0	0	0.0	0	0.0
3.	Availability and accessibility of government/private hospital						
	0-2 Km	0	0.0	0	0.0	0	0.0
	>2-4 Km	0	0.0	0	0.0	0	0.0
	>4-6 Km	51	34.0	40	26.7	91	30.3
	>6-8 Km	70	46.7	108	72.0	178	59.3
	Beyond 8 Km	29	19.3	2	1.3	31	10.3
4.	Enough medical supply for adequate health care						
	Never	6	4.0	2	1.3	8	2.6
	Rarely	13	8.6	17	11.3	30	10.0
	Sometimes	62	41.3	54	36.0	116	38.6
	Often	69	46.0	77	51.3	146	48.7
	Always	0	0.0	0	0.0	0	0.0
5.	Household ability to afford professional treatment						
	No	0	0.0	0	0.0	0	0.0
	Yes, if money is borrowed	3	2.0	6	4.0	9	3.0
	Yes, with much difficulty	58	38.6	49	32.6	107	35.6
	Yes, with some difficulty	77	51.3	92	61.3	169	56.3
	Yes, household can afford it	12	8.0	3	2.0	15	5.0

Table 21 pin-points that less than half (48.7%) of the sample households agreed on that they often had enough medical supply for adequate health care followed by sometimes (38.6%) and rarely (10.0%) while only 2.6 percent reported that there was not enough medical supply for adequate health care.

Data pertaining to household ability to afford professional treatment for illness reveals that in Sonipat district, half (51.3%) of the respondents

could afford professional treatment but with some difficulty. 38.6 percent said they could afford treatment with much difficulty, only 8.0 percent households could afford professional treatment while 2.0 percent sample households said that they afford professional treatment if money was borrowed. In Karnal district also, similar trend was observed where majority (61.3%) of sample households could afford professional treatment with some difficulty, 32.6 percent with much difficulty, 4.0 percent of households could afford professional treatment if money was borrowed and very few (2.0%) households could afford professional treatment with no difficulty.

Thus, it can be concluded from Table 21 that most of households faced frequent illness but they had access to PHC within 1-2 km, private hospital within 6-8 km and they often had enough medical supply. They could afford professional treatment with some difficulty.

3.2.6. Education Security

Education is the important necessity of life. Level of education at household level, distance of educational institutes, accessibility of educational institutes and perceived cost of education were the major determinants included to measure education security of rural households.

3.2.6.1. Education Security of Farm Families

Data presented in Table 22 show that among family members of selected households, most of members (29.8%) fell under 'can read/write' category followed by up to primary (27.6%), up to matric (23.1%), up to graduation (13.1%) and 6.1 percent members in total sample had attained vocational education.

Regarding distance of higher/vocational institutes, Table 22 reveals that majority (81.3%) of the farm families in Sonipat as well as Karnal districts (58.0%) had educational institutes at a distance of 4-6 km from their residence followed by more than 2-4 km (11.3%) in Sonipat and more than 6 km (39.3%) in Karnal. In aggregate sample also, majority (69.6%) had educational institutes at a distance of 4-6 km from their localities

followed by 23.3 percent who had access to these institutes at more than 6 km respectively.

Table 22. Education security of farm families

Sr. No.	Variables	Sonipat		Karnal		Total	
		f	(%)	f	(%)	f	(%)
1.	Household literacy level*	(n=502)**		(n=408)**		(n=910)**	
	Can read/write	143	28.4	129	31.6	272	29.8
	Up to primary	134	26.6	118	28.9	252	27.6
	Up to matric	119	23.7	92	22.5	211	23.1
	Up to vocational	35	6.9	21	5.1	56	6.1
	Up to graduation	71	14.4	48	11.7	119	13.1
2.	Distance of educational institutes	(n=150)		(n=150)		(n=300)	
	Less than 1 km	0	0.0	0	0.0	0	0.0
	1-2 km	0	0.0	0	0.0	0	0.0
	>2-4 km	17	11.3	4	2.6	21	7.0
	>4-6 km	122	81.3	87	58.0	209	69.6
	More than 6 km	11	7.3	59	39.3	70	23.3
3.	Accessibility of educational institutes*	(n=150)		(n=150)		(n=300)	
	College/technical education	86	57.3	69	46.0	155	51.7
	Senior secondary school	129	86.0	150	100.0	279	93.0
	High school	101	67.3	113	75.3	214	71.3
	Middle school	150	100.0	150	100.0	300	100.0
	Primary	150	100.0	150	100.0	300	100.0
4.	Perceived cost of education	(n=150)		(n=150)		(n=300)	
	Most expensive	0	0.0	0	0.0	0	0.0
	Expensive	79	52.7	118	78.6	197	65.6
	Affordable	64	42.6	20	13.3	84	28.0
	Cheap	7	4.6	12	8.0	19	6.3
	Very cheap	0	0.0	0	0.0	0	0.0

* Multiple response.

** Total members of selected households.

Data regarding accessibility of educational institutes show that in Sonipat district, 100 percent of farm families were having middle school and primary school, majority of farm families were having senior secondary school (86.0%), high school (67.3%) and 57.3 percent farm families were having technical education in their reach. In Karnal district, 100 percent of households were having primary school, middle school,

senior secondary school and majority (75.3%) were having high school and less than half (46.0%) were having educational institutes within their vicinity where they lived. Sakamma (2013) also concluded that majority of the households were having accessibility of high school in their locality itself and more than half were having college education in Kolar district.

It is clear from Table 22 that majority (78.6%) of households in Karnal district perceived the cost of education as expensive followed by affordable (13.3%), whereas in Sonipat district little more than half (52.7%) reported cost of education as expensive followed by 42.6 percent who reported that education was affordable for them. However, 6.3 percent respondents said that the cost of education was cheap for them.

It is concluded from Table 22 that educational institutes were situated at a distance of 4-6 km for majority of farm families and they perceived cost of education as expensive.

3.2.7. Access to Institutions

3.2.7.1. Access to Government/Welfare Institutions by Farm Families

The results pertaining to access/availability of institutes presented in Table 23 indicate that in Sonipat, 58.0 percent of sample households reported easy availability of government/welfare institutes followed by very easily available (18.7%). 12.7 percent respondents reported that these institutions were mostly not available while 10.6 percent reported sometimes available. In case of Karnal district, majority (66.0%) of sample households reported that these welfare institutes were easily accessible to them followed by sometimes available (20.0%) and very easily available (8.7%), only 5.3 percent respondents reported that these institutions were mostly not available to them.

Table 23 also shows data regarding frequency of contact by respondents with officials. It was noticed from Table 23 that 29.6 percent of farm families had contacted HAU scientist 2-3 times a month followed by 2-3 times every 6 months (39.0%), 2-3 times a year (19.0%) and never (12.3%).

Table 23. Access to government/welfare institutions by farm families

Sr. No.	Variables	Sonipat (n=150)		Karnal (n=150)		Total (n=300)	
		f	%	f	%	f	%
1.	Access/availability of institutes						
	Very easily available	28	18.7	13	8.7	41	13.7
	Easily available	87	58.0	99	66.0	186	62.0
	Sometimes available	16	10.6	30	20.0	46	15.3
	Mostly not available	19	12.7	8	5.3	27	9.0
	Not at all available	0	0.0	0	0.0	0	0.0
2.	Frequency of contact with officials						
a)	HAU scientist						
	Once in a week	0	0.0	0	0.0	0	0.0
	2-3 times/month	57	38.0	32	21.3	89	29.6
	2-3 times/6 months	49	32.6	68	45.3	117	39.0
	2-3 times/year	18	12.0	39	26.0	57	19.0
	Never	26	17.3	11	7.3	37	12.3
b)	Agricultural/extension officials						
	Once in a week	19	12.7	54	36.0	73	24.3
	2-3 times/month	67	44.6	72	48.0	139	46.3
	2-3 times/6 months	26	17.3	15	10.0	41	13.6
	2-3 times/year	38	25.3	9	6.0	47	15.7
	Never	0	0.0	0	0.0	0	0.0
c)	Local officials						
	Once in a week	43	28.7	79	52.7	122	40.7
	2-3 times/month	98	65.3	35	23.3	133	44.3
	2-3 times/6 months	9	6.0	20	13.3	29	9.7
	2-3 times/year	0	0.0	16	10.7	16	5.3
	Never	0	0.0	0	0.0	0	0.0
d)	Bank personnel						
	Once in a week	7	4.7	21	14.0	28	9.3
	2-3 times/month	58	38.7	36	24.0	94	31.3
	2-3 times/6 months	62	41.3	19	12.7	81	27.0
	2-3 times/year	23	15.3	74	49.3	97	32.3
	Never	0	0.0	0	0.0	0	0.0
3.	Frequency of receiving information related to agriculture from officials						
	Regularly	19	12.7	54	36.0	73	24.3
	Occasionally	87	58.0	62	41.3	149	49.7
	Rarely	38	25.3	13	8.6	51	17.0
	Can't say	6	4.0	21	14.0	27	9.0
	NA	0	0.0	0	0.0	0	0.0
4.	Respondents' satisfaction with the information						
	Fully satisfied	62	41.3	43	28.7	105	35.0
	Somewhat satisfied	27	18.0	49	32.7	76	25.3
	Somewhat dissatisfied	45	30.0	38	25.3	83	27.6
	Fully dissatisfied	16	10.7	20	13.3	36	12.0
	NA	0	0.0	0	0.0	0	0.0

As regards to agricultural/extension officials, Table 23 elucidated that in Sonipat district, less than half (44.6%) of the farm families had contacted agricultural/extension officials 2-3 times a month followed by 2-3 times a year (25.3%), 2-3 times every 6 months (17.3%) and once in a week (12.7%). Similarly, in Karnal district, 48.0 percent farm families contacted agricultural/extension officials 2-3 times a month, once in a week (36.0%), 2-3 times every 6 months (10.0%), 2-3 times a year (6.0%). Orisakwe and Agomuo (2016) reported that more than half of the farmers contacted extension officers twice a month and also found that, 36 percent of farmers had participated in one or more extension activities, whereas, two third (64.0%) of the farmers did not participate in any extension activities.

As regards to contact with local officials, they were contacted 2-3 times a month by majority (65.3%) of farm families followed by once in a week (28.7%) and 2-3 times every 6 months (6.0%) in Sonipat district. But in Karnal district, it was found that 52.7 percent of farm families consulted local officials once in a week followed by 2-3 times a month (23.3%), 2-3 times every 6 months (13.3%) and 2-3 times a year (10.7%). Similar data was recorded in the pooled sample.

As far as bank personnel were concerned, 41.3 percent of sample households contacted bank personnel 2-3 times every 6 months and after that 2-3 times a month (38.7%), 2-3 times a year (15.3%) and once a week (4.7%), whereas in Karnal district nearly half (49.3%) of the farm families consulted bank personnel 2-3 times a year and after that 2-3 times a month (24.0%), once a week (14.0%) and 2-3 times every 6 months (12.7%), respectively. Chikopela (2014) also identified in her study the sources of agricultural information in the households. Two sources of agricultural information were identified. These were Ministry of Agriculture and Livestock extension staff and Non-governmental organizations. Most of the respondents (54.7%) reported that extension workers were their main source of information and most of the information provided was on input procurement.

Table 23 further unveils that 58.0 percent of the respondents received information from extension officials occasionally related to agriculture,

followed by rarely (25.3%) while 12.7 percent regularly received information from extension officials. In Karnal district, less than half (41.3%) of the respondents received information occasionally followed by regularly (36.0%) while 14.0 percent said that they were not sure and responded as "can't say" and 8.6 percent rarely received information on agriculture.

From the results presented in Table 23, it can be discovered that in Sonipat district 41.3 percent of respondents were fully satisfied with the information provided by the officials followed by somewhat satisfied (18.0%) and fully dissatisfied (10.7%). But in Karnal district less than half (32.7%) of the respondents were somewhat satisfied followed by fully satisfied (28.7%), somewhat dissatisfied (25.3%) and fully dissatisfied (13.3%).

It can be concluded from Table 23 that majority of families' accessed government/welfare institutions, contacted HAU scientists, extension officials, local officials, bank personnel and received agriculture related information occasionally and one-third of them were fully satisfied with the information.

3.2.7.2. Overall Livelihood Security Index of Farm Families

Livelihood security index for each indicator was calculated by assigning weights to the components according to their value from 5 to 1. Frequency of each component was multiplied by corresponding weight and divided by total number of respondents. The distribution of farm families with regards to level of livelihood security index presented in Table 24 reveals that, food security was found to be having maximum score in both Sonipat and Karnal district (4.41 and 4.55 respectively) indicating that both the districts had high level of food security. Most of other livelihood security indices viz. nutrition security index (Sonipat- 3.21, Karnal- 3.54), economic security (Sonipat- 3.03, Karnal- 3.21), shelter/water and sanitation security (Sonipat- 2.85, Karnal- 2.96), health security (Sonipat- 3.02, Karnal- 3.08), education security (Sonipat- 3.03, Karnal- 3.00), access to institutions (Sonipat- 3.24, Karnal- 3.28) were found to be of medium level in both the districts. Shyamalie and Saini (2010) conducted a

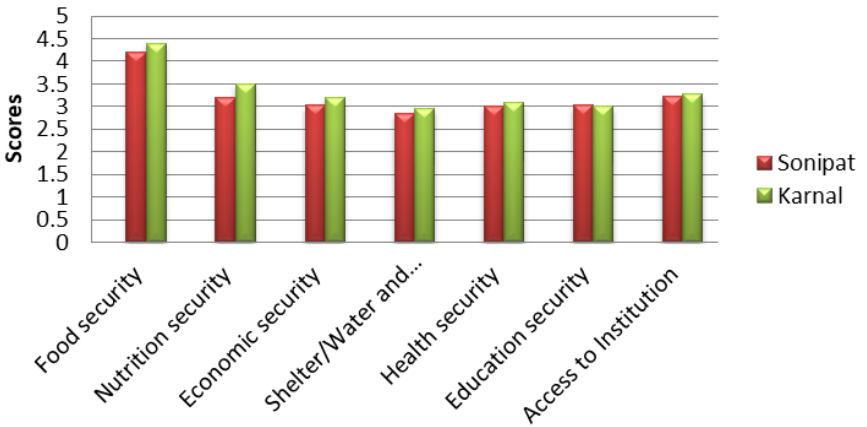
comparative study of Kangra district in India and Nuwara Eliya district in Sri Lanka in regarding to livelihood security of women in hills. They opined that food security, habitat security, health security, education security and social security were higher in Nuwara Eliya district compared to Kangra district, although economic security is same in both districts. The overall livelihood security index further reveals that one-fourth of the women in Kangra district were under the low livelihood security trap which is a matter of great concern. Akter (2016) measured livelihood security in sampled urban areas in Bangladesh. Five livelihood security indices were measured for outcomes of food, economic, education, health and shelter indices. For food security, food basket characterized 8 food groups. Main findings of the study were that only 2 percent of respondents could have diet of all 8 types of food. Health security indicated that 82 percent reported at least one member sick during 30 days recall. Educational security indicated lower average value. Two regions indicated insecure livelihood for food, economic, health, education and shelter.

Thus, it can be concluded from Table 24 (Figure 3) that food security scored highest in both the districts while water/sanitation security scored lowest. Karnal district had higher livelihood security indices for almost all the indicators as compared to Sonipat district.

Table 24. Overall livelihood security index of farm families

Sr. No.	Livelihood security outcomes	Sonipat (Scores)	Karnal (Scores)
1.	Food security	4.41	4.55
2.	Nutrition security	3.21	3.54
3.	Economic security	3.03	3.21
4.	Shelter/water and sanitation security	2.85	2.96
5.	Health security	3.02	3.08
6.	Education security	3.03	3.00
7.	Access to institution	3.24	3.28

Low: 1.00 - 2.33
Medium: 2.34 - 3.67
High: 3.68 – 5.00.



Source: Authors' calculations based on household survey data.

Figure 3. Overall livelihood security index of farm families.

3.3. Association of Independent and Dependent Variables

3.3.1. Relationship between Respondents' Personal Variables with Livelihood Capabilities

A glance over the data presented in Table 25 reveals that age was negatively and significantly (r = -0.239*) associated with human capital whereas it was not found associated with any other capital meaning thereby indicating that young age respondents' had more human capital. Family size was positively associated with human capital (r = 0.896*), social capital (r = 0.416*) and physical capital (r = 0.574*) but negatively associated (r = -0.323*) with financial capital indicating that larger the family size, more are the human capital, social capital and physical capital but they have lesser financial capital. Family education status was positively and significantly associated with human capital (r = 0.791*), social (r = 0.632*), physical (r = 0.734*) and financial capital (r = 0.781*) whereas not associated with natural capital thus showing that except natural capital, all other capitals were positively associated with financial capital.

Table 25. Relationship between respondents' personal variables with livelihood capabilities

Sr. No.	Variables	Human capital	Social capital	Natural capital	Physical capital	Financial capital
1.	Age	-0.239*	0.215	0.081	0.062	-0.021
2.	Family size	0.896*	0.416*	0.031	0.574*	-0.323*
3.	Family education status	0.791*	0.632*	0.019	0.734*	0.781*
4.	Size of house	0.023	0.184	0.033	0.621*	0.304*
5.	Occupation	0.625*	0.838*	0.020	0.819*	0.723*
6.	Annual income	0.573*	0.071	0.032	0.795*	0.885*
7.	Size of land	0.782*	0.186	0.011	0.473*	0.791*
8.	Social participation	0.231	0.810*	0.023	0.184	0.183
9.	Information source utilization	0.402*	0.683*	0.042	0.361*	0.201

* Significant at 5% level of significance.

As far as the size of house was concerned, its significant association with physical capital (r = 0.621*) and financial capital (r = 0.304*) can be seen from Table 25 but other capital was not associated with size of house. It can be further seen that occupation of respondents was positively and significantly correlated with human capital (r = 0.625*), social capital (r = 0.838*), physical capital (r = 0.819*) and financial capital (r = 0.723*). Annual income was also positively and significantly associated with human capital (r = 0.573*), physical capital (r = 0.795*) and financial capital (r = 0.885*).

Size of land was positively and significantly associated with human capital (r = 0.782*), physical capital (r = 0.473*) and financial capital (r = 0.791*) but no association with social and natural capital. Social participation was positively and significantly correlated with social capital (r = 0.810*) at 5 percent level of significance. As regards to information source utilization, it was found to be positively correlated with human capital (r = 0.402*), social capital (r = 0.683*) and physical capital (r = 0.361*).

Thus, it can be concluded from Table 25 that young age respondents having larger family size, higher education status, occupation, annual income, more land and more information source utilization had higher

human capital, physical capital and financial capital. But natural capital was not associated with any of the personal variables.

3.3.2. Relationship between Respondents' Personal Variables with Livelihood Securities

The relationship between various selected independent variables and the livelihood securities were examined. A glance at the Table 26 shows that age was significantly and positively correlated with food security (r = 0.557*), nutrition security (r = 0.482*), economic security (r = 0.286*), shelter/water and sanitation security (r = 0.389*), health security (r = 0.438*), education security (r = 0.462*) but no correlation was found with access to institutions. Family size was positively and significantly correlated with nutrition security (r = 0.397*), economic security (r = 0.521*), shelter/water and sanitation security (r = 0.526*), health security (r = 0.480*), education security (r = 0.382*) but negatively correlated with food security (r = -0.281*).

Family education status was positively correlated with all securities viz. food security (r = 0.725*), nutrition security (r = 0.612*), economic security (r = 0.629*), shelter/water and sanitation security (r = 0.713*), health security (r = 0.715*), education security (r = 0.718*) and access to institutions (r = 0.692*). Size of house was positively and significantly correlated with economic security (r = 0.385*).

Occupation of farm families was recorded to be positively and significantly correlated with all securities i.e., food security (r = 0.752*), nutrition security (r = 0.638*), economic security (r = 0.583*), education security (r = 0.772*), access to institutions (r = 0.881*). Annual income of households was also positively and significantly correlated with all securities i.e., food security (r = 0.712*), nutrition security (r = 0.652*), economic security (r = 0.702*), shelter/water and sanitation security (r = 0.628*), health security (r = 0.738*), education security (r = 0.752*) and access to institutions (r = 0.421*).

Table 26. Relationship between respondents' personal variables with livelihood securities

Sr. No.	Variables	Food security	Nutrition security	Economic security	Shelter/ water & sanitation security	Health security	Education security	Access to institutions
1.	Age	0.557*	0.482*	0.286*	0.389*	0.438*	0.462*	0.021
2.	Family size	-0.281*	0.397*	0.521*	0.526*	0.480*	0.382*	0.165
3.	Family education status	0.725*	0.612*	0.629*	0.713*	0.715*	0.718*	0.692*
4.	Size of house	-0.021	0.186	0.385*	-0.110	0.043	0.125	0.065
5.	Occupation	0.752*	0.638*	0.692*	0.592*	0.583*	0.772*	0.881*
6.	Annual income	0.712*	0.652*	0.702*	0.628*	0.738*	0.752*	0.421*
7.	Size of land	0.689*	0.472*	0.654*	0.115	0.614*	0.196	0.381*
8.	Social participation	0.022	0.026	0.056	0.086	0.021	0.152	0.486*
9.	Information source utilization	0.335*	0.398*	0.401*	0.382*	0.478*	0.328*	0.443*

* Significant at 5% level of significance.

Size of land was found to be correlated with food security (r = 0.689*), nutrition security (r = 0.472*), economic security (r = 0.654*), health security (r = 0.614*) and access to institutions (r = 0.381*). Social participation was correlated with access to institutions (r = 0.486*) and non-significant correlation with other securities.

Table 26 further highlights that information source utilization was found to have positive and significant correlation with all securities i.e., food security (r = 0.335*), nutrition security (r = 0.398*), economic security (r = 0.401*), shelter/water and sanitation security (r = 0.382*), health security (r = 0.478*), education security (r = 0.328*) and access to institutions (r = 0.443*) at 5 percent level of significance.

Thus, it can be concluded from Table 26 that family education status, occupation, annual income and information source utilization were positively and significantly associated with all the livelihood securities. Age, size of land was positively correlated with most of security aspects. Family size was also found positively and significantly associated with all

types of securities except food security as it was negatively and significantly associated.

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Chapter 2

A STUDY ON SOCIO-ECONOMIC AND LANDHOLDING PATTERNS OF ORGANIC FARMING SYSTEMS IN NORTHERN KARNATAKA

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ABSTRACT

The study aims to analyze the socio-economic features of farmers involved in organic cultivation besides the study also explores to find the landholding patterns in the northern part of Karnataka state. The study has used both primary and secondary data for fulfilling the objectives of

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the study with a sample size of 75 sample respondents from each district, in total consisting of 225 samples. The findings reveal that, the average family size of the sample farmers was 6.15, 6.06, and 5.38 in Bagalkot, Bijapur, and Gadag districts respectively. About literacy rate the proportion of illiterates was found to be highest in Bagalkot district (34.66 percent) when compared to Gadag (26.66) and Bijapur (25.33) district. Further, the study also reveals that the literacy rate in the districts such as Bijapur (72.23%) and Gadag (73.34) was found higher than the Bagalkot district literacy rate (65.34%). However, these three districts literacy rate is on par with Karnataka state literacy rate 66.60%. Therefore, there may not be any problem for the extension workers to educate the farmers regarding recent developments in agriculture and other enterprises to increase their level of income and productivity in farms. The findings on the source of irrigation convey that the major source of irrigation Bagalkot district was through wells (33.77%) followed by bore well (30.06%). Similarly, in Bijapur district the major source of irrigation was through other sources (40.12%) followed by bore well (34.14%), canals (20.74%), wells (4.67%) and tank (0.32%).

Keywords: organic farming systems, socio-economic, landholding patterns

1. INTRODUCTION

In recent years, the use of technology has boosted higher agriculture production especially high yielding and disease resistance varieties. These technologies have huge input usage besides irrigation, especially fertilizers and pesticides which we call them synthetic agrochemicals which were widely used inputs during the past Green revolution. However, this increase in production has slowed down and in some cases there are indications of a decline in productivity. The impact of the Green revolution has unrevealed the importance of the high use of pesticides and other chemical use in the production process which affects not only human beings but also our agriculture environment and natural resources (Subba Rao, 1999). The impact on cost associated with Health and Environmental problems due to excessive use of inputs have given space for policymakers and scientists. On the other hand, land fragmentation, decline in the natural

resource base, high cost for farm inputs recovery, and other health hazards have made unfavorable situations of livelihood to many farm families (Ninan and Chandrashekar, 1993). While incomes in urban areas have risen, farm incomes in real terms have declined in many parts of India during the past decade. Since the 1990s, a growing number of farmers have adopted organic agriculture to improve the economic viability of farming and combat negative social and environmental side effects of conventional farming (Parrot and Marsden, 2002). The Organic Farmers' groups and NGOs have formed an 'organic grassroots movement' that supports organic farmers, establishes organic marketing channels and tries to influence policies. However, proper understanding of potential and constraints of organic farming is necessary as a basis for decision making support strategies for farmers and further research.

In organic farming, the local resources are managed well with the use of the recycling system. The term ORGANIC explains the association of farm with soil health. The resource availability especially for organic resources is limited in nature. However, due to changes in climate conditions, input resources of organic nature have confirmed as most commercial and eco-friendly when compared to agrochemicals (Huang et al., 1993).

The principal distinctiveness of organic farming comprises of protecting the natural resources in its natural ways such as increasing the fertility of soils by maintaining organic matter levels by humus concentrations in the soils and also it helps in increasing the soil microbial and biological activity which helps in fixing nitrogen especially in legumes this action leads to efficient recycling of organic matters present in the soils such as crop residues, weed, animal husbandry and livestock wastes, and management of pest and disease control which solely depends on natural control of disease management such as natural predators, crop rotations, crop diversification with help of on farm-produced organic manuring (Yadav et al., 2013). Organic agriculture has been defined in various ways. All these definitions, however, primarily focus on ecological principles as the basis for crop production and animal husbandry. To promote organic agriculture and to ensure fair practices in international

trade of organic food, the Codex Alimentarius Commission, a joint body of FAO/WHO framed certain guidelines for the production, processing, labeling, and marketing of organically produced foods intending to facilitate trade and prevent misleading claims.

In India, Organic farming dates back as one of the oldest science and with this practice some animals were worshiped such as cow, it was worshipped (and is still done so) as a God. In traditional form, the Indian agriculture exclusively relay on Javik Krishi, which uses extensively the crop residues, animal waste, and other on-farm and off-farm resources which are more beneficial for even soil microbes environments. This kind of microenvironment helps the plant growth and overall development. Many studies convey that organic farming systems are more viable than the conventional farming system, Ramesh et al., (2010) study indicates organic farming practice was found to be always profitable in the long run though initially crop productivity is reduced by 9 percent on the other end net profits are increased by 22 percent more when compared to conventional farming system. Apart from these advantages, the organic produce has a value of 40 billion dollar annually, its self indicates the awareness among change in global food consumption patterns and awareness about plant health in specific and environmental issues in general (Hans and Rao, 2018).

Organic farming according to Henning et al., (1991) is the science of farming, consists of values that reflect an attentiveness of social and ecological realities and the ability of the individuals to take effectual actions. To put into practice, organic farming is structured to function with natural resources and also to conserve resources and encourage soil health through diversity, to minimize environmental and other waste impacts by preserving farm productivity. Codex Alimentarius Commission conveys organic agriculture as a completed food production system that helps in maintaining the good agro-ecological health and also soil biological activities (FAO, 1999).

Today organic farming systems research with a farmer's perspective occupies a pride of place in India's agricultural research agenda. Organic Farming systems concept, after tracing the evolution of general systems

theory as a system referring to crop combination or enterprise mix in which the products and/or the by-products at one enterprise serve as inputs for the production of other enterprises (Maji, 1991). The whole farming rather than the individual crops/enterprises need to be considered in the decision making under the farming systems approach.

2. METHODOLOGY

The present study aimed to analyze the socio-economic characters, land use patterns, and sources of irrigation of sample respondents of three districts such as Bagalkot, Bijapur, and Gadag in Karnataka. In these northern parts of Karnataka state, the state government has implemented The National Project on Organic Farming (NPOF) and National Horticulture Mission (NHM) scheme of Department of Agriculture and Cooperation which are significantly contributed to organic agriculture growth in Karnataka state. Besides, these three district farmers produce is better quality, the stakeholders have registered some internationally acclaimed certification process for export, import, and domestic markets. Further, the study used both primary and secondary data to draw meaningful decisions. For data analysis technique of tabular analysis was used by computing averages and percentages to compute the different socio-economic characters such as Age, Education, family size, occupation pattern, and others of sample farmers. The percentages and averages were computed to obtain meaningful results.

3. RESULTS AND DISCUSSION

3.1. Socio-Economic Characteristics of Sample Farmers

The information on the socio-economic characteristics of the sample respondents is presented in Table 1. The average age of the sample

respondents was 43.14 years, 42.13 years and 41.43 years in Bagalkot, Bijapur and Gadag districts, respectively. Literate sample respondents possessing education ranging from primary to college level. In Bagalkot district, 28.02 percent, 18.66 percent, 13.33 percent, and 5.33 percent of the respondents had an education level up to primary school, secondary school, high school, and college-level respectively. In Bijapur district, 32.01 percent, 24 percent, 16 percent, and 2.66 percent of the respondents had an education level up to primary school, secondary school, high school, and college education level respectively. In Gadag district, 24 percent, 29.33 percent, 12 percent, and 8 percent had an education level up to primary school, secondary school, high school, and college-level education respectively.

The occupational pattern of the sample respondents revealed the proportion of sample respondents who were involved mainly on agriculture and allied activities constituted 96 percent, 92 percent, 97 percent each in Bagalkot, Bijapur and Gadag districts respectively. The pattern of landholding was concerned, about 73.25 percent, 75.21 percent, and 78.31 percent of the cultivable land were under rainfed agriculture and 26.75 percent, 24.79 percent, and 21.69 percent of cultivable land were irrigated in Bagalkot, Bijapur and Gadag district respectively.

The socio-economic characteristics of the respondents include literacy, family size, occupational pattern, and landholding pattern were depicted in Table 1. Concerning the age of the sample farmers it was observed that most of the sample farmers are of the middle age group. Because of their age obviously, they were curious about new things and could take innovative decisions to adopt new technologies to enhance their farm income. The average family size of sample farmers in the study are revealed the family size was found to be almost similar in all the districts constituting 6.15,6.06 and 5.38 people in Bagalkot, Bijapur and Gadag districts, respectively indicating the dominance of nuclear family with one or two children.

Table 1. Socio-economic characteristics of the sample respondents

Sl. No.	Particulars	Units	Districts		
			Bagalkot	Bijapur	Gadag
1	Average age	Years	43.14	42.13	41.43
2	Family size	Nos.			
a.	Adult male		2.46 (40.01)	2.23 (36.79)	2.41 (44.79)
b.	Adult female		1.91 (31.05)	1.63 (26.89)	1.76 (32.72)
c.	Children		1.78 (28.94)	2.20 (36.32)	1.21 (22.49)
	Average family size		6.15	6.06	5.38
3	Education level	Nos.			
a.	Illiterate		26 (34.66)	19 (25.33)	20 (26.66)
b.	Primary		21 (28.02)	24 (32.01)	18 (24.01)
c.	Secondary		14 (18.66)	18 (24.00)	22 (29.33)
d.	High school		10 (13.33)	12 (16.00)	9 (12.00)
e.	College		4 (5.33)	2 (2.66)	6 (8.00)
	Subtotal		75	75	75
4	Occupational pattern	Nos.			
a.	Agriculture + Allied activities		72 (96.00)	69 (92.00)	73 (97.33)
b.	Agriculture + Allied activities + Business		3 (4.00)	6 (8.00)	2 (2.67)
	Subtotal		75	75	75
5	Landholding	Ha			
a.	Rainfed		1.67 (73.25)	1.76 (75.21)	1.48 (78.31)
b.	Irrigated		0.61 (26.75)	0.58 (24.79)	0.41 (21.69)
	Average landholding		2.28	2.34	1.89

Source: Primary Data.

Note: Figures in parentheses indicate percentage to respective total.

(N = 225, Each district n = 75 samples).

About the educational level of the sample respondents, it was noticed that majority of the farmers were literate in all the study districts, the literacy level of sample respondents ranged from primary to college.

Further, the farmer's receptive capacity may ease the process and adoption of technology. The occupational pattern of sample farmers revealed the proportion of sample respondents who were involved in agriculture was more than 90 percent in all districts and individually it accounted to 96 percent, 92 percent, and 97.33 percent in Bagalkot, Bijapur and Gadag district respectively.

The study conveys, a majority of farm families depend on agriculture and allied activities for their livelihood and employment. The pattern of landholding of sample respondents revealed rainfed area accounts about more than 70 percent in all three districts and the proportion of irrigated land was 21.69 percent, 24.78 percent, and 22.48 percent in Bagalkot, Bijapur and Gadag district respectively. This implied a typical dry agro-climatic feature of these districts. Due to less potentiality of irrigation projects, still a major portion of cultivable areas depend on rainfed agriculture.

3.2. Landholding Patter under Existing Organic Farming Systems in the Study Area

The landholding pattern under existing organic farming systems in the study area was worked out and results are presented in Table 2. It is interesting to note that almost all sample farmers cultivating owned land and none of them were taken land on lease basis for cultivation. Rainfed agriculture was predominant in most of the farming systems in the study area as a proportion of rainfed area in total holding was more than 95 percent. The average operational holding size varied between 1.39 to 1.79 ha in the major farming systems identified in Bijapur district, whereas in Bagalkot it was 1.56 to 1.87 ha, and in Gadag it was 1.35 to 1.96 ha.

The landholding pattern under existing organic farming systems in the study area was worked out and results are presented in Table 2. In the Bijapur district, the majority of the sample farmers were having dryland in FS-III (98.56%) while, FS-II (98.72%) in the Bagalkot district and FS-I in Gadag (98.52%). On the contrary irrigated lands were found more in FS-I

(4.43%) in Bijapur district followed by FS-III in Bagalkot (3.66%) and Gadag (1.94%). The total owned land was found maximum in FS-II (1.79 ha) followed by FS-I (1.87 ha) in Bagalkot and FS-III (1.96 ha) in Gadag.

3.3. Sources of Irrigation in the Study Area

The net irrigated area of Karnataka state was found to be 3237554 ha. The major source of irrigation Karnataka was through Borewell (35.21%) followed by canals (32.78%), other sources (13.10%), wells (12.55%), and tank (6.36%). On the other hand, the net irrigated area was found to be highest in Bagalkot (261933 ha) followed by Bijapur (251863 ha) and Gadag (67576 ha). The major source of irrigation Bagalkot district was through wells (33.77%) followed by bore well (30.06%). Similarly, in Bijapur district the major source of irrigation was through other sources (40.12%) followed by bore well (34.14%), canals (20.74%), wells (4.67%) and tank (0.32%). On the other hand, bore well was the major source of irrigation in Gadag district followed by canals (28.10%0, other sources (24.47%), wells (1.31%) and tank (1.22%).

3.4. Area under Major Crops in the Study Area

The area under major crops in the study area is depicted in Table 4. In the cropping pattern, cereals group, sorghum was the main crop grown in Bagalkot (29.48%) followed by Bijapur (27.52%) and Gadag (16.84%). However, in the Karnataka state, paddy is found to be the major crop (13.31%) followed by sorghum (12.15%) and other crops. The area under total cereals and minor millets in Karnataka state was 5372146 ha while, in which the share of crops in gross cropped area in Bagalkot was 53.78 percent followed by Bijapur (44.96%) and Gadag (32.61%). Among pulses, Bengal gram was found to be the major crop grown in Bagalkot (12.75%) followed by Bijapur (15.36%), Gadag (10.70%), and Karnataka (6.39%).

Table 2. Landholding pattern under existing organic farming systems in the study area (Area in ha.)

Sl. No.	Particulars	Bijapur			Bagalkot			Gadag		
I	Cultivated Land	FS-I	FS-II	FS-III	FS-I	FS-II	FS-III	FS-I	FS-II	FS-III
	Rainfed	1.51 (95.57)	1.778 (97.69)	1.37 (98.56)	1.81 (96.79)	1.54 (98.72)	1.58 (96.34)	1.33 (98.52)	1.442 (98.10)	1.922 (98.06)
	Irrigated	0.03 (4.43)	0.042 (2.31)	0.02 (1.44)	0.06 (3.21)	0.02 (1.28)	0.01 (3.66)	0.02 (1.48)	0.028 (1.9)	0.038 (1.94)
II	Total owned land	1.54 (100)	1.79 (100)	1.39 (100)	1.87 (100)	1.56 (100)	1.59 (100)	1.35 (100)	1.47 (100)	1.96 (100)
III	Leased inland	-	-	-	-	-	-	-	-	-
IV	Total operational holding	1.54	1.79	1.39	1.87	1.56	1.59	1.35	1.47	1.96

Figures in the parentheses indicate the percentage of total owned land.

*In Bagalkot District	*In Bijapur District	*In Gadag District
FS-I Green gram + Wheat + Ground nut + Dairy	FS-I Green gram + Sorghum+Dairy	FS-I Sorghum + Green gram + Dairy
FS-II Sesamum + Sorghum + Dairy	FS-II Maize + Chickpea + Lime + Goat rearing	FS-II Chilli + Onion + Cotton + Mango
FS-III Maize + Dairy	FS-III Groundnut + Wheat + Dairy	FS-III Maize + Ground nut + Dairy

Source: Primary Data.

Table 3. Sources of irrigation in the study area

Sl. No.	Sources of irrigation	Districts			Karnataka State
		Bagalkot	Bijapur	Gadag	
1.	Canals	69978 (26.72)	52242 (20.74)	18987 (28.10)	1061338 (32.78)
2.	Tank	2020 (0.77)	811 (0.32)	823 (1.22)	206047 (6.36)
3.	Wells	88447 (33.77)	11764 (4.67)	887 (1.31)	406243 (12.55)
4.	Borewell	78734 (30.06)	85990 (34.14)	30341 (44.90)	1139885 (35.21)
5.	Others sources	22754 (8.69)	101056 (40.12)	16538 (24.47)	424041 (13.10)
6.	Net irrigated area	261933 (100.00)	251863 (100.00)	67576 (100.00)	3237554 (100.00)

Source: District at a glance (2010-11) of Bagalkot, Bijapur and Gadag districts.
Karnataka state at a glance (2010-11).

The area under pulses in Bagalkot district was 18.24 percent followed by Bijapur (22.39%), Gadag (23.68%), and Karnataka (20.02%). In the oilseed crops, sunflower was the major crop in Bijapur (18.17%) followed by Bagalkot (4.32%) while, groundnut (11.91%) in Gadag. And groundnut in Karnataka (7.48%). However, the area under oilseeds in Bagalkot was 10.58 percent followed by Bijapur (25.35%), Gadag (25.15%) and Karnataka (20.02%). The sugarcane crop was found to be a major crop grown in Bagalkot (11.91%) followed by Bijapur (2.50%) while, cotton in Gadag (10.01%) and Karnataka (3.60%). The area under commercial crop in Bagalkot was 12.50 percent followed by Bijapur (3.20%), Gadag (10.09%) and Karnataka (6.79%). The area under horticultural crops was 4.91 percent in Bagalkot followed by Bijapur (4.09%), Gadag (8.47%), and Karnataka (14.99%). Among horticultural crops, Vegetables are the major crops grown in Bagalkot (3.61%) followed by Bijapur (2.13%), Gadag (7.93%) and Karnataka (9.00%). The total cropped area in the Bagalkot district was 475044 ha followed by Bijapur (77378 ha), Gadag (350039 ha), and Karnataka (11371394 ha).

Table 4. Area under major crops in the study area

Sl. No.	Crops	Districts (in hectares)			State
		Bagalkot	Bijapur	Gadag	
I	Cereals				
1.	Paddy	87 (0.02)	12 (0.002)	1905 (0.54)	1513987
2.	Sorghum	140022 (29.48)	226724 (22.84)	70395 (20.11)	1381882
3.	Bajra	22009 (4.63)	33180 (4.29)	1621(0.46)	265608
4.	Wheat	25668 (5.40)	65369 (8.45)	33917 (6.83)	268600
5.	Maize	67666 (14.24)	45111(5.83)	28283 (7.22)	1068296
6.	Other cereals and minor millets	13 (0.003)	8 (0.001)	196 (0.063)	32649
7.	Total cereals and minor millets	255465 (53.78)	370404 (41.41)	136327 (35.23)	5372146
II	Pulses				
1.	Bengal gram	60586 (12.75)	126551 (16.35)	44735 (12.78)	726189
2.	Red gram	1056 (0.22)	48686 (6.29)	1365 (0.39)	596622
3.	Other pulses	24993 (5.26)	9229 (1.19)	52879 (6.54)	764320
	Total	86635 (18.24)	187466 (23.84)	98979 (19.71)	2087131
III	Oilseeds				
1.	Groundnut	18787 (3.95)	49465 (6.39)	49785 (11.37)	850276
2.	Sunflower	20517 (4.32)	149721 (19.35)	48710 (13.92)	794142
3.	Others	10949 (2.30)	9670 (1.25)	6651 (1.90)	631629
	Total	50253 (10.58)	208856 (26.99)	95146 (27.18)	2276047
IV	Commercial crops				
1.	Sugarcane	56598 (11.91)	20604 (2.66)	178 (0.05)	281100
2.	Cotton	2466 (0.52)	5553 (0.72)	41834 (7.67)	409024
3.	Mulberry cultivation	298 (0.06)	235 (0.03)	164 (0.05)	82098
	Total	59362 (12.50)	26392 (3.41)	27176 (7.76)	772222
V	Area Under Horticultural crops				
1.	Fruits	6172 (1.30)	16117 (2.08)	2264 (0.65)	681988.8
2.	Vegetables	17157 (3.61)	17547 (2.27)	33147 (9.47)	1022983
	Total	23329 (4.91)	33664 (4.35)	45411 (10.12)	1704972
	Total	475044 (100)	773782 (100)	350039 (100)	

Source: District at a glance (2010-11) of Bagalkot, Bijapur and Gadag districts.
Karnataka state at a glance (2010-11).
Figures in the parentheses indicate the percentage of total area.

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Chapter 3

AN INTEGRATED APPROACH FOR GENDER IN FARMING SYSTEMS: A WAY FORWARD FOR TRANSFORMATION AND EQUITY

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ABSTRACT

Conceptual lock has resulted in the failure of the agricultural extension and advisory services to properly serve women in farming systems. Women's needs as farmers are to be included in the development agenda in order to mainstreaming gender in farming systems, since women contribute a large percentage to total family income. Focusing on access is not enough ensuring women as well as men can implement what they learn requires a conceptual model in order to achieve gender equality. Integration of gender indicators are essential to make farming systems analysis more gender sensitive. Gender based

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farming systems analysis could be used to simulate the effects of a change in agricultural practices on gender relations, either with the aim to do no harm or with the objective to achieve more gender equality. Specific needs of the farmers can be targeted and agricultural scientists, technologists and extensionists can be benefited from the knowledge of female farmers and the designed interventions have a higher chance to be implemented effectively. Government policies and programs should be revised to address women's practical and strategic needs for gender transformative change. One of the main tasks of a gender-responsive/transformative research and extension farming systems approaches is to capture, record, replicate, and upscale such methodologies to effect broader social change.

Keywords: gender, farming systems, empowerment, equity, transformation

1. INTRODUCTION

Women account for 43% of the agricultural labor force in developing countries However, their access to productive resources (such as land and livestock), inputs (fertilizers and improved seeds), and services (credit, extension) for agriculture reflects a "gender gap" that most often is rooted in social norms specific to a given geography and culture (FAO 2011). The nature of the farming systems in which women practice agriculture may be quite important for determining the extent of the disparities observed through this gender gap. Gender sensitivity in agricultural research and development is considered to be crucial for effectively contributing to gender equity, but also for improving the effectiveness of agricultural interventions in terms of poverty alleviation and improvement of household nutrition. Yet farming systems research till not incorporated the analysis of gender relations even when working in the context of smallholder households. As more than 30 years of research have repeatedly revealed that women hold an important role in smallholder agricultural production.

1.1. Gender Equality

Gender equality is has traditionally studied in terms of indicators such as education, health, labour force and market participation rate, political empowerment etc. The UNESCO defines Gender equality as means that women and men have equal conditions for realizing their full human rights and for contributing to and benefiting from economic, social, cultural and political development. Gender equality is therefore the equal valuing by the society of the similarities and the differences of men and women and the roles they play. It is based on women and men being full partners in their home, their community and their society (2003).

According to UNDP 2007, Gender equality means women and men have equal opportunities to realize their individual potential, contribute to their country's economic and social development, and benefit from their participation in society. It refers to that stage of human social development at which the rights, responsibilities and opportunities of individuals will not be determined by the fact of being born male or female. In most societies, however, distinct gender roles and responsibilities restrict the opportunities and resources available to women and men, frequently in ways that contradict women's basic human rights and threaten overall human development. At the 2000 UN Millennium Summit, over 150 countries committed themselves to eight "millennium goals". One of these goals is the promotion of gender equality and the empowerment of women. There are several gender-related assessments based on different datasets that provide benchmarks at the country level. The aim is firstly to identify existing strengths and weaknesses as a useful guide for policy to reinforce women's empowerment and gender equity. Secondly with these indices the intention is to learn from the experiences of those countries that have had greater success in promoting the equality of women and men (Jagar and Rohwer 2009).

There are three common gender-related indices, which are discussed below in detail.

1. Gender inequality Index (GII) The GII is an inequality index. It measures gender inequalities in three important aspects of human development—reproductive health, measured by maternal mortality ratio and adolescent birth rates; empowerment, measured by proportion of parliamentary seats occupied by females and proportion of adult females and males aged 25 years and older with at least some secondary education; and economic status, expressed as labour market participation and measured by labour force participation rate of female and male populations aged 15 years and older. The GII is built on the same framework as the HDI—to better expose differences in the distribution of achievements between women and men. It measures the human development costs of gender inequality. Thus the higher the GII value the more disparities between females and males and the more loss to human development. The gender inequality index for India has been reported to be 0.524 and it ranked 127 out of 160 countries in the year 2017 (UNDP, Human Development report, 2017).
2. The Gender Development Index (GDI) measures gender gaps in human development achievements by accounting for disparities between women and men in three basic dimensions of human development—health, knowledge and living standards using the same component indicators as in the HDI. The GDI is the ratio of the HDIs calculated separately for females and males using the same methodology as in the HDI. It is a direct measure of gender gap showing the female HDI as a percentage of the male HDI. The Gender Development index (GDI) for the year 2017 was 0.841, whereas the value for human development index in case of males was 0.683 whereas it was 0.575 in case of females, India ranked 114 out of a total of 164 countries (UNDP Human Development reports, 2017).

Global Gender Gap Index (GGGI) was developed by the World Economic Forum is a measure of the gap between women's and men's

achievements in 3four broad outcomes: health, education, economic participation, and political empowerment (WEF, 2014). The GGGI (and each of its sub- indices) range from 0 (inequality) to 1 (equality). In, 2017, 18 India's overall score was 0.67 and it ranked 108 out of a total of 149 countries (World Economic Forum 2017, 2018). The ratio of estimated female to male earned income for India was reported to be 0.31 and India ranked 157 out of a total of 168 countries (Human Development report, 2007-08).

Application of these indices in farming systems: Amongst the defined indices, some can be applied in integrated farming system

1. Gender inequality index: It can be used for measuring gender inequalities in occupational health measured by ratio of work hardships/drudgery perceived by men and women, empowerment measured by proportion of females involved in agricultural decision making, ownership, access to and decision making over productive resources *viz.* land, livestock, agricultural equipment, credit etc., control over income and expenditure, leadership in economic and social groups over males and economic status measured by labour force participation rate of female and male populations.
2. Gender development index: GDI can be applied in farming systems by measuring the gender gaps by accounting the disparities between men and women in occupational health, farming systems knowledge and wages earned.

1.2. Role of Gender in Farming Systems

Farming systems to a large extent depend on complex inter-relationships between men's and women's labour. At the centre of these inter-relationships, however, lies an asymmetry of male and female interests, duties, obligations and contributions within the farm-household. Farming systems cannot be understood without taking into account the

evolving and complex farm-family roles (FAO, 1995). When applied to agriculture, systems analysis focuses on boosting productivity and production by studying the socio-economic and agro-ecological context, as well as reviewing farming systems. Gender analysis, on the other hand, examines the roles, activities, responsibilities, opportunities and constraints of each member of the community under review, and attempts to achieve greater equality between women and men within their spheres of interaction. Although the research areas of gender and farming systems analysis intersect at various points, each has its own scope. While gender analysis takes into consideration economic production, reproduction and community participation, farming systems analysis tends to focus on the technical and socio-economic aspects of agricultural production. A conceptual framework, designed to combine both approaches, would therefore offer a better opportunity for grasping the complex and heterogeneous reality of peasant economies.

Five main gender patterns of farm management have been identified: separate enterprises, separate tasks, shared tasks, separate fields, and women-owned or women-managed farms. While men, women and children work to the same degree during the peak or harvest period. Women's work is predominant in the transplanting, weeding, harvesting, threshing, grain cleaning and strorage, load carrying, livestock care and management. Women's are continuously engaged in off season. In addition, men's labour input is most critical for a more narrow range of farming activities (especially land preparation, sowing, pesticide/weedicide application and marketing), or else where the mechanization involves. In contrast, women's labour input is constant throughout the year, encompassing a wide range of labour- intensive, often tedious, tasks. Women's labour is also characterized by high fragmentation in terms of time. Women have a very little or no ownership rights and men are reluctant to share control with them. They are not involved in decision making process as they have less access to information about technology by virtue of their inferior educational status and relative isolation from public life.

Development interventions have often had adverse consequences on rural women's socio-economic status and productive/reproductive roles largely because the linkages between farming systems, labour profiles, and population over time have not been systematically taken into account. In India, the percentage share of females as cultivators is decreased from 32.93 per cent to 24.0 per cent and as agricultural labourers the percentage share was increased from 38.87 to 41.1 per cent (Census of India 2001, 2011). New technologies whose introduction displaces more women than men farmers, and whose use by men only widens the productivity gap between women and men. Some production technologies increase the labour burden on women farmers without increasing their share of or control over farm revenue. Agricultural extension services, credit, inputs, technical assistance, etc. which tend to be targeted to men only, thereby widening the male/female productivity gap, marginalizing women even further.

1.3. Relevance of Gender in Farming Systems Research

Women provide crucial support in farming systems however, they remained confined as workers. Farm tools available are mainly used by male farmers, and rural women are left to use traditional tools and procedures resulting in low efficiency, drudgery, occupational health risks, and low income (Majumdar and Shah 2017). Also, breeding new varieties should take into account gender aspects. Women and men often have different preferences for maturation periods, yields, tastes and colours, relating to their different resources and needs but also to their different knowledge about processing and nutritional requirements. Unequal access to credit and formal markets restricted the adoption of high-yielding varieties to only men. A study that looked at adoption rates of new agricultural practices in Ethiopia found that all of the proposed innovations had raised women´s labour burden unequally to that of men (Teklewold et al. 2013). Considering gender beforehand is likely to have produced better adoption rates. Along with this reasoning, also the FAO recommends

production interventions to be gender sensitive in order to reach higher effectiveness (FAO 2011).

1.3.1. Relevance as Farmers

Women play substantial roles in farming systems and are vigorously involved in farm and livestock management, but their contribution in farming systems is generally overlooked and undervalued which has reflected them as invisible workers. Many studies found that the work women did in agriculture was not recognized and coined the phrase of women being "invisible farmers" (Sachs 1983). Despite increasing evidence of women´s large share in the agricultural labour force, women´s contribution to farming often still remains invisible, women's labour contribution not being valued. The study conducted by Verma et al. 2017 has shown that on an average a farm woman contributes nearly 5232 hr annually in the pre-dominant farming systems of Western plain zone of Uttar Pradesh which has an estimated economic value worth Rs 10,104,6/- but she is having very limited access to economic resources, *viz.* agricultural land, animals, income from farm etc.

1.3.2. Relevance as Decision Makers

International Food Policy Research Institute (IFPRI, also a member of the CGIAR), looked at the division of labour between women and men in various farming systems in Sub-Saharan Africa, who does which tasks - whether it be planting, weeding, harvesting, processing, marketing or food preparation -differs dependent on local context and culture. How the rights of women and men to access, manage and own key resources are organized vary accordingly (Meinzen-Dick et al. 2012). They proposes the introduction of a household typology that differentiates between: male managed; female managed, jointly managed and separately managed farming systems. Mapping of the dominant household structure of a region is hoped to inform researchers and development workers about the gendered aspects of farming and allow them to target appropriate decision makers.

Table 1. Gender problematization and prescription in farming systems

Country/Agro ecological region/District	Gender Problematization	Prescription	References
East African Great Lakes Region	Gender differentiated norms, roles and practices in banana-based farming systems. Less access to information due to low participation in Farmer learning groups.	Enhance the potential of women to implement the role and practices related specific improved practices in banana based farming systems.	(Iradukunda et al. 2019)
South-central Cameroon, Central Africa	Position of women farmers in both indigenous social organisation and national economies is different from men's; they work under different constraints in their farming.	Sexual division of labour is an important aspect of farming, men's and women's differential access to resources might be expected to have an independent effect on cropping patterns.	(Guyer 1980)
Western plain zone of Uttar Pradesh, India	Carrying of dung through basket as headload exhibiting highest drudgery score (62.58) was a feminine farm operation performed by (88%) women in FS_3 : Crop + Horticulture (vegetables) + Dairy followed by (83%) women in FS_4: Horticulture + Crop + Dairy.	The innovation in farm technologies as well as technology transfers should be gender specific in terms of load carrying activity.	(Verma et al. 2018)
Oromia, Ethiopia, South-Eastern Madagascar.	Horticultural interventions tend to increase the workload of female farmers and run the risk of negatively affecting the well-being of women as well as the nutritional status of households. Other dividers are male-dominated extension services, the executive role of women in horticulture and low access to inputs.	Mitigation strategies that should be developed can include territorial, technological and training solutions that aim to change behavior.	(Nischalke et al. 1980)

Table 1. (Continued)

Country/Agro ecological region/District	Gender Problematization	Prescription	References
Malwai	Women's agri-cultural productivity on women-managed plots remains lower than that of men on men-managed plots. This is attributed to women's continuing weaker access, in comparison to men in the same household, to stocks of capitals necessary for production: social, financial, human, natural, political, cultural, and physical etc.	Household methodologies (HHM) including gender action learning systems intervene directly in intra-household gender relations to strengthen overall smallholder agency and efficacy as economic agents and development actors. Significant shift towards sharing of on-farm tasks and household tasks, and joint realization of the benefits from agricultural produce in Gender Action Learning Systems households in maize based farming systems. Respondents in GALS households, particularly de facto women-headed households, report an increase in social standing and participation in community life	Farnworth and Colverson, 2015; World Bank, 2012; Peterman et al., 2014; FAO, 2010; Flora and Flora, 2008; Udry, 1996). (Farnworth et al. 2018).
Tribal Development Block, Udaipur, Rajasthan.	Women are overburdened with all type of farm activities except ploughing and leveling including rearing small herd of livestock in maize production system of tribal development block, Kherwara, Distrit Udaipur. Highest being involved in removing of stalk, weeding, harvesting and post harvesting activities due to male migration for alternate employment.	Gender sensitive off and on farm income generating activities should to introduced to reduce the the female overburdened and male migration.	(Jain et al. 2017).

1.4. Gender Analysis in Farming Systems: An Integrated Assessment Approach

Integrated Farming System is a combination of different but dependent set of enterprises are used so that the by-product from component can be utilized as input for the other part of the system, so the efficient resource utilization/allocation could be achieved viz. family labour, soil health and fertility, income and employment generation, greater empowerment of family members etc. Integrated Farming System is an important area to ensure sustainability and food security for the enhancement of both tangible and intangible benefits of the system and equitable distribution of benefits across both the gender. Till now researches predominantly focus on generating suitability or environmental sustainability or economic viability however gender issues with respect to integrated farming systems may provide very important insights about the applicability and suitability of IFS in rural Indian society (Paul et al., 2016).

As the roles of men and women in societies are often different, their needs vary accordingly. The improvement in small farmer livelihoods calls for sustainable farming systems that include the farm and non-farm economy and addresses gender perspectives for effective investment policies and development strategies. Agricultural programs and services are more effective when they are targeted within particular farming systems. There are also differentiated gender roles in farming systems with men and women playing vital, but complementary roles. Yet the limited access to, and control over resources by women compared to men, limits their productivities and therefore productivities of the whole system (Drafor et al., 2005). Moser (1993) makes the conceptual distinction between practical and strategic gender needs. She defines these two types of needs as follows:

Practical gender needs (PGNs) are the needs women identify in their socially accepted roles in society. PGNs do not challenge, although they arise out of, gender divisions of labour and women's subordinate position in society. PGNs are a response to immediate perceived necessity, identified within a specific context. They are practical in nature and often

inadequacies in living conditions such as water provision, health care and employment.

Strategic gender needs (SGNs) are the needs women identify because of their subordinate position in society. They vary according to particular contexts, related to gender divisions of labour, power and control, and may include such issues as legal rights, domestic violence, equal wages, and women's control over their bodies. Meeting SGNs assists women to achieve greater equality and change existing roles, thereby challenging women's subordinate position. The significant involvement of women in agricultural work and their extensive economic contribution has not received much recognition due to her limited access to economic resources, viz. agricultural land, animals, income from farm etc. By and large, they have remained as invisible workers. The study conducted by Verma et al. 2017 depicted that that on an average a farm woman contributes nearly 5232 hr annually in the pre-dominant farming systems as family worker which has an estimated economic value worth Rs 10,104,6/- whereas, the farm women working as hired labourers contribute 1656 hours annually receives Rs 33,007 which is 14 to 35% less than the government wage rate. Moktanand Mukhopadhey (2012) found mean annual participation hour of farm women in agricultural activities was 1366 hrs who made economic contribution up to Rs 15000. Another study conducted by Kavita and Sandeep (2014) resulted into Rs 46,412 and 57,427 as farm women's share in household income of Muzaffarnagar and Baghpat from all the economic resources. Farm models are available hoped to identify solutions for enhancing the income and food security of farm households. They combine biophysical and economic analysis of data but do not yet sufficiently consider gender aspects. An integrated assessment of gender analysis in farm models has been developed by Hemminger (2014).

a) Conceptual Framework (Figure 1)
b) Extension to DEED approach

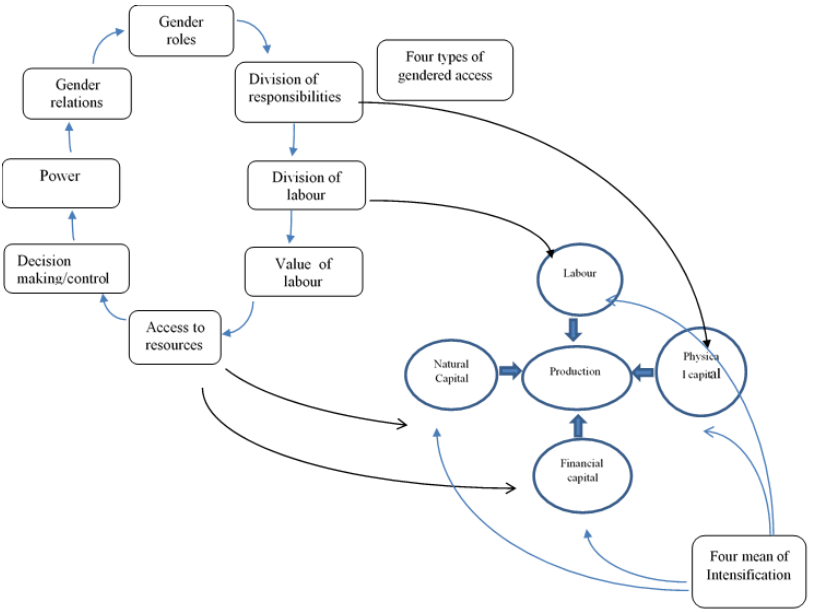

Figure 1. Conceptual framework showing four types of gendered access to productive resources necessary for agricultural intensification. Extension to the gender wheel by Parker et al. 1995.

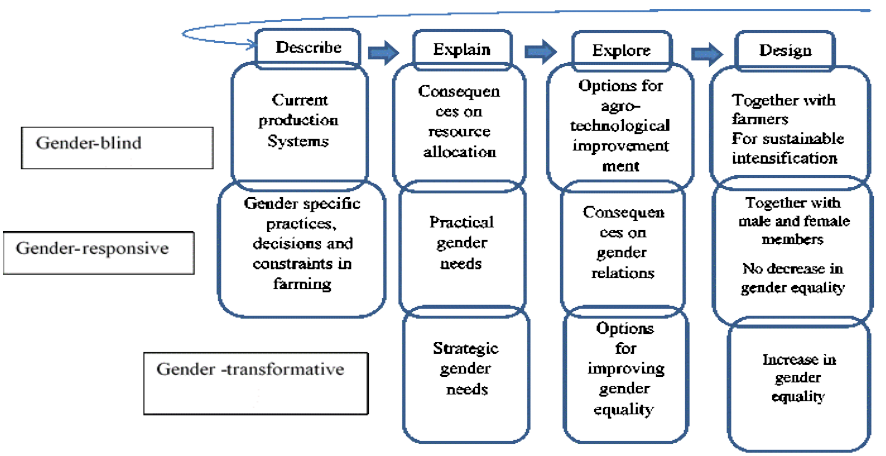

Figure 2. Gender responsive vs gender transformative extension to the DEED approach to farm scale models described by Giller et al. 2011.

The gender transformative approach considers the more tangible manifestations of gender inequality as products of interrelated and interacting social, cultural, and political institutions (e.g., norms, relations, policies). The latter need to be understood, challenged, and changed in order to achieve sustained forms of gender equality. Therefore, gender transformative research has two intentions: first, it must analyze and understand the more or less tangible gender issues associated with a certain research problem or context. Second, it aims to actively challenge and transform inequalities. In this regard, understanding the features and causes of gender inequalities is considered a precondition for stimulating change, as opposed to being an end in itself. It is important to note that transformation is conceived of as coming from within communities or households, and not as imposed from outside. Therefore, gender transformative research can only give impulses to stimulate and direct changes. The gender transformative approach promotes the mainstreaming of critical analysis and change and can be distinguished from other approaches through the Interagency Gender Working Group (IGWG) gender equality continuum adapted below (Figure 3).

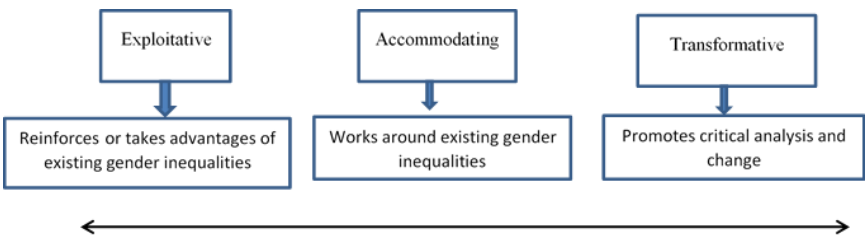

Figure 3. Gender equality continuum (IGWG).

Exploitative approaches promote gender stereotypes and thus reinforce inequalities. An example would be an intervention that extends invitations for nutrition activities to women only; researchers and extension officers emphasize women's responsibilities and supposedly "superior capacity" in this area. At the same time, training in mechanized technologies is predominantly offered to men, who are seen as having "higher technical abilities".

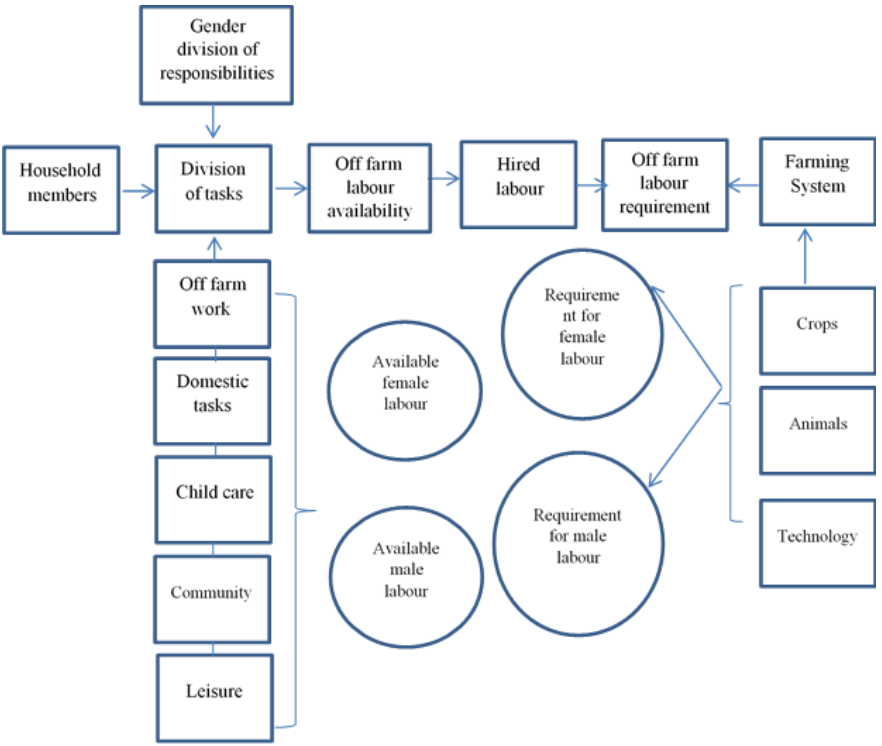

Figure 4. Inter-linkages between gender division of responsibilities and on farm labour requirement.

Accommodating approaches do not question inequitable gender norms but work around them. Taking the example of a community in which labor-intensive post-harvest activities are assigned to women, a project with an accommodating approach would make efforts to reduce women's drudgery, while at the same time not challenging the culturally constructed gender roles. Transformative approaches seek to establish equitable gender relations. Part of this is to build awareness of the fact that gender norms are not "natural" or "given" but man-made and thus transformable. An example would be an intervention that includes husbands, wives and other household members, as well as community leaders, in nutrition activities, thereby underlining the shared responsibility of different actors in this area. Training in mechanized technologies is provided to both men and women,

if possible in gender-separate groups. This allows participants to learn in a more relaxed atmosphere and to bring up their gender-specific needs.

1.5. Empowerment

Empowerment is a multi-dimensional concept and among the many approaches to define and measure it. Kabeer 1999 defined empowerment as a process by which those who have been denied the ability to make strategic life choices acquire such ability. Empowerment is then defined as the increase of a person's ability to exercise these choices. According to him this ability can be investigated from three interrelated dimensions. The first dimension relates to resources. He differentiated between material resources in the economic sense and social and human resources. This categorization can be related to the sustainable livelihood framework. Material resources referring to financial, manufactured and natural capital and social and human resources being equal to social and human capital, whereas the existence of material resources is a prerequisite to making choices in terms of available options, human and social resources can help to enhance a person's ability to exercise choices (e.g., education and acquired skills enhance options for earning an income, social networks can help to acquire necessary information or support for decision making). The degree to which a person can access resources also reflects the socio-cultural as well as the formal legal rules and norms that govern their distribution. The second dimension is agency, "the ability to define one's goals and act upon them" and is expressed in the person's influence in decision making, but also in his or her intellectual abilities, e.g., in bargaining, negotiating, defending one's view against conflicting goals and reflecting on and analyzing one's own situation. The third dimension is achievements in terms of well-being outcomes or achievements. According to Diener (1984) well-being can be divided in physical and subjective wellbeing, the former referring to a person's health status which is dependent on the fulfilment of basic needs, such as nutrition, housing etc.,

the latter to a person's perceived quality of life, which can be influenced by many factors not only the person's wealth.

However, The Women's Empowerment in Agriculture Index (WEAI) particularly focuses on the agency (or decision-making) aspect of empowerment. The WEAI was developed by the International Food Policy Research Institute (IFPRI), Oxford Policy and Human Development Initiative (OPHI), and the United States Agency for International Development (USAID), and is a direct measure of multidimensional deprivations that women and men face in the domain of agriculture. The relationship between the Women's Empowerment in Agriculture Index (WEAI) and market orientation of farm production in India was studied in the Chandrapur District of Maharashtra by Gupta et al. 2017 and classified the households into three groups—(1) landless, (2) food cropping, and (3) cash-cropping—that reflect increasing degrees of market orientation found that women are disempowered in two major domains of agriculture—resources (access and decision-making) and leadership (group membership).

Behavioral change processes must be set in motion in order for the gender transformative framework to be implemented in a real life project. A lack of independent access to productive resources, an inability to participate effectively in discussions and form meaningful goals, and an inability to implement recommendations made by researchers (whether formally trained or farmer) are intrinsic conditions of "powerlessness". Powerlessness is underpinned by cultural norms, which differ from place to place. Much work on gender has been ineffective because of attempts to respond directly to visible gender inequalities by creating the inverse situation. For instance, if women are considered to have low incomes, no land ownerships then off farm income-generation schemes are introduced. If women have a low understanding of food security and nutritional needs, then they are trained in vegetable growing, post-harvest processing, and storage and nutrition skills. Many such initiatives have not succeeded because they have not challenged the underlying reasons why women may have a low income or may be poor at managing household food security. They also have not succeeded because they position men and women as

being in conflict rather than in collaboration, and thus may act to deepen conflict rather than enhance cooperation.

Step 1: To tackle the underlying norms and power structures that creates and reproduce gender inequalities an extension and advisory facilitation system (as opposed to as service) is required. A facilitation system emphasizes not only the creation of knowledge products for dissemination to end users, but also the process of creating knowledge with those users. To create such a system an effective conceptual framework is needed to understand and map the domains in which power is exercised, negotiated, and expressed. Visualization is a useful way of drawing attention to core processes and highlighting interactions and links. Frameworks are not intended to model reality. Rather, they should be deployed as discussion documents to stimulate exchanges among stakeholders about how unequal gender relations arise and how to respond to the structural conditions that create disempowerment. Frameworks should be used to help identify and build on existing entry points for change, or create new ones.

Step 2: Operationalizing the Conceptual Framework through Empowerment Pathways Once the basic conceptual framework has been developed, it will be necessary to create robust, workable "empowerment pathways" between domains—to and from the individual, the community, and the wider world—to ensure that change cannot be "undone", and that it is truly resilient over time. Empowerment pathways can be based on the format of "impact pathways" used by many development agencies, which envisage a trajectory of inputs, activities, outputs, outcomes and impacts. Creating empowerment pathways will require the involvement and co-operation of direct and indirect stakeholders, including women's groups, men's groups working for change in gender relations, relevant government agencies, civil society networks, private sector actors, traditional leadership structures, etc. Such stakeholders will need to be brought together in different combinations to develop specific empowerment pathways for example between developing a women's sense of worth through literacy classes (agency) and supporting her effective participation in a producer cooperative (structure) (Franworth and Colversion 2015).

Table 2. Female contribution (%) in different enterprises of pre-dominant farming systems of Western plain zone of Uttar Pradesh and Hill zone of Uttarakhand

S.No	Farming Systems	Enterprises									
		Crop production		Livestock production & mgt		Fruits production		Vegetables production		Overall	
		FL (%)	HL (%)	FL (%)	HL (%)	FL (%)	HL (%)	FL (%)	HL (%)	FL (%)	HL (%)
	Western plain zone of Uttar Pradesh										
1.	FS_1: Crop+ Dairy (1C+1-2B)	35.5	12.6	52.7	13	0.0	0.0	0.0	0.0	22.05	6.4
2.	FS_2: Crop + Horticulture (Fruits)+ Dairy (2C+ 1-2 B)	17.3	23.8	33.8	56	0.0	20.16	17.2	0.62	17.07	25.14
3.	FS_3 : Crop + Horticulture (Vegetables) + Dairy (1C + 1B)	34.7	9.9	56.8	17	0.0	1.5	43.4	15.0	33.72	10.85
4.	FS_4 : Horticulture +Crop+ Dairy (1C+1B)	29	6.2	55.1	0.0	6.7	0.0	43.4	2.29	33.55	2.12
	Hill zone of Uttarakhand										
1.	FS_1: Horticulture (V/S) + Livestock (Dairy/poultry/goatry) +Crop	78.14	12.70	49.83	0.0	32.5	5.0	60	4.37	55.11	5.51
2.	FS_2 : Livestock (Dairy/poultry/goatry) + Crop + Horticulture (V/S/F)	79.03	13.15	46.75	0.0	33.06	8.12	57.99	2.49	54.20	5.94
3.	FS_3 : Crop + Livestock(Dairy/poultry/goatry)	82.03	5.18	27.08	0.0	12.5	0.0	9.81	0.87	32.85	1.51
4.	FS_4 : Horticulture (vegetables/spices) + Crop	64.30	10.37	29.75	0.0	12.5	-	39.36	5.75	36.47	5.37
5.	FS_5: Horticulture (Fruits/Vegetables) + Dairy	49.30	6.29	53.5	0.0	60.25	21.75	72.59	17.90	58.45	11.48

* V = Vegetables, S = Spices, F = Fruits, C = Cow, B = Buffalo.

2. CASE STUDIES

2.1. Gender and Farming Systems

Survey was conducted to know the women's work involvement, access and control over the resources, decision making, drudgery prone activities and livelihood opportunities of women in pre-dominant farming systems of Meerut Saharanpur and Bulandshahar from Western plain zone and Nainital district hill zone of Uttarakhand. The total sample comprises a random sample of 240 households i.e., (4 District x 3 blocks/district x 2 villages/ block x 10 households) using a stratified sampling frame. Four farming systems *viz* FS_1: Crop+ Dairy (1C+1-2B), FS_2: Crop + Horticulture (Fruits)+ Dairy (2C+ 1-2 B), FS_3 : Crop + Horticulture (Vegetables) + Dairy (1C + 1B), FS_4 : Horticulture +Crop+ Dairy (1C+1B) were found pre-dominant in western plain zone of Uttar Pradesh. In case of hillzone of Uttarakhand five farming systems *viz.* FS_1: Horticulture (V/S) + Livestock (Dairy/poultry/goatry) +Crop, FS_2: Livestock (Dairy/ poultry/goatry) + Crop + Horticulture (V/S/F), FS_3: Crop + Livestock (Dairy/poultry/goatry), FS_4: Horticulture (vegetables/spices) + Crop, FS_5: Horticulture (Fruits/Vegetables) + Dairy were found pre-dominant.

2.1.1. Female Contribution

Highest female contribution was found in FS_3: Crop + Horticulture (Vegetables) + Dairy (1C + 1B) (44.5%) including hired and family female laborers. Further, women's highest involvement in crop production activities was found in FS_1, livestock and fruit production in FS_2 and the highest involvement in vegetable production was found in FS_3 and FS_4. Further, it was observed that the involvement for hired female laborers was found much more in FS_2 as compared to the family female laborers. This was due to their better socio-economic conditions as compared to other farming systems. When hilly farming systems was studied, it was found that the highest female contribution was found in FS_5: Horticulture (Fruits/Vegetables) + Dairy (69.9%) followed by FS_1 (60.61) and FS_2

(60.14). Enterprise wise study of women's involvement showed that FS_3 was found highest in terms of women's involvement in crop production activities, FS_5 was found highest in livestock production and management, fruits and vegetable production activities.

A study conducted on contribution of female in pre-dominant farming systems of Western plain zone of Uttar Pradesh and Hill zone of Uttarakhand depicted that on an average 47.51 per cent contribution of women as family labourers and 5.96 per cent contribution of women as hired labourers was found in the pre-dominant farming systems of Hillzone of Uttarakhand whereas, 26.6 per cent contribution of women as family labourers and 11.12 per cent contribution of women as hired labourers was found in the pre-dominant farming systems of Western plain zone of Uttar Pradesh (Figure 5).

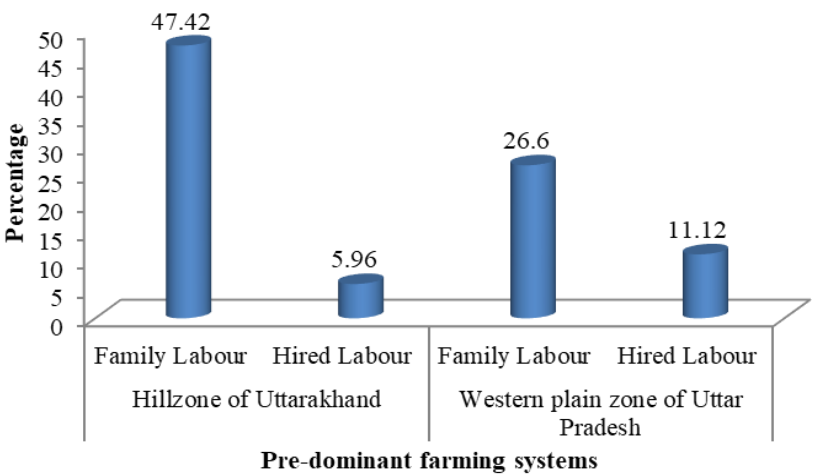

Figure 5. Female contribution (%) in pre-dominant farming systems of Western plain zone of Uttar Pradesh and Hill zone of Uttarakhand.

2.1.2. Decision Making

The decision of women in pre-dominant farming systems of hills was considered by the male counterparts but the final decision was taken mostly by men except few activities. When the matter of purchase and sale comes the women's involvement in decision making found limited up to

only consultation in 18-25 percent of farm families. When the decision making in Western plain Zone of Uttar Pradesh was concerned it was found that the decision making of women in agricultural activities was limited up to consultation with their husbands except storage and retention of produce for consumption. In terms of livestock final decision of selling and purchase of milk was found to taken by fifty per cent of women.

2.1.3. Gender Sensitivity in Farming Systems

Crop + Horticulture (vegetables) + Dairy (FS_3) may be tagged as gender sensitive farming systems due to the higher amount of feminine farm operations and drudgery prone activities in western plain zone of Uttar Pradesh. Horticulture (Fruits/Vegetables) + Dairy (FS_5) followed by FS_1: Horticulture (V/S) + Livestock (Dairy/poultry/goatry) +Crop, FS_2: Livestock (Dairy/poultry/goatry) + Crop + Horticulture (V/S/F) and FS_4: Horticulture (vegetables/spices) + Crop may be tagged as gender sensitive farming hilly farming systems due to maximum female contribution as well as maximum Load carrying drudgery Index (LCDI).

The case study implies that women's needs as farmers are to be included in the development agenda in order to mainstreaming gender in farming systems, since women contribute a large percentage to total family income. Extension systems will also have to be more innovative and flexible to account for social and cultural obstacles and for time and mobility constraints of women. The innovation in farm technologies as well as technology transfers should be gender specific. Improvement in productivity and efficiency related to hill farming systems makes it possible for women to spend their time on other income generating activities. Promotion of equal access for women to farm resources and opportunities will helpful in increasing the family income and ensuring nutritional security of the small and marginal land holders. Government policies and programs should be revised to address women's practical and strategic needs for gender transformative change.

2.2. Empowerment

Six months impact study from the project" *Integrated Farming System for improvement of nutrition and livelihood of farm women under different agro ecosystem* shows the positive effect of nutrition interventions on haemoglobin level of women farmers in both the farming systems. A significant improvement ($p \leq .05$) in haemoglobin level was noticed after consuming diversified and nutritionally enriched diet in FS_1 : Crop + Livestock (0-1 C + 1B) farming system. Similarly, in FS_2 = Livestock + Crop (0-1C + 1-2 B) farming system an improvement was again noticed, however it was statistically not found significant. In terms of chronic energy deficiency estimation mean values shows the normal BMI in both the farming systems but the higher values of standard error shows higher deviation from normal which shows the persistence of mild to moderate level of chronic energy deficiency especially amongst the women farmers of FS_2 : Livestock + Crop (0-1C + 1-2 B) farming system. Nutritional impact study shows the positive effect of nutrition interventions on BMI values amongst the women farmers in both the farming systems, however the improvement was statistically not found significant in both the farming systems. Results of above project showed that confidence level of farm women's of cluster village improved due to their exposure to latest tools and techniques related to their respective farming systems. Their existing farming system was providing them cereals, potato sugarcane and milk but there was lacking of pulses, oil crops and green vegetables in their farming system as well as in food chain. They learned how pulses and oil crops can be grown in same condition with little cultural management. They realized that these crops (pulses, oil crops and green vegetables) can also be grown for which they were dependent on market. Nutritional security of farm women's were also improved by simple interventions of vegetables either as roof top gardening or kitchen gardening along with consumption of pulses grown at own fields. Women farmers who started vermi-composting as an enterprise in their farming systems, they realized early and extra income by less care and least inputs. The commercialization of kitchen gardening, vermicomposting and inclusion of improved interventions like

trichocard application and mineral mixture resulted into a net gain in the income was Rs. 1,18,000/- approximately. Whereas another intervention of utilization of sesamum along with urdbean not only reduce the blue bull menace but also resulted into generation of an income around Rs. 28000/- hectare basis. For reduction in the expenditure on oil, improved variety of mustard viz. RH749 with improved yield 20.85 q/ha compared in comparison to other varieties yield 14.89 q/ha and oil content has been introduced for attaining round the year needs of oil for cooking. To enhance their skills regarding processing and value addition of various farm produce, they were trained by experts of Institute for processing of fruits and vegetables, Iron enrichment of jaggery by using indigenous techniques.

(a)

(b)

(c)

(d)

Figure 5. (a) Exhibition cum sale of value added processed products through SHG formulation. (b) Training of women farmer for vermicomposting. (c) Training of women farmers on processing of sugarcane into value added jaggary. (d) Demonstration and distribution of mineral mixture by women farmers for improving diet of their animals.

Feedback of farm women after project related activities was also recorded which showed improvement in their farming skills. Women Self Help group (*Devanjali Mahila Samuh*) Registration. No. 353883 has been formulated in Satheri village, Dist Mujaffarnagar for the skill enhancement of women farmers including rural youths in secondary agriculture activities as a diversified income generating avenue under Farmer First Project. Different trainings and capacity building programmes on value addition and processing of various products have been delivered to the women's group. The group has gained expertise in the development different products *viz.* blended squash, mixed jam, pickling techniques, ginger paste, value addition in sugarcane including ready to serve, nutritionally enriched jaggary production etc. Apart from this they have been trained in packaging of various products under different packaging material. The group has also gained experience on labeling, marketing and maintaining of sale records by selling the developed products through various exhibitions, farmer fairs, door to door marketing, order on phone calls etc. The group has earned around Rs 48,000/- net income by selling various value added products *viz.* blended squash, mixed jam, ginger paste, turmeric powder, coriander powder, red chilly powder, gram, pearl millet, mixed flours, rice, potato flakes, pearl millet buiscuits (fried) vermicelli, porridge, various types of pickles *viz*. mango, lemon, chilly, mixed, aonla etc. It has been concluded that off farm entrepreneurship, secondary agriculture with the right assistance can strengthen their capacities besides adding to the family income and national productivity.

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Principal Investigator	39.00 Lakh Rs were granted for the project entitled "Comparative study of role of women in pre-dominant farming systems of Western Plain Zone of U.P and Hillzone of Uttarakhand" by ICAR-IIFSR, Modipuram. The grant was awarded for characterizing the gender sensitive farming systems in different agro-ecosystems.	02/2014 to 01/2018
Principal Investigator	54.00 Lakh Rs were granted for the project entitled "Characterization of existing farming systems in Uttarakhand" by ICAR-IIFSR, Modipuram. The grant was awarded for characterization of gender sensitive, resource efficient farming systems including resource budgeting of Hill zone and Tarai and Bhabhar zone of Uttarkhand	01/01/2018 to 31/12/2020
Principal Investigator	12.75 Lakh Rs. (Upto March 2020) has been released and fund for next financial year has yet to be released for the research project entitled "ON-FARM programme in Farming Systems Perspective under Tribal Sub Plan" by AICRP-IFS-TSP-PC Unit, ICAR-IIFSR, Modipuram. The grant was awarded for improving the livelihood and nutrition of tribal farmers through farming systems research.	08/2017-continuing
Co- Principal Investigator	33.0 Lakh Rs. were granted for the project entitled "Development of Package of Machineries for Complete Mechanization of Small Land Holders under different Farming Systems Situation" by ICAR-Extra Mural Fund. The grant was awarded for developing the small farm mechanization package.	02/2016-03/2018
Co-Principal Investigator	90.0 Lakh Rs. were granted for the project entitled "Ensuring Food and Nutritional Security through Integrated Farming Systems in Western Uttar Pradesh" by ICAR- Farmer FIRST scheme.	10/2016-03/2020
Co- Principal Investigator	14.30 Lakhs Rs were granted for the Network project entitled "Integrated Farming System for improvement of nutrition and livelihood of farm women under different agro eco system" by ICAR-CIWA Bhubaneshwar	03/2015-04/2017
Co- Principal Investigator	47.00 Lakh Rs were granted for the project entitled "Characterization and Mapping of Farming Systems in India" funded by ICAR-IIFSR, Modipuram.	04/2014-03/2016
Co-Principal Investigator	85.00 Lakh Rs were granted for the project entitled "On Farm value addition for livelihood improvement of small farm households in Western Plain Zone of Uttar Pradesh" funded by ICAR-IIFSR, Modipuram.	11/2013-10/2018

Co- Principal Investigator	48.95 Lakh Rs were granted for the project entitled "Evaluation and Identification of Farm Implements under Different Farming Systems funded by ICAR-IIFSR, Modipuram.	1-10-2018 -30-10-2024

Professional Appointments:

Name of the Organization	**Address of Organization**	**Department**	**Designation**	**Duration (from mm/yy to mm/yy)**	**Brief job description/Nature of work**
ICAR-Indian Institute of Farming Systems Research	ICAR-Indian Institute for Farming Systems Research, Modipuram, Meerut, Uttar Pradesh, India, 250 110	Indian Council of Agricultural Research, New Delhi	Scientist	01/01/2013 till date	Characterization of gender sensitive farming systems. Ergonomics studies in the prevailing farming systems of Western plain zone of Uttar Pradesh. (Analysing the physiological work load through capturing the heart hate, energy expenditure, postural discomfort and work efficiencies under prevailing farming systems). Evaluation of work efficiencies by using improved tools developed by different ICAR institutes and private manufacturing units on the farm workers. Analysis of chronic energy deficiency status, food consumption pattern, dietary diversity, nutrient intake, surplus and deficient food and nutrition status under prevailing farming systems of different agro climatic regions. Developing secondary agricultural module through value addition and processing of locally available fruits and vegetables.

Diversified Tribal Integrated farming system Crop (paddy-wheat+ mustard+ lentil) + Livestock (1C/1B + poultry) + KG + Mushroom + Vermicomposting (0.405 ha) has been developed is at 100 tribal farmers field.

Honors:

1. Award of certificate and 2nd prize conferred to Dr Nisha Verma by ARCC Karnal 2014-15 for the research publication entitled "Value Addition of horticultural crops: A source of nutritional security and income generation for rural women of Odisha" published in Bhartiya Krishi Anusandhan Patrika 29 (4) 194-200 by Verma N, Shukla A K, Sarkar A.Nath A, Dutta D, Kumar P and Gangwar B (2014).
2. Best oral paper presentation award given by International Horticultural Congress at Kalimpong, Darjeeling 2014 for the paper presentation entitled "Evaluation of horticulture based IFS models for providing livelihood security to small and marginal farmers of western plain zone of Uttar Paradesh (2014) by Poonam Kashyap, Kamta Prasad, Harbir Singh, Avinash Kansal, A K Prusty and Nisha Verma.
3. Best poster paper presentation award conferred to Dr Nisha Verma for the research paper entitled *"Pashchimi Uttar Pradesh ki pramukh krishi pranaliyon mein mahilaaon se jude krishi kaarya evam unse sambandhit kathinaiyan"* by IIFSR on 26-09-2017 during Hindi Pakhwada.
4. Best poster paper presentation award conferred to S Bains, N Grewal, S Grewal, I Kaur, and N Verma by College of Home Science, Punjab Agricultural University, Ludhiana at the National Seminar on Women and Rural Development: Critical issues on May 2 and 3, 2012.

5. Award of Honour for Best MSc Thesis work in the area of Social Sciences by Punjab Agricultural University Science Club on 10th March 2009.
6. Young Scientist Award from New Age Mobilization Society, New Delhi on the occasion of National Conference on Identification, Convergence, Implementation and Extension of Science-Tech-Research for Sustainaible Development (ICIESSD-2019) during 20-21 April, 2019.
7. Women Scientist Award from Pragati International Scientific Research Foundation Meerut, India on the occasion of International Conference on Sustainable Agriulture Production for Food, Nutritional and Livelihood Security: A challenge for Asian Farmers 25-27 September 2019 at Pattaya, Thailand.

Publications from the Last 3 Years:

1. Verma Nisha, Kashyap Poonam, Arya MPS, Singh M.P., Nath Amit and Singh M.P. 2017 Economic quantification of women's work in farming system: A case study of western plain zone of Uttar Pradesh. *Indian Journal of Agricultural Sciences* 87 (3): 355-362. (NAAS rating 6.25) National Journal.
2. Dutta Debashis, Nath Amit, Mishra Dushyant, Verma Nisha and Kumar Pawan; 2016 Phytochemical studies on antioxidant activities of two types of Karonda (Carrissa carandus) during storage. *Indian Journal of Horticulture* 73 (4): 632-626. (NAAS rating 6.13) National Journal.
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Book Chapters:

1. Verma Nisha, J.P. Singh, Dushyant Mishra, Amit Nath, Poonam Kashyap, and Debashis Dutta Berberis aristata D.C (2017). *Under-utilized Fruit Crops of India.* 142-154.
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Chapter 4

INTERCROPS INVOLVING LEGUMES ENHANCE PRODUCTIVITY IN SMALLHOLDER CROP-LIVESTOCK FARMING UNDER A CHANGING CLIMATE IN EASTERN AND SOUTHERN AFRICA: A REVIEW

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ABSTRACT

The smallholder farming systems in eastern and southern Africa (ESA) depend on natural rainfall for crop and livestock production. However, climate change effects increasingly influence overall productivity in ESA smallholder farms. Prolonged dry spells have become more frequent which leads to moisture scarcity and low crop yields. Many cropping systems that are common in ESA are designed to maximize efficiency and productivity under optimum conditions. Hence, it is important to investigate potential cropping systems that are resilient to the impacts of climate change and promote conservation of resources in smallholder farms. One possible practice is intercropping cereals with different legume types. This has been traditionally used by farmers and has several benefits including reduced risk of total crop failure, more soil cover to protect the soil surface from direct sun and raindrop impact, improved resource use efficiency, reduced pests, diseases and weeds infestation and increased crop yield. Although intercropping different crop species has several benefits if properly combined in space and time, the crop mixtures practiced by farmers are not fully understood by researchers/scientists. Crops respond differently to environmental stress, and they have potential to complement each other. This review aims at providing an overview on the potential and setbacks of intercropping in maintaining crop yields in changing climate in smallholder farmers in ESA set-up.

Keywords: cropping systems, grain legumes, rainfed agriculture, sustainable agriculture

INTRODUCTION

Crop and livestock production in eastern and southern Africa (ESA) depends mostly on natural rainfall. However, due to climate change, the frequence of prolonged mid-season droughts has increased in ESA which reduces crop and livestock productivity. Temperature increase has been projected at 0.03°C per year in this region since 1975 and the maximum

temperature is expected to increase by 2.6°C between 2010 and 2050 (Girvetz et al. 2019; Cairns et al. 2013). The intensity of daily rainfall also increases. High rainfall intensity accompanied with impermeable soils reduces rainfall infiltration thus leading to high runoff and soil erosion (Girvetz et al. 2019). Farmers in southern Africa are more affected by climate change because they receive rainfall in unimodal pattern, unlike in east Africa where most parts experience bimodal rainfall patterns. Only 5% of farmers in ESA have access to irrigation, thus moisture scarcity is a key factor affecting agriculture productivity (Rosegrant, Ringler, and De Jong 2009). Furthermore, challenges with low soil fertility are common across the region which reduce crop yield that directly affects food supply for farmers and as well as livestock feed. Farmers have limited resources to purchase fertilisers and improved seeds hence, crop yields in both regions are below their potential which continues to worsen food insecurity. For example, the average maize (*Zea mays*) yield in ESA smallholder farms is below 1 t ha^{-1} which is below the demonstration trial yields of 5-6 t ha^{-1} (Abdulkadir et al. 2017; Munialo et al. 2019).

To improve food security in smallholder farms of ESA, increasing crop diversity and cropping intensity as a sustainable intensification practice has been recommended (Rusinamhodzi 2020). This includes incorporating grain, herbaceous (crops grown for livestock feed or green manure cover crops) and tree legumes in smallholder farmers cropping systems. Legumes can be introduced as intercrops, rotational crops or as boundary planting and hedgerows. However, most smallholder farmers in ESA own small piece of land which influences the cropping systems they practice.

With small land sizes, intercropping has potential to increase crop yields and conserve natural resources in smallholder farms. Intercropping is an ancient cropping system that began in 7000CE in the west Meso-America (using maize, common bean (*Phaseolus vulgaris*) and squash (*Curcubita spp*) and has spread across the globe (Zizumbo-Villarreal and Colunga-García Marín 2010), for example maize/squash intercrop is very common in Zimbabwe. Intercropping is defined as growing of two or more different crops together or one after the other on the same piece of land at the same time or season (Ofori and Stern 1987). There are four main types

of intercroppping practiced in ESA, namely; a) mixed intercropping where two or more crops are grown without distinct row arrangement; b) row intercropping where the crops are grown in distinct rows randomly, or simultaneously with the first crop; c) strip intercropping where crops are grown in strips wide enough such that each crop grows independently from each other but also interacting erogonomically and d) relay intercropping where the second crop is grown after the first one has reached reproductive stage but not yet ready for harvesting (Mousavi and Eskandari 2011; Ofori and Stern 1987). The designs of the intercropping systems could be either substitutive or additive which ensures the productivity of the main crop is maintained (Giller 2001).

Intercropping with legumes has several benefits which include improved resource use efficiency, reduced weeds, pests and disease infestation improved soil fertility and nitrogen (N) in the system through biological nitrogen fixation (BNF) and increased overall productivity (Mucheru-Muna et al. 2010). Several legumes including groundnut (*Arachis hypogea*), pigeon pea (*Cajanus cajan*), soybean (*Glycine max*) and cowpea (*Vigna unguiculata*) are drought tolerant hence, the chances of total crop failure are reduced when they are included as intercrops (Maqbool et al. 2015; Ndungu et al. 2018). The drought tolerance characteristic of legumes is crucial in the success of the intercrops in smallholder farming systems.

Although intercropping has several benefits, there is a downside of competition between companion crops. Also there can be an increase in labour requirements through crop establishment, management and harvesting in intercrops. Farmers have noticed that there is crop competition which reduces crop yields of the main crop and also it can be laborious hence, some farmers don't like to intercrop. However, this challenge can be addressed by crop arrangements which increases planting distance between species, include compatible species which compete less and also staggering planting dates of the crops involved (Francis, Prager, and Tejada 1982).

Farmers in ESA have been growing different crop mixtures over a long period of time, while the benefits and interaction between the intercropped

species are not fully understood by scientists, however these crop mixtures work for smallholder farmers. This paper aims at providing an overview of the potential of legumes to maintain or improve productivity under a changing climate in smallholder farming systems in ESA. The study focuses on reviewing past research on intercropping in ESA regions, highlighting on the complementary effects of various crop mixtures common in this region.

COMMON CROP MIXTURES IN EAST AND SOUTHERN AFRICA AND THEIR BENEFITS

In ESA, farmers mostly grow maize, sorgum and cassava as the main crops and they are often intercropped with grain legumes (Table 1). Several benefits of legumes have been reported in smallholder farms and these include higher productivity (Figure 1). Himmelstein et al. (2017) and Mupangwa et al. (2017) reported high land equivalent ratio of intercrops involving legumes in sub-Saharan Africa. This suggests that intercrops including legumes have high potential to improve food and nutrition security.

Intercropping with legumes increase soil cover which improves infiltration and reduce evaporation hence moisture is preserved (Table 1). Grain legumes have shallow rooting depth, thus root exudates and decomposed roots releases nutrients reachable to the next crops. Most of the fixed N, is used up by grain seeds thus retention of crop residues is essential to maintain soil N build up. Herbaceous legumes or green manure crops such as silver leaf desmodium and velvet bean have potential to improve companion crop yields in intercrop, however they are underutilized in ESA. These herbaceous legumes fix considerable amounts of N and produce high biomass. High biomass production permits farmers to retain crop residues in the field for soil fertility build-up and also have some supplementary biomass for livestock feed. This improves both crop and livestock production.

Table 1. Potential crop mixtures and their benefits in smallholder farming systems

Crop mixtures	Benefits	Reference
Cassava (*Manihot esculenta*)/forage legumes	Reduce nitrogen (N) leaching, carbon losses, diseases and pests	Hassen et al. (2017)
Cassava/common bean	Increases N in the soil, increase cassava and common bean yield	Pypers et al. (2011)
Cotton (*Gossypium Hirsutum*)/cowpea	Improved N balance	Rusinamhodzi, Murwira, and Nyamangara (2006)
Maize/cowpea	Improvement in soil structure and fertility, correct soil acidity, improve soil fertility, control obnoxious weeds, conserve soil moisture, quality livestock feed, less light competition, high nitrogen efficiency, high land equivalent ration and increase in maize grain yield, improve water infiltration	Thierfelder, Cheesman, and Rusinamhodzi (2012); Masvaya et al. 2017; Rusinamhodzi et al. (2012); Mzezewa, Gwata, and van Rensburg (2011)
Maize/groundnut	Reduction of parasitic weed infestation (*Striga* sp), improve food security, better marketability, reduce fall army worm, reduce termite damage on maize	Silberg, et al. 2020; Hailu et al. (2018)
Maize/common bean	Increase N in the system high land equilavalent ratio, less light competition, reduce maize stem borer, promotes soil fauna richness and abundance, reduce witch weed infestation	Nassary et al., (2020); Sennhenn et al. (2017); Kebede et al. (2018); Ayuke et al. (2019); Randrianjafizanaka et al. (2018)
Maize/bambara nut (*Vigna subterranea*)	Restore soil fertility, increase N in the system increase soil pH	Rutto et al. (2011)
Maize/pigeon pea	Low labor requirement, deep root capture leached nutrients, improve rainfall infiltration, insect control, weed suppression	Ortega et al. (2016); Kamanga et al. (2010); Saidia et al. (2019); Ngwira et al. 2013; Mhango et al. (2013); Kimaro et al. (2009)
Maize/soybean	Better markertability, reduced soil loss, increase maize yield, reduce fall army worm, more N in the system	Ortega et al. (2016); Bashagaluke, et al. (2018); Hailu et al.(2018)
Maize/lablab (*Lablab purpureus*)	Conserve soil moisture, more biomass production of high quality for animal feed, high rhizobium inoculation leading to better soil restoration, better water balance	Sennhenn et al. (2017); Massawe et al. (2016); Ngwira et al. 2013: Mthembu et al. (2018)
Maize/*Crotalaria juncea*	When biomass is used as mulch it can replace fertiliser N for many years but however these legumes increase N_2O emmission in the atmosphere	Raji et al. (2020)

Crop mixtures	Benefits	Reference
Millet (*Pennisetum glaucum)*/ mungbean (*Vigna radiata*)	Increase in millet yield and soil moisture conservation	Trail et al. (2016)
Potato (*Solanum tuberosum*)/lablab	Reduce sedimentation or soil erosion	Nyawade et al. (2018)
Cocoa/Gliricidia	N fixation in the field	Kaba et al. (2017)
Maize/*Gliricidia sepium*	Increase maize yield stability, addition of soil organic matter, more N through biological nitrogen fixation (BNF)	Sileshi et al. (2012); Beedy et al. (2010)
Maize /*Leucaena* spp	Increase in rain use efficiency (RUE) and yield stability	Sileshi et al. (2011)
Maize/*Desmodium* spp	Suppressing striga weed, improves soil fertility, improved organic matter, increase maize yield	Khan et al. (2014); Midega et al. (2013); Khan et al. (2008)
Maize/Velvet bean (*Mucuna pruriens*)	Weed suppression, increase in maize yield, addition of soil organic matter, maintain soil humidity, improved phosphorus and potassium uptake	Correia et al. (2014); Flores-Sanchez et al. (2013), Mhlanga et al. (2015)
Sunflower (*Helianthus annuus*)/soybean	Enhances total crop productivity	Olowe and Adebimpe (2009)
Maize/*Crotalaria ochroleuca*	Decrease in soil bulk density, increase water infiltration capacity and increased nitrogen supply	Fischler et al. (1999)

Tree legumes are often included in the cropping systems as hedgerows for production of fodder and firewood and in addition they reduce runoff, soil loss, increase soil organic matter, access leached nutrients and act as wind breaks. They also provide other benefits including provision of habitats for insects that offer pollination and pests control (Kuyah et al. 2016) and for soil organisms that influence soil structure, e.g., Calliandra hedgerows and mulch increased earthworm density in Kenyan smallholder farm (Muoni et al. 2019). Also tree legumes in intercrops enhances water regulation through high soil cover and changes in micro-topography which increases water infiltration (Kuyah et al. 2019). Such ecosystem service is crucial in smallholder farms where water scarcity is high.

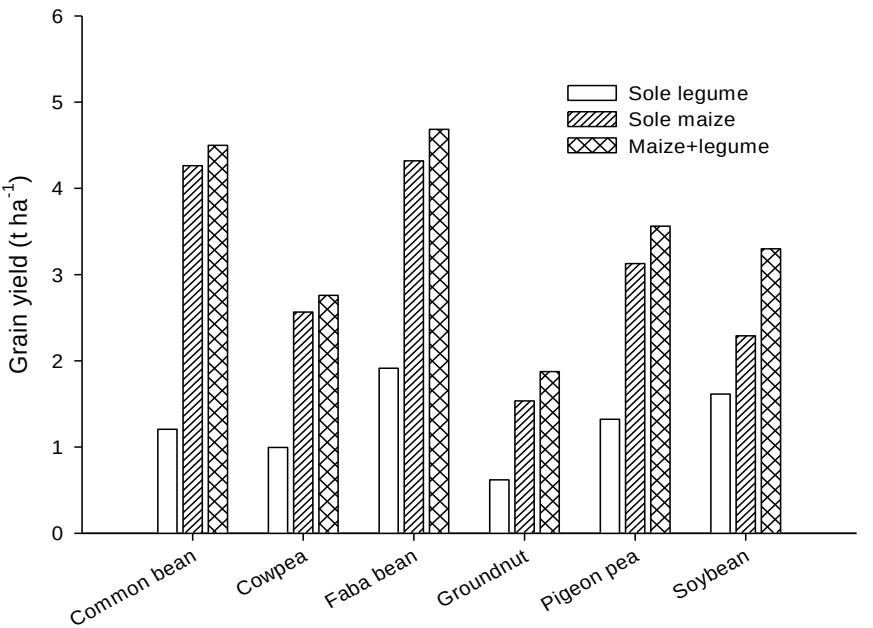

Figure 1. Maize and legumes grain yields grown as sole crops and intercrops in a range of environmental conditions in smallholder farming systems. Plots based on data extracted from 24 publications from sub-Saharan Africa (for details of papers used, contact the authors).

COMPLEMENTARY EFFECTS OF INTERCROPPING WITH LEGUMES

Intercrops with legumes offers several complimentary effects on soil, water and crop interactions thus they are commonly successful in improving overall productivity. Intercropping increases the number of roots binding the soil which reduces soil erosion through wind and water. The roots releases root exudates that improves nutrient cycling and soil pH (Gregory 2006). The decomposed roots act as a source of organic matter that enhance soil structure through soil particles aggregation and release of the nutrients for the subsequent crop (Gregory 2006). Intercrops including legumes reach total soil cover early in cropping seasons which reduce the impact of raindrops, runoff, and evaporation of water and improves water infiltration (Thierfelder, Cheesman, and Rusinamhodzi 2013) hence soil and water conservation is high under intercrops involving legumes (Rusinamhodzi et al. 2012).

Intercrops involving tree and grain legumes with deep roots such as pigeon pea has potential to reach water from deeper soil layer (Sekiya and Yano 2004). This water can also be used by companion crop through hydraulic lift (Kuyah et al. 2016) which has been refered to as sprinkler-like function by Sekiya and Yano (2004). These findings could be utilized in ESA where several tree legume species including pigeon pea, *Gliricidia sepium* and *Calliandra calothyrsus* have been grown in smallholder farms as hedgerows or double up legume systems (Smith et al. 2016). These tree legumes could access water in deep layers during mid-season dry spells thus reducing their effect on grain yield. However, there is need to reduce stomata opening through pruning and defoliation for the success of the sprinkler-like function (Sekiya and Yano 2004). Deep roots also help recycle leached nutrients that are otherwise unreachable by crops with shallow root system.

Addition of N in the system through BNF is among the key complimentary benefit of intercropping with legumes especially in low N soils (e.g., Masvaya et al. 2017). Legumes tend to fix more N when its

demand is high, hence some studies have reported that it is beneficial to involve them in intercrops in poor soils (Kumar and Rai 2017; Rusinamhodzi et al. 2012). The fixed N can benefit the subsequent crop when the legume crop residues are retained in the field (grain legumes), treated as green manure cover crops (herbaceous legumes) or dropping of the leaves (tree legumes) (Öborn, Harrison, and Weldesemayat 2019; Kuyah et al. 2019). The decomposed roots also release some of the remaining N from BNF that is utilized by the subsequent crop. Increasing N in the system helps to increase crop yields and income, as well as reduce the organic fertilizer requirements hence farmers could invest in other things such as irrigation facilities.

Several legume species (including cowpea, soybean, velvet bean, dolichos lablab and common bean) grown in ESA smallholder farms have competitive advantage over weeds (Mhlanga et al. 2015; Muoni et al. 2014). These legumes have a fast growth rate thus they smother weeds and utilize light, water and nutrients better (Rugare, Pieterse, and Mabasa 2019). In addition, some legume species produces allelochemicals that kill weeds e.g., velvet bean. Reduction in weed density reduces competition with the crops hence high crop yields are obtained in smallholder farms.

Most farmers in ESA practice crop and livestock farming hence they are usually challenged to produce enough biomass to feed their livestock and retain in the field for soil fertility build-up (Duncan et al. 2016). Intercrops with legumes increases biomass production, which can be used to feed livestock and/or retained in the field to improve soil fertility. Legumes crop residues have better quality than cereal residues hence there is potential to get high quality manure from livestock. This has been successful in strip cropping which generated enough biomass without compromising maize yield in southern Africa (Thierfelder, personal communication). Generated manure can later be used as a source of nutrients for crop production (Tittonell, Gérard, and Erenstein 2015). Improved soil fertility accompanied by moisture conservation results in enhanced crop productivity in smallholder farms. More biomass production through legume use results in higher organic matter build-up

which increases soil biota (Muoni et al. 2019). Soil biota play a key role in nutrient recycling which also increases crop yields.

CHALLENGES OF INTERCROPPING WITH LEGUMES

The major challenge associated with incuding legumes in intercropping is increase in competition for resources (inter and intra species competition). The interspecies competition often experienced at the early stages of growth reduces biomass yield (Xiao et al. 2018). Xiao et al. (2018) observed poor biomass accumulation in wheat and faba bean intercrops, however the complementation at the later growth stages results in positive outputs. Cenpukdee and Fukai (1992) also demonstrated that intercropping cassava with soybean and with pigeon pea resulted in different responses of the cassava. For example, intercropping with pigeon pea resulted in competition for light due to the huge canopy of the pigeon pea and this resulted in reduced cassava yield. Tree legumes in intercrops also compete for soil moisture and nutrients such as phosphorus, although several benefits can be observed in these intercrops (Kuyah et al. 2016). Successful intercrops depend on a good balance between competition and complementarity between species (Gebru 2015). Species complementarity may be temporal or spatial i.e., in temporal complentarity, species use resources at different times thus reducing competition whereas spatial involved exploitation of resources at different spaces e.g., different soil horizons (Cenpukdee and Fukai 1992). Thus, choice of appropriate planting dates, spatial patterns and compatible species can reduce competition in intercrops. In some cases, allelopathic effects may occur between the primary and the secondary crops and these lead to reduction in crop yield.

Planting of more than one crop in intercropping systems can be labour intensive. Some intercrop combinations require that there is space between the intercrops, and this results in doubling the labour needed for sowing the involved species (Dahlin and Rusinamhodzi 2019). Furthermore, the use of improved implements is usually difficult in intercropping systems.

Machinery used for operations such as weeding, herbicide application and harvesting are designed for uniform crop stands and this results in difficult practical management especially if the involved crops have different cultivation practice requirements for nutrient application, herbicide use, etc. However, in regions where labour is available and cheap, these operations may be done manually. Harvesting is often difficult in intercrops although this depends on the species involved. In intercrops that involve vigorously growing and trailing legumes such as velvet bean, harvesting of the main crop becomes labour intensive due to the need to untangle the trailing vines from the main crop before being able to harvest. Thus, this is an unattractive attribute for farmers who are already labour constrained. The involved crops may also require different harvesting techniques thus requiring multiple harvests to be carried out.

Farmers have limited resources to purchase essential inputs including improved seed, fertilizer and inoculums (Vanlauwe et al. 2019). Legume breeding has not received adequate attention hence the formal sectors are interested in few species such as common bean and soybean. Legumes in intercropping systems are often left to depend on natural soil fertility (e.g., for phosphorous) for initial growth which degrades the soil overtime (Rusinamhodzi 2020; Cordell, Drangert, and White 2009). Hence, the yields of legumes in intercrops are reduced by poor fertilization strategies.

There are few legume species (e.g., pigeon pea and cowpea) that have been bred to suit intercropping systems (Saxena et al. 2018; Adeniyan, Ayoola, and Ogunleti 2011). Thus, some other species succumb to competition for light and other production resources e.g., faba bean and soybean (Dolijanović et al. 2013). This results in limited number of species that could be used in intercrops by farmers. Several legume species (especially herbaceous and tree species) have potential in intercropping systems in ESA smallholder farms however, they are not common and farmers are less willing to try them (Maasdorp, Jiri, and Temba 2004; Öborn, Harrison, and Weldesemayat 2019). Many farmers in this region have adopted a "wait and see" strategy, hence if these species are not tried in their area the chances to adopt them are low (Sheahan and Barrett 2017).

CONCLUSION

Intercrops including legumes result in soil and water conservation, which increases productivity under harsh environmental conditions. Different crop mixtures including deep-rooted crops such as pigeon pea and tree legumes improve resource use efficiency through utilization of leached nutrients and water in deep soil layers.

Grain legumes are commonly intercropped with cereal crops which helps improving nutrient security and dietary diversity in smallholder farms. However, some of the grain legumes including soyabean and faba bean are susceptiable to competition which reduce their productivity. This can be addressed by breeding varieties specifically for intercropping, which has been done for other species like pigeon pea. Apart from grain legumes, farmers should use herbaceous and tree legumes in their intercropping systems since they offer soil fertility improvement and provision of quality livestock feed as well as other products and services. The promotion of such options could be achieved by offering farmers technical know-how and, in addition, improved market systems so that they realize more profit from incorporating legumes in their farms.

In conclusion, the drop in cereal yield usually observed in cereal-legume intercrops reduces farmers' interest of practicing intercropping if they depend on the cereal crop. However, in most cases of cereal-legume intercropping there is an increase in overall productivity of the combined cereal and legume crops. In circumstances where there is use and market for legumes, there is opportunity to improve profitability while increasing food and nutrition security on smallholder farms.

In intercropping systems, competition between companion crops and additional labour are major issues which further reduces its adoption in smallholder farms. Furthermore, seed unavailability for some potential legumes limits farmers options on crops to use in intercrops (for example common bean and sobean are ready available because the formal sectors are more interested in them).

Due to the ability of legumes to i) improve soil fertility through BNF and addition of organic matter; ii) conserve soil moisture by improving

water infiltration, reducing runoff and sprinkler-like function; and iii) conserve soil by reducing soil loss in intercrops, legume intercropping have potential to maintain or improve productivity in a changing climate. Including legumes in intercropping systems in ESA smallholder farming systems will also support food and nutrition security and resilience.

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