Millets and Sustainable Agriculture

Study conducted by Vertiver and Iora Ecological Solutions to support research under TIGR^{2}ESS programme

Under the mentorship of

The Department of Biotechnology

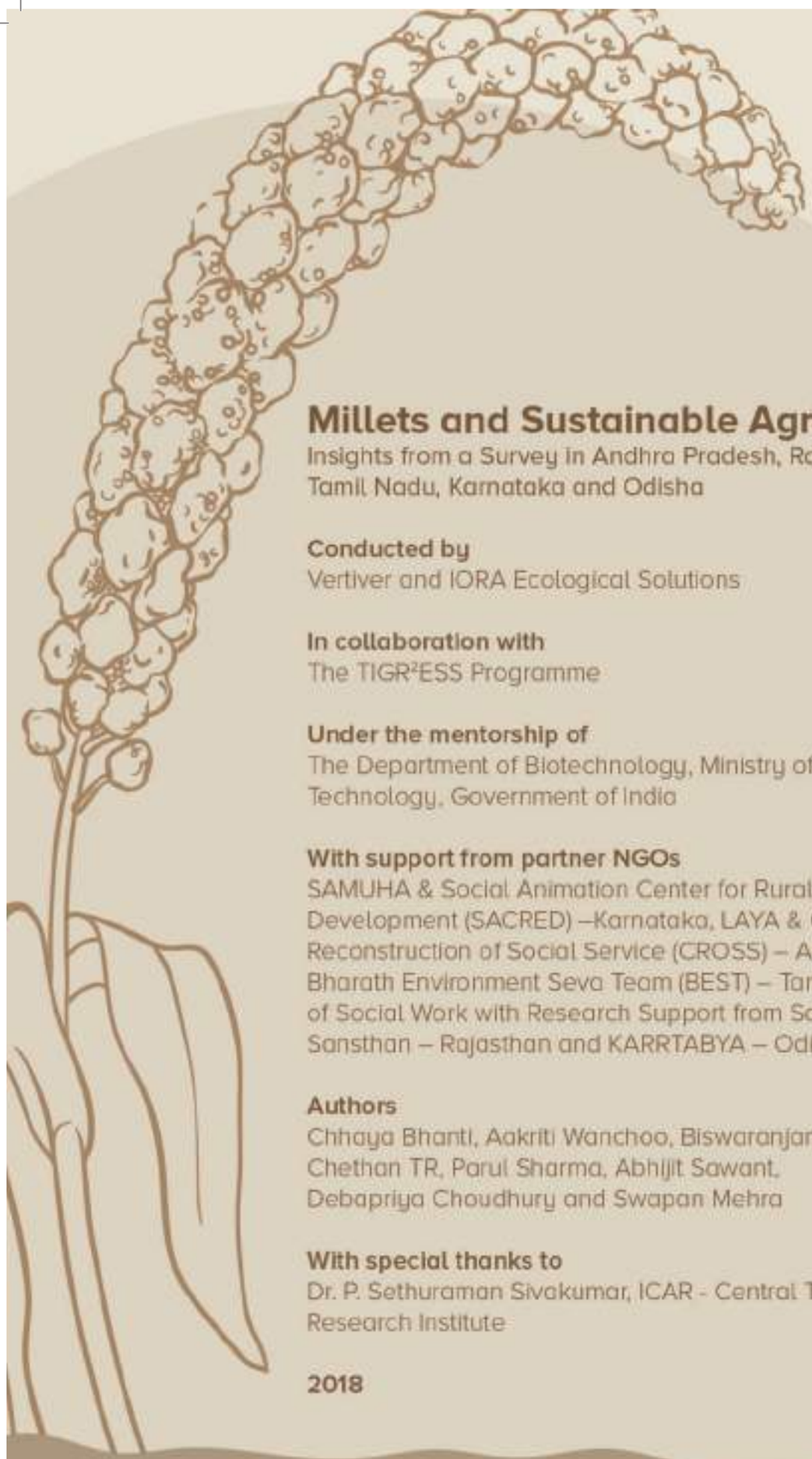
TIGR^{2}ESS

Vertiver
enabling sustainability

IORA
Ecological Solutions

> **In light of the challenges faced by India's agriculture sector like climate change, erratic weather events, soil degradation and water scarcity, millets propose a viable and sustainable solution.**

This survey was conducted from April 2018 to June 2018 by Vertiver and Iora Ecological Solutions — organizations with expertise in forestry, biodiversity, agriculture and climate change. This survey forms part of a preliminary assessment of farmer behaviour, practices and needs pertaining to millet production in ten different agro-ecological zones in India.



Millets and Sustainable Agriculture

Insights from a Survey in Andhra Pradesh, Rajasthan, Tamil Nadu, Karnataka and Odisha

Conducted by
Vertiver and IORA Ecological Solutions

In collaboration with
The TIGR²ESS Programme

Under the mentorship of
The Department of Biotechnology, Ministry of Science and Technology, Government of India

With support from partner NGOs
SAMUHA & Social Animation Center for Rural Education and Development (SACRED) –Karnataka, LAYA & Community Reconstruction of Social Service (CROSS) – Andhra Pradesh, Bharath Environment Seva Team (BEST) – Tamil Nadu, Udaipur School of Social Work with Research Support from Sanjhi Sansthan – Rajasthan and KARRTABYA – Odisha.

Authors
Chhaya Bhanti, Aakriti Wanchoo, Biswaranjan Mohanty, Chethan TR, Parul Sharma, Abhijit Sawant, Debapriya Choudhury and Swapan Mehra

With special thanks to
Dr. P. Sethuraman Sivakumar, ICAR - Central Tuber Crops Research Institute

2018

Vertiver | IORA

Improving Livelihoods

>70% prefer growing millets over other staples because of high profitability

Farmers deriving **1/3rd** of their total crop income from millets

Adequate availability of quality seed with **>80%** having access to good quality seeds

Food Security

Inter-cropping systems are widely prevalent with almost **75%** farmers practising

Self- consumption of millets among farmers ranges from **1/3rd** to **2/3rd** of their produce, high among small and semi-medium farmers

>50% of the farmers prefer to grow millets for own consumption and nutritional quality

Table of Content





List of Figures

List of Tables

1. Background & Objectives

Millet production in India has been declining owing to changes in consumption and farming patterns. Before the Green Revolution, starting in the mid-1960s, millets made up more than 40% of all cultivated grains in India. H**owever, the emergence of rice and wheat as preferred substitutes has brought a 35% decline in millet production in the past 40 years.** *Figure 1.1 illustrates this decline.* Dryland farming areas where millets and pulses are traditionally the staple grains for household consumption have also transitioned to paddy and wheat owing to apolicy push (Rao, Reddy and Seethrama, 2007). Millet grains provide substantial benefits of drought resistance and good productivity in water scarce areas and also possess remarkable nutritive values.

In India, arid and semi-arid regions account for more than **60% of the cultivated area under millets,** providing **around 40% of the food produced.**[1] These regions are characterized by long dry seasons and inadequate & unpredictable rainfall.

In the past few decades, recurrent droughts and frequent dry spells have led to further land degradation and desertification. This has resulted in low productivity in the crop and livestock sectors. In arid and semi-arid conditions, the cropping choice is restricted due to moisture stress, low soil fertility, poor and saline soils, and lack of assured sources of irrigation (Bantilan, 2013). Given these challenges faced by India's agriculture sector, including climate change, erratic weather events, soil degradation and water scarcity, millets propose a viable and sustainable solution.

Enhancing the production of millets potentially holds the key to greater food and farmer security in India. However, in order to achieve this growth, gaps on both demand and supply side of millets need to be addressed. Policies that encourage poor,' low yield productivity, lack of availability of 9 adequate land and lack of access to adequate post-harvesting processing centres and policies are among the reasons for declining millet cultivation.

[1] (Gulati and Kelley, 1999)

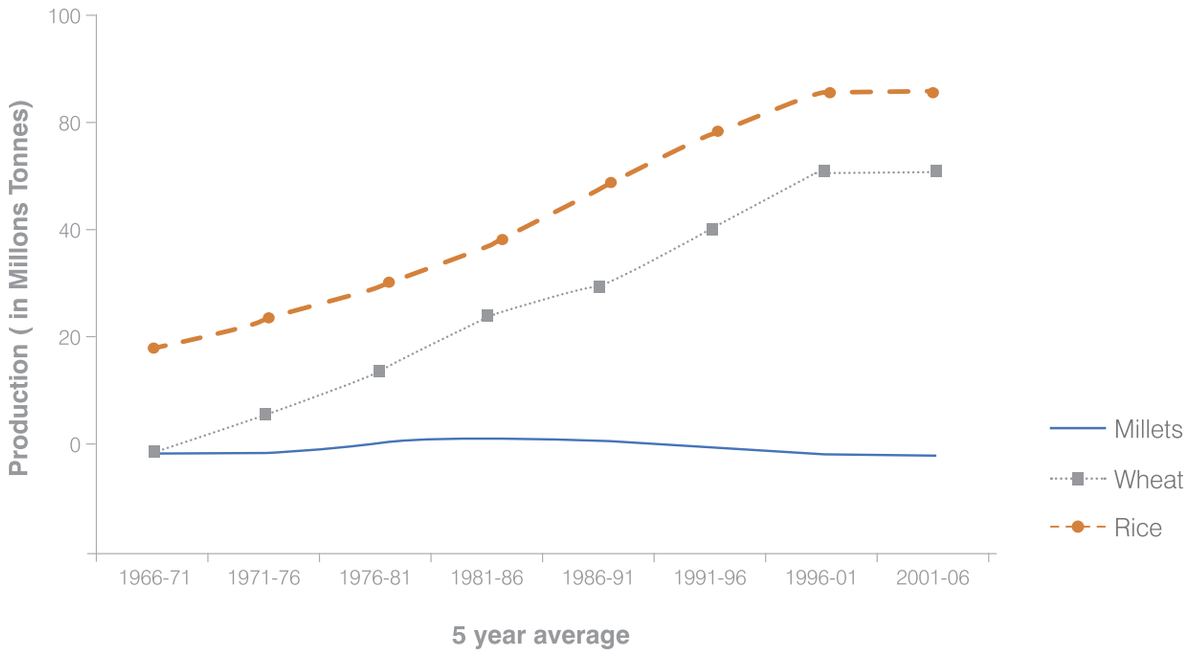


Figure 1.1: Millet production compared to other crops (Adekunle et al., 2018)

The Indian Government has declared 2018, as the "National Year of Millets." While this marks a significant step to puttng the millets back on the path of growth, additional research is needed to identify gaps in the millet value chain in India.

Designing and implementing effective interventions across plant science, farm inputs, extension and capacity building, market linkage, gender equality, value addition and consumer awareness should be based on primary understanding of the needs in the value chain.

Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies (TIGR²ESS) Programme 1, a major Cambridge-led collaborative project aims to define the requirements for a second, more sustainable Green Revolution. The TIGR²ESS programme as part of its key components, acknowledges and appreciates the need for research on millets and hence commissioned a brief multi-tier socio-economic survey to carry out a preliminary identification of these issues, such that this understanding can lead to mainstreaming research and policy actions for millets in future collaborative work. The survey was led by Delhi-based organizations Vertiver and Iora Ecological Solutions with support from partner NGOs in each landscape. The study aimed at understanding farmer preferences for growing millets, how millets contribute to farmer livelihoods, cultivation practices market linkages and consumer perceptions of millets. The study also attempted to gain insight on gender roles, trends in changing weather patterns due to climate change and digital connectivity of farmers. The output from the survey is expected to serve as input to potentially developing programme approaches for enhancing millet growth in India and to inform design of further activities under the TIGR²ESS programme.

1

To **understand the cultivation practices and the economics of millet farming** across major millet growing Agro Ecological Zones (AEZs) in India.

2

To **learn about challenges and opportunities for farmers** in millet production

3

To **compare farmer preference for crop types and varieties in different states** vis-à-vis millets and other crops

4

To understand **market linkages for millets at village level** and across the broader market value chain

5

Evaluate **suitability of millet varieties to the AEZs** in consideration

6

To understand **consumer behaviour towards millet consumption.**

Research Objectives

1.1. Millets: A Roadmap for the Future

Millets are hardy crops that can thrive in adverse agro-ecological situations, which makes them a sustainable crop for farmers. Millets have the following key characteristics:

- Millets do not require substantial inputs in the form of irrigation and fertilisers, being hardy and resilient to the vagaries of weather and changes in climate.
- Millets are high in micronutrient content and have been traditionally used as staples and in the production of various foods and beverages across India owing to high nutritious value.
- Millets are a rich source of fodder and therefore support farmer livelihoods
- The nutritional properties of millets provide food and health security to farmers and consumers alike.
- Millets can not only grow in poor soil and climatic conditions but owing to their short growing season, they can fit into multiple cropping systems under irrigated as well as dry land farming; providing nutritious grain and fodder in a short span. Their prolonged and easy storability under ordinary conditions has accorded them the status of “famine reserves”; and this feature is of great relevance for India, as the country’s agriculture suffers from the vagaries of monsoon (Kumar et al., 2018) .
- Millets are rainfed and require far less water than other mainstream crops; a key benefit as water scarcity becomes a growing challenge.

Some key millets grown in India are:

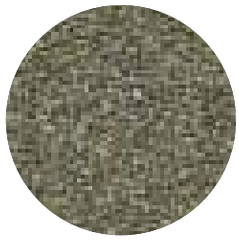
Finger Millet *(Ragi)*

Pearl Millet *(Bajra)*

Sorghum *(Jowar)*

Kodo Millet *(Kodra)*

Little Millet *(Kutki)*



Foxtail Millet *(Kangni)*

These millets were found to be known by fifty-one different names across the landscapes in which this survey was conducted. India contributes to the entire production of Barnyard, Kodo and Little Millet and ranks first in the production of most millets (Table 1.1) worldwide.

Millets	Crop Area (000 ha)	Production (000 tons)	Yield (kg/ ha)	% of world production	World Production rank
Barnyard millet	146	151	1034	99.9	1
Finger millet	1138.3	1822	1601	53.4	1
Foxtail millet	72.6	50.2	691	2.2	3
Kodo millet	200	84.2	419	100	1
Little millet	255.5	119.9	469	100	1
Pearl millet	7129	10280	1442	44.5	1
Proso millet	31	20	645	1.4	9
Sorghum	5650	4410	781	6.9	6
Total millets	14622.4	12531.7	857	-	-

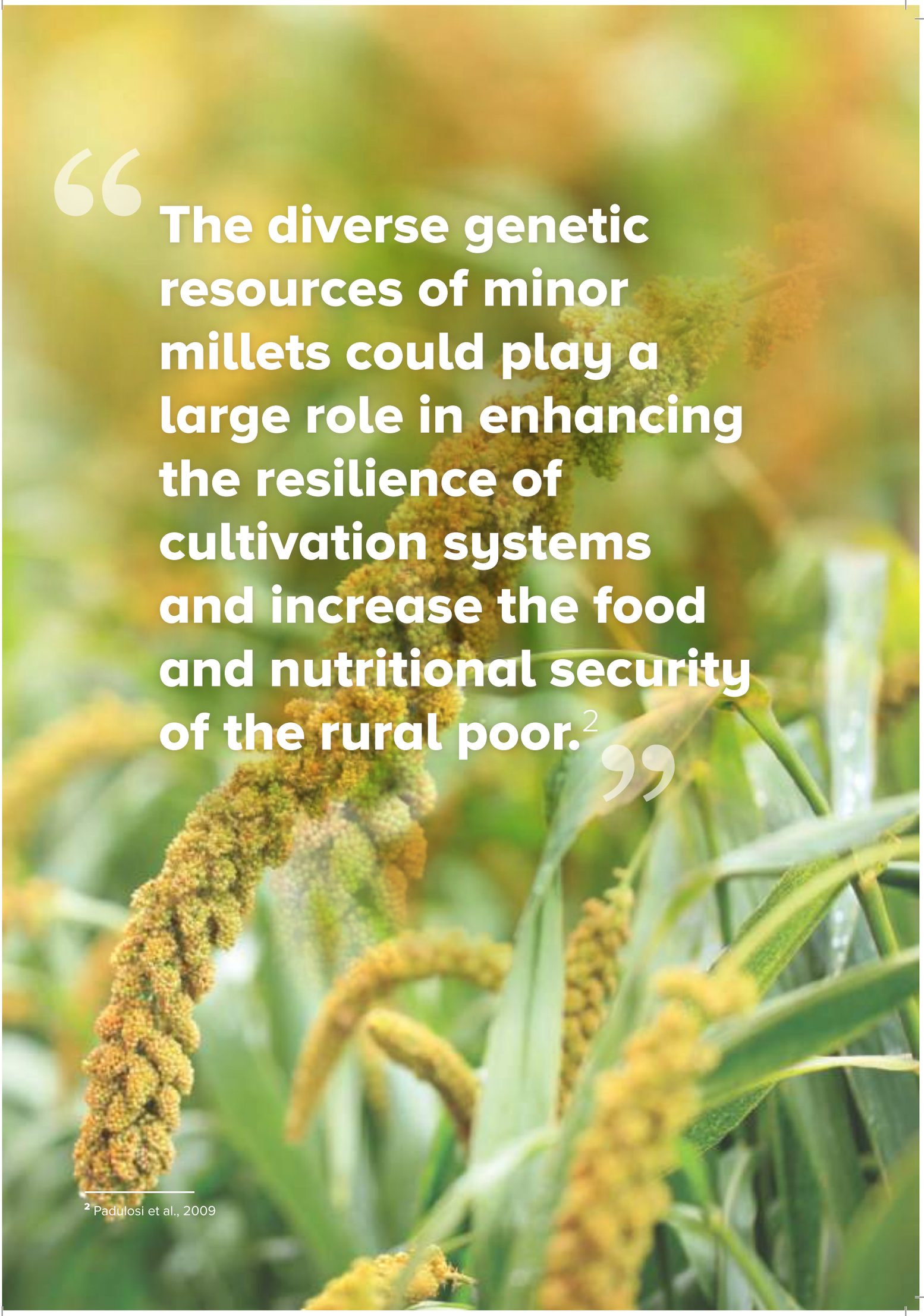
(IIMR estimates based on FAO/DES-GOI data)

Table 1.1: Contribution of India to Global Millets Production during 2016

Market Year	Domestic Consumption in '000 MT	Growth Rate
2013	11600	6.42 %
2014	11600	0.00 %
2015	10500	-9.48 %
2016	11300	7.62 %
2017	11500	1.77 %
2018	11700	1.74%

(The World Factbook, 2018)

Table 1.2: Domestic Consumption & Growth Rate of Millets



“The diverse genetic resources of minor millets could play a large role in enhancing the resilience of cultivation systems and increase the food and nutritional security of the rural poor.”[2]

[2] Padulosi et al., 2009

2. Secondary Literature

2.1 Millets: Climate Smart, Nutritious Cereals

The government of India has declared 2018 as the 'National year of Millets' and is promoting their cultivation due to their resilience and nutritional value (Govt promoting millets on mission mode: Minister, 2018). Compared to other grains, Millets are more nutritious, owing to their high content of dietary fibres, resistant starches, vitamins, essential amino acids, storage proteins and other bioactive compounds (Amadou, Gounga and Le, 2013; Saleh et al., 2013). Millets could possibly also play a role in reducing the risk of heart disease, diabetes and high blood pressure due to presence of slow releasing sugars and high amounts of polyphenols known to play a role in lowering the rate of fat absorption (Singh, 2016).

Millets are also C4 crops, which are efficient users of water and nutrients, making these crops better suited to cope with impacts of climate change such as rise in temperature and droughts (Bhat, Rao and Tonapi, 2018).

The water requirement during the growing period for certain millets is 25% lower than for sugarcane and banana and 30% lower than for rice.[3]

Millets also grow well on low fertile soils with pH that can range from acidic to basic, where other crops are not able to survive (Kumar et al., 2018). **The six minor millets grown in India – Finger millet, Kodo millet, Foxtail millet, Little millet, Proso millet and Barnyard millet – due to their wide genetic adaptation, are able to grow in diverse soil types, different photoperiods and varying rainfall patterns.** Additionally, they are also able to grow on marginal, arid and mountainous terrains making them excellent candidates to replace rice and wheat which might be slower to adapt to climate change (Padulosi et al., 2009).

[3] Sakamma et al., 2017

In India a total of 114.01 million hectares (M ha) of land is degraded. Of this 23.62 M ha has been degraded by water erosion, 8.89 M ha by wind and, salt affected and acidic soils comprise 22.76 M ha (Trivedi, 2010). In 2015-16 about 36 M ha of land was classified as fallow and bringing in 40% of this under millet cultivation could increase their production by up to 48 million tonnes (Rao, Mukherjee and Tonapi, 2017).

Millets can play a major role in enabling adaptation of farmers to climate change and to increase their resilience to weather vagaries.

2.2 High Yielding Varieties (HYV) and Biodiversity

The natural diversity inherent in millets, has been greatly enhanced with the development of high yielding varieties (HYVs). The creation of mapping populations, use of molecular markers and advancements in sequence information have resulted in the development of numerous HYVs of millets, which apart from having higher yields are also more resistant to pests and diseases (ICAR - IIMR, 2017; Kumar et al., 2018) .

The increase in the biodiversity of millets due to the introduction of **HYVs has resulted in about 140 subspecies of pearl millets with 33% of the world's** approximately 65,400 accessions are stored at ICRISAT.

In addition to this, ICRISAT also maintains 10,193 accessions of six small millet species and the Indian National Bureau for Plant Genetic Resources (NBPGR) maintains 27% percent of the world's approximately 35,400 accessions of finger millets (FAO, 2010).

However, whilst genetic diversity has increased due to the introduction of hybrid varieties, there has also been a decline in the diversity of farmer varieties and landraces. **Studies have shown that over the last 10 years, significant traditional genetic resources of millets have been lost** (FAO, 2010). Landraces, which are described as dynamic populations of a cultivated plant with a historical origin and distinct identity, are often genetically diverse and locally adapted and are associated with farmer practices of seed selection, management and knowledge (Camacho - Villa et al., 2005). These plant varieties are known to be important sources of traits for local adaptations, yield stability, nutrition and stress tolerance. These locally adapted landraces with climate resilient traits have been displaced by modern agriculture with the use of hybrids and improved cultivars (Ceccarelli, 2011). For example, the number of rice cultivars grown in India declined from 40,000 before colonialism to 30,000 in the mid-19th century and many thousands lost post the green revolution (Heal et al., 2003).

Considerable efforts have been made for ex situ conservation of landraces with the establishment of gene banks, where the aim is to maintain the genes and genotypes of the planting material as a representative of the diversity of that crop. However, there is also a need for in situ, on-farm conservation of landraces in centres of crop diversity. This involves the management of these landraces in farmers' fields where they originated and farmers preferences, knowledge, management practices and social organisation (Bellon and Etten, 2013). Both

forms of conservation should complement each other in order to maintain biodiversity and for the adaptation of food systems to climate change.

The **PPVFR (Protection of Plant Varieties and Farmers' Rights) Act gives farmers ownership of plant genetic resources** and this authority registers local landraces of different species of cultivated crops conserved by farmers and communities, enabling recognition of effort and benefit sharing. However, India does not presently have an extensive national DNA database of Indian plant species or landraces and researchers rely on the allele frequency calculations of western species. This lack of a genetic database inhibits the correct identification and thus the protection of local varieties and farmers rights (Ragupathy et al., 2016).

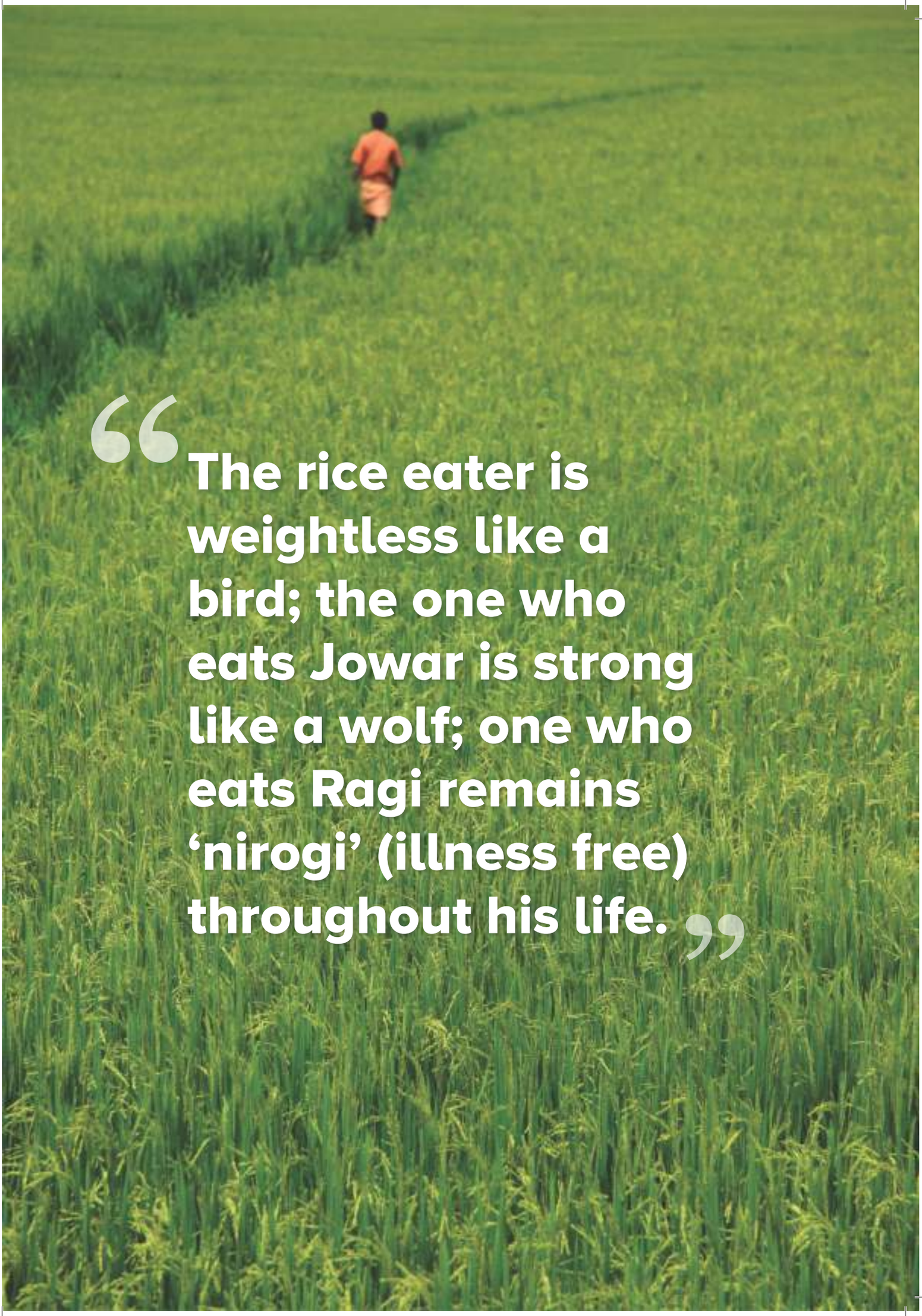
2.3 Millet Production, Post-Harvest Processing and Markets

Cultivation of millets is a labour-intensive process involving high levels of drudgery (Iliger et al., 2017). Whilst there are numerous machines available for processing major cereals, this mechanisation is not as readily available for the processing of millets (Balasubramanian, R and Sharma, 2007). Whilst millet-specific threshers, decorticator, destoners and polishers have been designed by both government agencies and private companies (Kumar et al., 2018), the majority of millet farmers do not have adequate access to these machines (Swaminaidu, Ghosh and Mallikarjun, 2013). Additionally, millets being small seeded and usually a low-price commodity, are not cleaned, graded and dried properly before they are taken to market. This in turn results in problems in storage, post-harvest losses and further decrease in price. Expenses on labour form on an average 50% of the variable cost of millet farming where activities such as harvesting and threshing constitute 28% of the cost. Studies have shown that the installation of 14 a processing unit in a tribal village can result in a cost benefit ratio of 2.05 for the community (Nagaraj et al., 2013; Ambrose et al., 2017).

Apart from easing the post-harvest processing of millets, farmers also require support in terms of both input and marketing at a standard comparable to that provided to other crops (Swaminaidu, Ghosh and Mallikarjun, 2013). It is necessary to have well established local formal and informal seed markets where farmers are able to trade seed varieties. This would not only help maintain genetic diversity but also enhance incomes by developing a resilient farming system (Nagarajan, Smale and Glewwe, 2005).

There has been a recent increase in demand for nutritious alternatives to rice and wheat. However, millets are still not that popular among the urban population. **A lack of awareness of their nutritional benefits and low availability are the main reasons for their low demand.**[4]

[4] YOURSTORY, 2017


“The rice eater is weightless like a bird; the one who eats Jowar is strong like a wolf; one who eats Ragi remains ‘nirogi’ (illness free) throughout his life.”

2.4 Millet Productivity and Profitability

Traditionally, millets have been a part of the staple diet in India. Studies state that **90% of tribal farmers in Bastar, Chattisgarh, cultivate Kodo millet, Little millet and Finger millet only for their own consumption.[5]**

A study in Madhya Pradesh also found that minor millets are used as the main source of food for tribal communities (Priyam, 2017) .Of the millets produced globally, about 80% are used as food and the remaining as fodder or for brewing purposes (Saleh et al., 2013) . In the past few decades, productivity of major millets has seen a significant increase mainly due to the introduction of hybrid varieties that are high yielding and better suited to deal with biotic and abiotic stresses. Before the Green Revolution in India, 40% of all grains grown were small millets, contributing more than 50% to the GDP. However, the overall production of millets has seen a decline since then due to significant decrease in area under cultivation (Pray and Nagarajan, 2009; Adekunle et al., 2018). Studies have shown that the net return per hectare from millet cultivation is negative under rainfed farming due to low yields and high production costs. Despite this negative return, farmers choose to grow millets mainly for their own consumption and for the quality and quantity of fodder they provide (Sakamma et al., 2017). This negative return on investment may be the reason for why the area under millet production has decreased significantly and why they are now cultivated mainly for subsistence and not commercial purposes (Narayanamoorthy, 2013; Pant and Srivastava, 2014). Government policies that favour the production of rice and wheat and the under development of the millet value chain have further contributed to their decline.

The increase in rice cultivation has resulted in an 18% increase in greenhouse gas emissions from agriculture.[6]

[5] Sahu and Sharma, 2018

[6] Vetter et al., 2017; Adekunle et al., 2018

2.5 Role of Women in Farming

In developing countries, agriculture is under performing and one of the reasons is that women do not have equal access to resources and opportunities to increase their productivity.

According to estimates, if female farmers had the same access to resources as male farmer, **the yield on their farms could increase by 20-30%.** This could **raise the total agricultural output in developing countries by up to 4%, reducing the number of hungry by 12-17%.**[7]

Studies have also shown that in developing countries, rural women are the poorest and most vulnerable. Furthermore, poverty is on the rise among rural women in most developing countries. The majority of policy initiatives aimed at reducing poverty have looked at rural women as recipients of benefits, rather than active participants in the process. **In addition to this, the patriarchal nature of societies in developing countries results in no accounting of women's contribution to agriculture and other sectors in the economy (Prakash, 2003).**

Amongst the rural population in India, 84% of women depend on agriculture for their livelihoods, where they make up 33% of cultivators and 47% of agricultural labour.

[7] FAO, 2011

BUSINESS-CREATIONS / Shutterstock.com

Their typical work is limited to less skilled jobs such as sowing, transplanting, weeding and harvesting. In addition, it is solely women who manage other activities that support agriculture such as fisheries and animal husbandry.

A decade ago, **94% of the female agricultural work force in India was involved in cereal farming.**[8]

Most of the activities performed by women leaves them with severe pain in the legs, neck, hands and back due to constant bending or squatting. **They face an increasing risk of injuries and the drudgery of farm labour results in frequent miscarriages, infant death and premature births (Why we don't talk about women farmers, 2017).** The tools for these activities are designed and tested only on men and are in some cases not suitable for women.

[8] Rao, 2004; Khyade and Khyade, 2016

[9] Singh, Gite and Agarwal, 2006

CRS PHOTO / Shutterstock.com

Studies have also shown that **when women farmers use tools designed especially for them they are able to increase their productivity by several folds.**[9]

The participation of women in agriculture in India is on the rise and their roles are evolving due to the migration of male workers to urban and semi-urban centres. **Whilst they are increasingly becoming involved in traditionally male dominated farm related activities, there isn't a corresponding reduction in their other duties (Pay parity sought for women in agriculture, 2012; Women farmers need policy attention, 2017).** And whilst women play an active role in farm-related activities, in most households they do not have the decision-making power (Satyavathi, Bharadwaj and Brahmanand, 2010).

According to the Census in 2011, **only 12.8% of landholdings were owned by women and the largest portion of operational holdings by women (25.7%) were in the marginal and small farmer categories.**[10]

Since women are not listed as primary earners or owners of land, they are unable to participate in mandi panchayats, liaising with district officials, getting loans or bargaining for minimum support prices (MSPs) (The invisible women farmers, 2017). According to the Indian labour journal of 2015, on an average, women daily wage farm labourers earn between 18-30% less than men for different farming activities, with the biggest pay gap seen in ploughing and tilling (Indian Labour Journal, 2007).

Most agricultural policies and projects fail to consider the differences in the roles of men and women, the constraints they face and access to resources and how these factors might be relevant to the proposed intervention. This results in the assumption that most technology, infrastructure, market access and policy interventions will have the same impact on both men and women. **There is an urgent need to understand and capture the differences of gender roles in farming so that appropriate policy decisions can help create gender equality (FAO, 2011).**

[10] Singh, Gite and Agarwal, 2006

3. Research Methodology

In order to address the research objectives and gain a holistic understanding of the millet value chain, primary data was collected from millet farmers and traders from selected AEZs of India. In addition to the field survey, a web-based online survey was also conducted, focusing on the end consumers of millets. Following are the details of the study components:

Farmers

A household survey was carried out in five states, representing different AEZs, covering a sample size of **495 farmers**.*

The survey aimed at understanding the millet farming practices and preferences, use of millets and market linkages with the perspective of understanding gender roles and climate change.

Traders

Interactions were carried out with agriculture traders across these states to understand the value chain of millets and market dynamics.*

Consumers

An **online consumer survey among urban consumers** was conducted to understand the consumer's preference and perception at the supply end of the millet value chain.

* *The data collection for both the above-mentioned surveys were done through different partner institutions working in the study geographies and thematic areas of environmental conservation, ecological farming, livelihoods, gender etc.*

3.1. Study Methodology

The study followed a five-step process: The first step involved defining the scope of research in concurrence with the goals of the TIGR²ESS program. As a next step, geographies (states, districts) were shortlisted where qualitative focus group discussions were carried out to understand the dynamics of millet farming and value chain. The choice of the geographies was primarily driven by the need to represent various Agro Ecological Zones (AEZs) where farmers grow millets as one of the staple crops (Table 1). Within each of the chosen states, potential field data collection partners (Table 2) were identified who were then mobilised to support farmer/ village level surveys in remote locations.

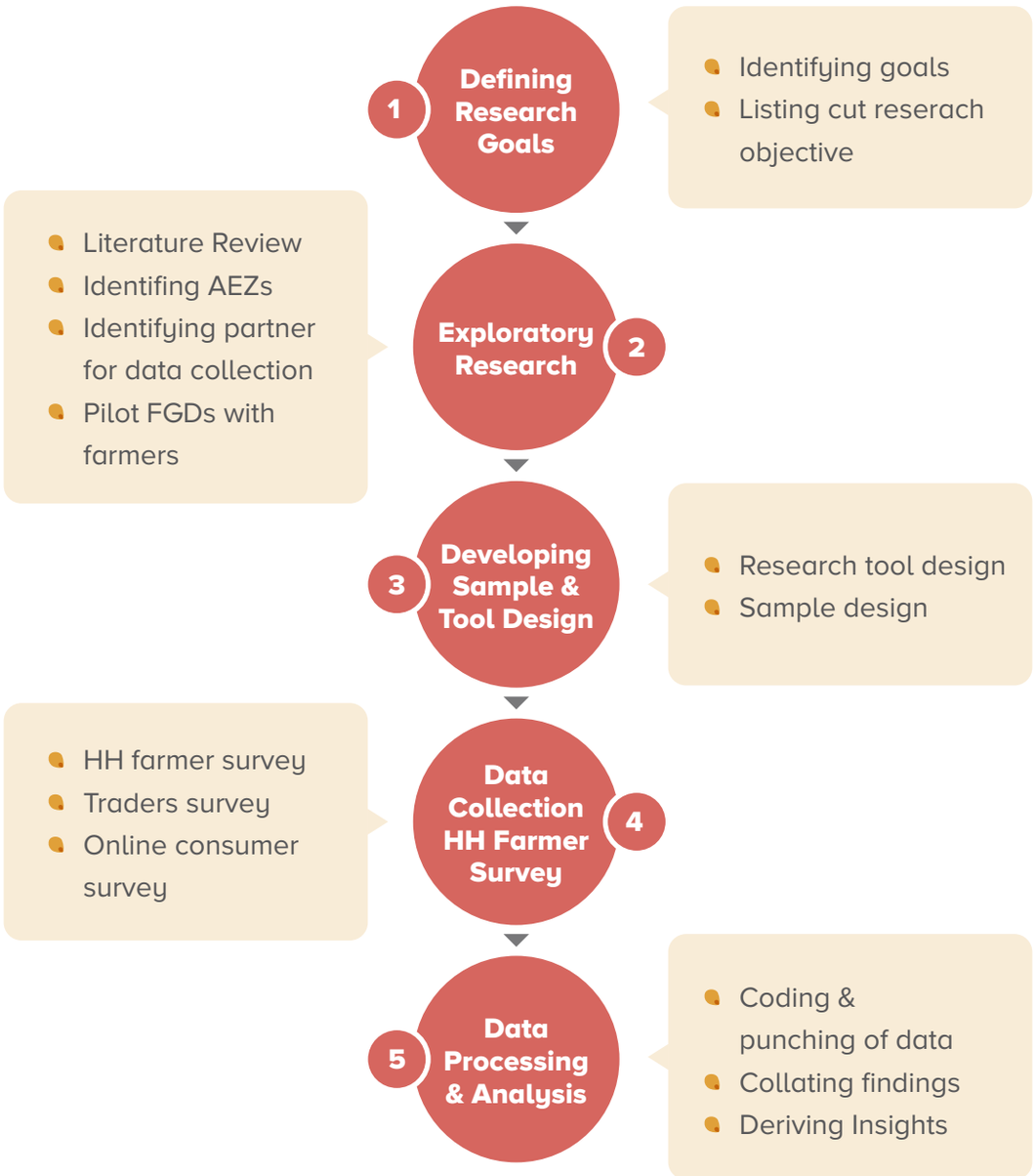


Figure 3.1: Study Methodology Members of IORA/VERTIVER and partner NGO conducting HH survey in Odisha

3.2 Sample Design

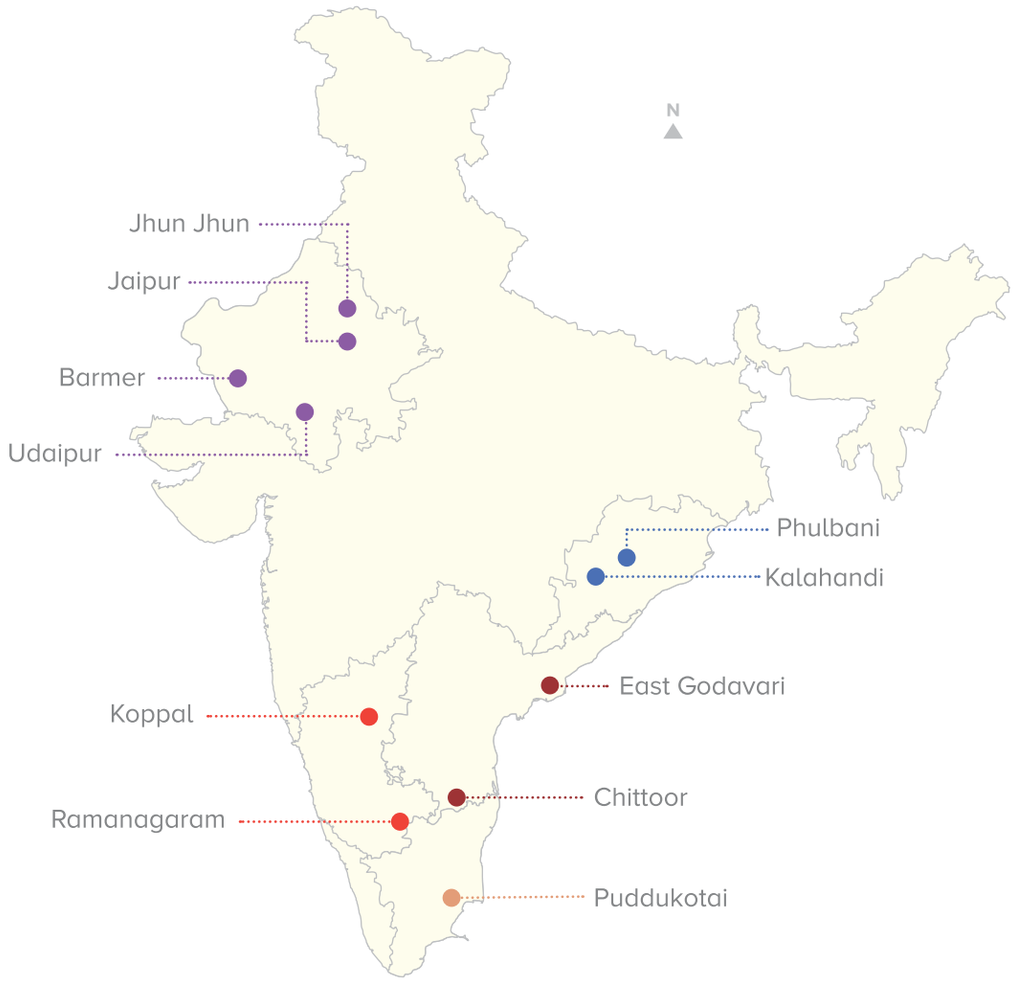
States with prevalence of millet farming were chosen for the survey. Districts in each state represented different AEZs. Within districts, villages were selected randomly, and farmer households were identified with the help of NGOs across socio-economic and gender strata. The key parameters considered for farmer selection included land holding and gender. A sample size of 100 was planned for each state with 33% quota set for female farmers. A sample size of 495 was finally achieved across five states. The stratification of the farmers were as follows:

Farmer Type	AP	Karnataka	TN	Odisha	Rajasthan	Total
Marginal	26	35	14	31	38	144
Small	54	36	25	42	28	185
Semi-Medium	36	24	19	19	9	107
Medium	3	14	5	8	4	34
Big	1	11	–	–	13	25
Total	**120**	**120**	**63**	**100**	**92**	**495**

Note: *Marginal farmer: less than 1 ha land (less than 2.5 Acres of land), small farmer: 1-2 ha land (2.5 to 5 Acres of land), Semi-medium farmer: 2-4 ha land (5 to 10 Acres of land), Medium farmer: 4-6ha land (10 to 15 Acres of land), Large farmer: above 6ha (More than 15 Acres of land).*

Table 3.1: Farmer type distribution by state

Farmers in Barmer district of Rajasthan during an FGD



Survey Landscapes

- Hot Arid eco region with desert and saline soil
- Hot Arid eco region with red and black soil
- Hot sub humid eco region with and laterite soil
- Hot Arid eco region with red soil
- Hot Arid eco region with red loamy soil
- India boundary

Figure 3.2: Agro Ecological Zones (AEZs) covered

IORA/VERTIVER member conducting FGDs in Koppal district of Karnataka

State	AEZ	Districts
Rajasthan	Western Arid Plain Zone Western Plain Semi-Arid Eastern Plains Sub Humid Southern Plains	Barmer Jhunjhunu Jaipur Udaipur, Jhadol
Odisha	South Western Undulating Zone North Eastern Ghat Zone	Kalahandi Phulbani/Kandhamal
Karnataka	Eastern Dry Zone Northern Dry Zone	Ramnagara Koppal
Andhra Pradesh	North coastal Zone Southern Zone	East Godavari district Chittoor
Tamil Nadu	Cauvery Delta Zone	Pudukkottai

Table 3.2: Districts covered across states

3.3. Research Tools

Based on desk review, secondary data and findings from the focus group discussions (FGDs), a list of information areas on which data would be collected was created. These information areas were used as input for the research tools developed for the final survey. The following tools were developed:

- **Farmer level questionnaire:**
  The farmer level questionnaire included **questions on land and farming practices, seed quality and availability, cost analysis and pesticides, postharvest practices, harvesting, storing and marketability of millets.** Additionally, the questionnaire also included questions related to climate change, gender and digital connectivity.

- **Trader Questionnaire:**
  Three questionnaires were prepared for village level aggregators, traders and wholesalers containing questions on supply chain, sale price and other market dynamics.

- **Online questionnaire for consumer survey:**
  An online survey was hosted on the Survey Monkey platform. The questions were included to cover perception about millets, preference for millets, eating habits etc.

The HH farmer survey questionnaire was finalised after consultations and review with the Department of Biotechnology (DBT), ICRISAT and University of Cambridge. After due calibration, the questionnaires were rolled out through farmer surveys across the study villages.

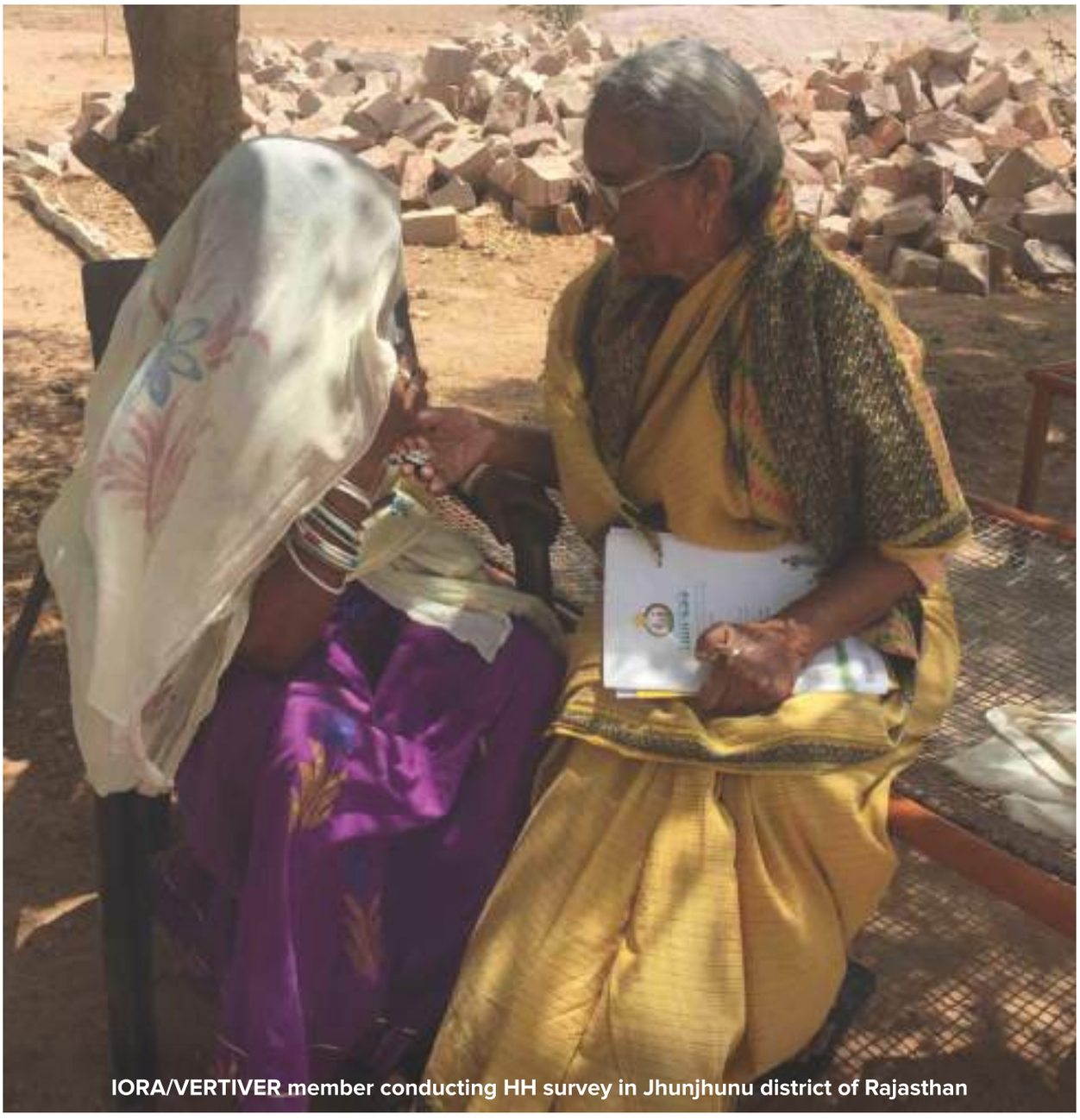
3.4. Limitations of Study

- **Analysis at Stratified Level**
  While the study covered a significant sample size of nearly 500 farmers across

five states, multi-stratification across socio-economic and gender categories in each state, limited the analysis to descriptive statistics by state/gender/ farmer category only.

- **Variability of Open Ended Data**
  Variations in crop nomenclature deviated from crop categories specified in survey leading to confusion on crop types across geographies.

- **Possible Bias in some responses:**
  Although the survey tools were designed to reduce respondent bias and only capture the opinion of the farmer, in some districts, the farmers interviewed were accompanied by family member/ fellow farmers, which could have possibly affected their responses



IORA/VERTIVER member conducting HH survey in Jhunjhunu district of Rajasthan

4. Research Findings

General Information

- Marginal and small farmers comprised 67% of the sample; Male to female ratio of the respondents was 70:30.
- The literacy rates for women were lower in all states except in Andhra Pradesh.
- The average number of crops grown per farmer was three and millets were being grown universally across AEZs.
- Finger millet was the most widespread, followed by Pearl millet.
- Whilst the majority of farmers surveyed show a strong preference for growing millets from both an agricultural and a nutritional perspective, we know that millet cultivation is on the decline in India.
- Key needs stated by farmers for improving cultivation were agri-inputs and technical guidance
- Key source of information about agricultural know-how was fellow farmers, followed by TV, extension workers and farmer associations.

Millet Economics

- Income from millets as ratio of total farming income ranged from 10-50% with Karnataka having the highest numbers (52%).
- Farmers in all states were unaware of MSPs for millets other than a few in AP.
- Majority of farmers, again except a few in AP, did not know of the inclusion of millets in the PDS.
- Farmers mostly sell their produce to Block Level Traders, with selling prices being variable across states.
- Farmers in Karnataka and Tamil Nadu received a higher return from supplying clean and graded millet produce and farmers in both these states also have direct links to higher profit markets.
- The majority of farmers interviewed (90%) had bank accounts but did not use them for their transactions, perceiving digital transactions to be too risky.

Millet Cultivation & Uses

- Intercropping was widely prevalent with 75% of farmers intercropping with millets and this was highest in Karnataka (99%) and lowest in Rajasthan (42%) where intercropping was mostly practices with beans and pulses
- The use of millet as part of the daily diet was almost universal across states and the majority of farmers were growing millets primarily for self-consumption rather than for sale. For consumption patterns as well, Finger millet was the most popular except in Rajasthan where it was Pearl Millet.

Seed Preference

- Said they had access to high quality seeds.
- The majority of farmers in AP, TN and Odisha showed a strong preference for using traditional seeds for millet cultivation, whereas, the opposite was seen in Karnataka and Rajasthan.

Gender, Climate Change & Future

- Women's participation in labour-intensive activities was found to be higher than men, in addition to being the primary caretaker of livestock in most of the cases.
- Majority of farmers indicated a change in their cropping patterns, decline in rainfall, increase in incidence of pests and diseases over last couple of decades.
- Most farmers did not want their children to take up agriculture as a profession due to low incomes, non-profitability and the uncertainty involved in it due to changing climate.

From the consumer of millets

- From consumers' point of view, millets are nutritious and were the staple food in the past.
- Demand for millets was seen to be rising but lack of availability and limited product choices acted as a barrier to increased usage.

IORA/VERTIVER member conducting FGDs in Koppal district of Karnataka

4.1. General Overview of Findings

The survey was conducted across Andhra Pradesh, Karnataka, Tamil Nadu, Odisha and Rajasthan and covered 495 farmers. The proportion of male to female respondents was 70:30 in the sample size achieved. Among farmer types, the highest proportion emerged from the 'small farmer' category. The distribution of sample by gender and farmer type is shown in Table 4. 1 and Table 4. 2.

The average overall literacy rate of 58.6% amongst the farmers surveyed was lower than the national rural average literacy rate of 64.3% (Ministry of Rural Development, 2011). The average literacy across men was 67% as compared to 44% among women, which were also lower than the national rural adult literacy rate of 74.1% and 50.6% for males and females respectively (Ministry of Statistics and Programme Implementation, 2017). When compared among states, literacy levels among men were considerably high

Gender	AP	Karnataka	TN	Odisha	Rajasthan	Total
	69	76	53	67	79	344
	51	44	10	33	13	151
Total	120	120	63	100	92	495

Table 4.1: Sample Size achieved Distribution by Gender

Farmer Type	Land Holding (acres)	AP	Karnataka	TN	Odisha	Rajasthan	Total
Marginal	<2.5	26	35	14	31	38	144
Small	2.5-5	54	36	25	42	28	185
Semi Medium	5-10	36	24	19	19	9	107
Medium	10-15	3	14	5	8	4	34
Big	>15w	1	11			13	25
		120	120	63	100	92	495

Table 4.2: Sample Size distribution by farmer type

in Karnataka (81%) and Rajasthan (75%) while literacy level among women were found to be low in Rajasthan (42%) and very low in Odisha (12%) (Figure 4.1). The gap in literacy levels among men and women was significant in Odisha (45%) and Rajasthan (34%). At the national level as well, Rajasthan shows the biggest gap in male and female literacy levels at 27.1% (Ministry of Statistics and Programme Implementation, 2017).

The average annual income from farming was the highest in Andhra Pradesh, followed by Tamil Nadu and Karnataka. Income from farming is the least in Odisha among all states, across all farmer types. When compared, women seem to have higher incomes than men in farming, almost across all farmer categories (Figure 4. 2). This could be attributed to additional income generated from dairy farming which was identified as

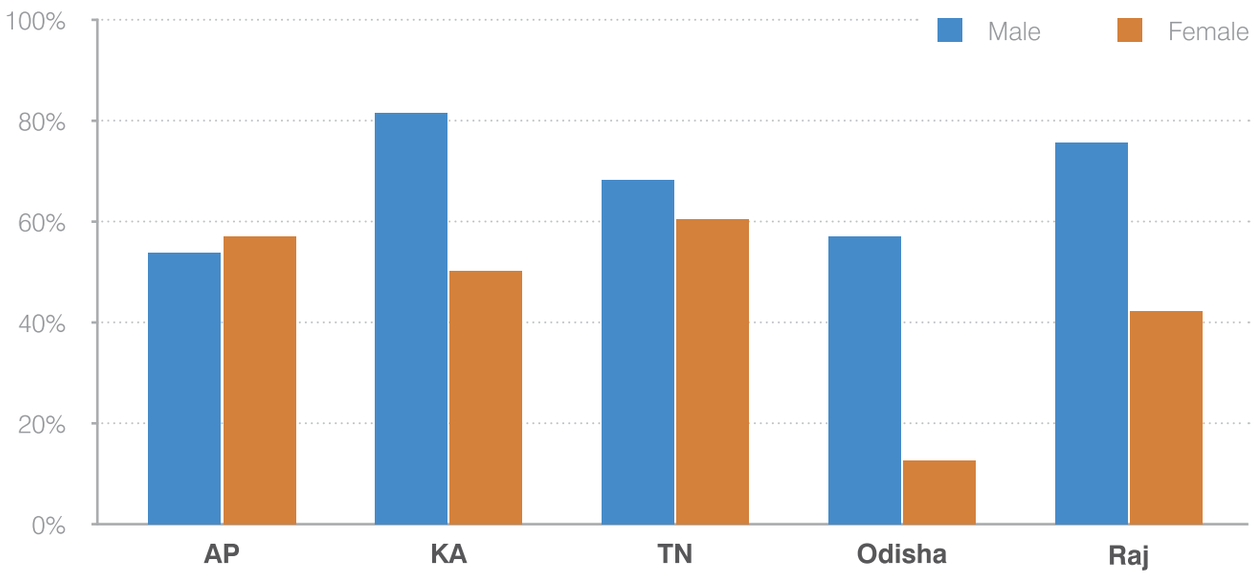


Figure 4.1: Literacy Level across states by Gender

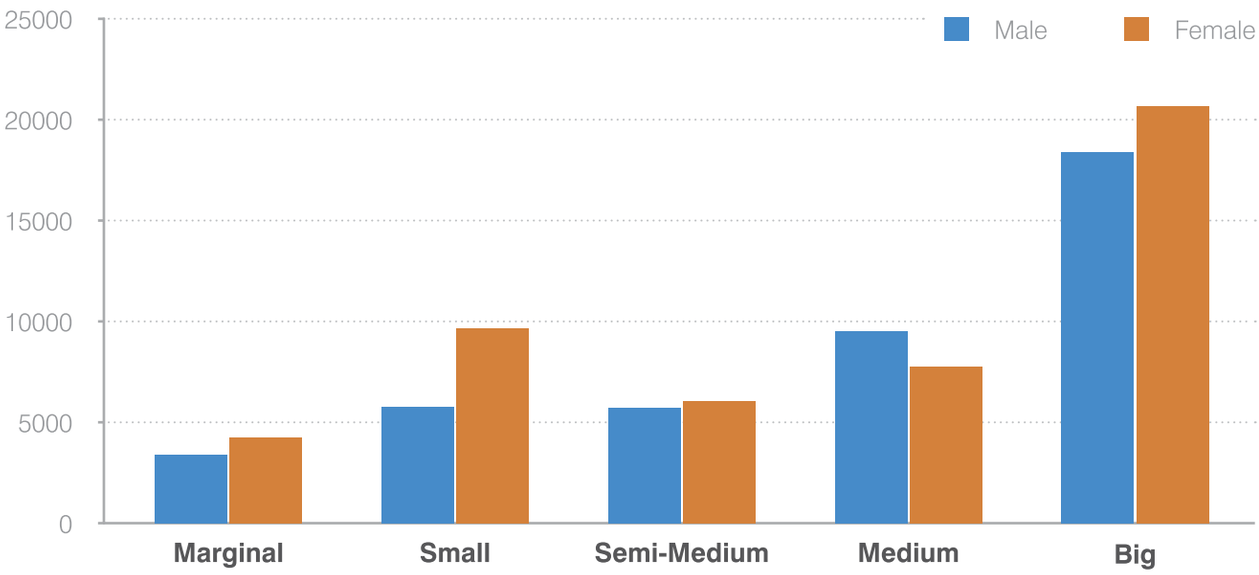


Figure 4.2: Income across Farmer Categories by Gender

a source during discussions with the NGO partners in the study areas. Of the total farmers surveyed, 33.7% fall below the poverty line, which is higher than the national average of farming households below the poverty line (22.5%) (Chand, 2017).

The highest proportion of these were present in Odisha where overall 69% of farmers were in the BPL category, with both male (76.1%) and female (54.5%) having the highest numbers (Figure 4. 3). According to the Consumption Expenditure Survey of 2011-12, this state also has the second highest rate in the country for farmers below the poverty line (32.1%). Tamil Nadu showed the opposite trend with an overall average lower than the national average with only 4.8% of farmers below the poverty line followed by Andhra Pradesh at 15.8%. Tamil Nadu also had the lowest proportion of their income coming from millet farming at only 10% (Figure 4. 3).

4.2. Millet Uses

Traditionally millets have been a part of the staple diet in India. The results from the study indicate that the small, semi-medium, and medium farmers consumed over half of the millets produced in their farm, with semi-medium farmers consuming more than other categories (62%). The millets are preferred as first choice compared to other staples like corn, wheat and rice by over 50% of farmers belonging to all categories, with highest preference from semi-medium (89%) and small farmers (72%).

The survey also indicates that the use of millet as part of the farmers' diet is prevalent across states and is particularly high in the states of Tamil Nadu (84%), Karnataka (79%) and Rajasthan (73%). In Rajasthan, most farmers prefer Pearl millet and Moth bean, which are frequently used in making Chhash, Rabadi,

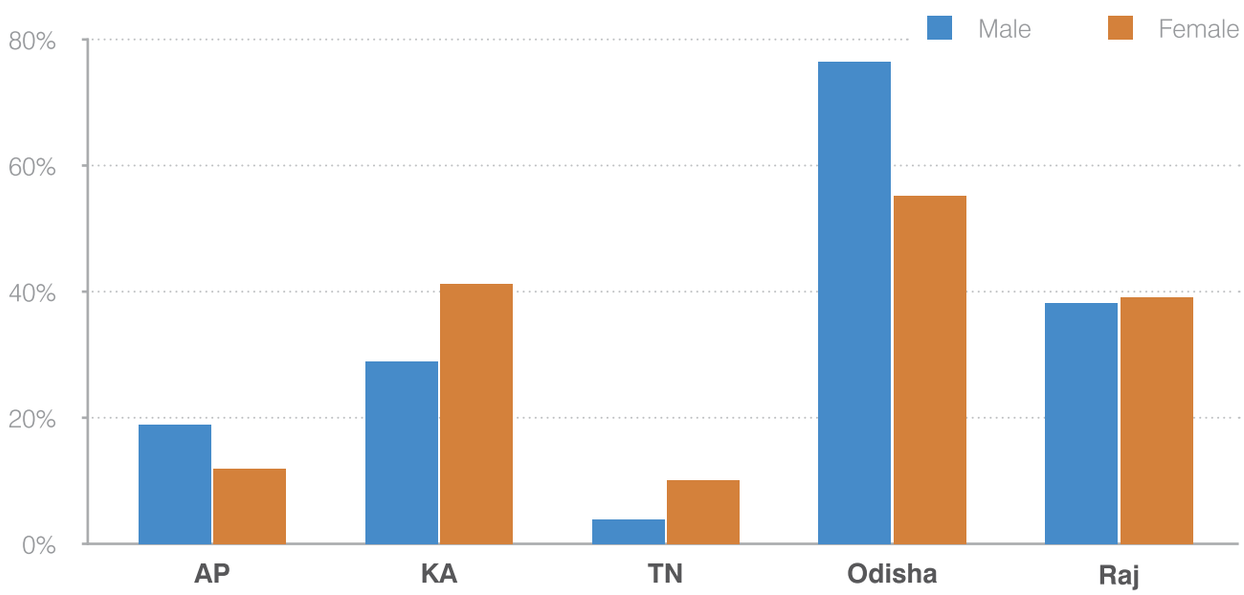


Figure 4.3: Farmers below poverty line

and Khichadi etc.

On an average, a higher proportion of female farmers, especially in Andhra Pradesh and Karnataka consider millets as a good nutrition supplement to other grains and eat them as an alternate food. However, this trend is not driven in equal proportion by the use of millets as a nutritional supplement to other grains. Millets find negligible use as nutritional supplement in Odisha (Figure 4.5). In the states of Karnataka and Andhra Pradesh, nearly half of the farmers use millets as a nutritional supplement to other grains. On

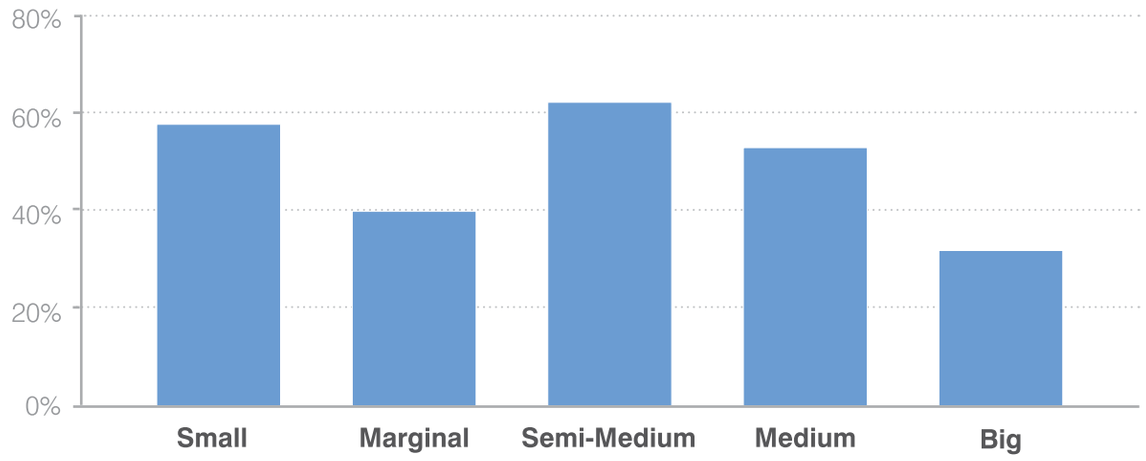


Figure 4.4: Proportion of millets consumed (%) from their own harvest (By Farmer Type)

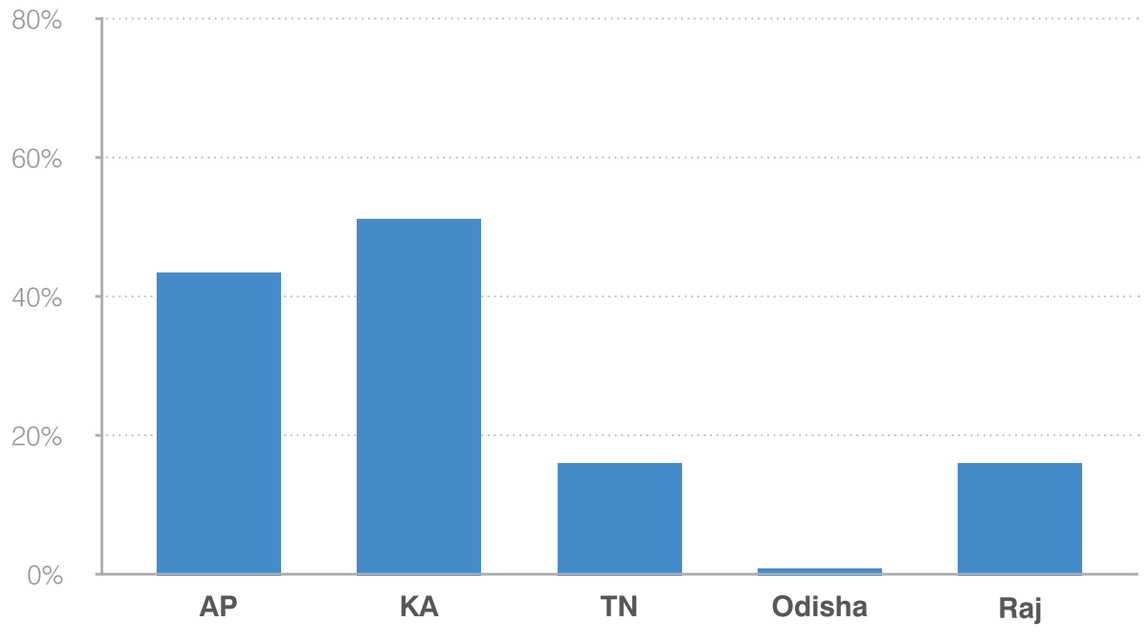


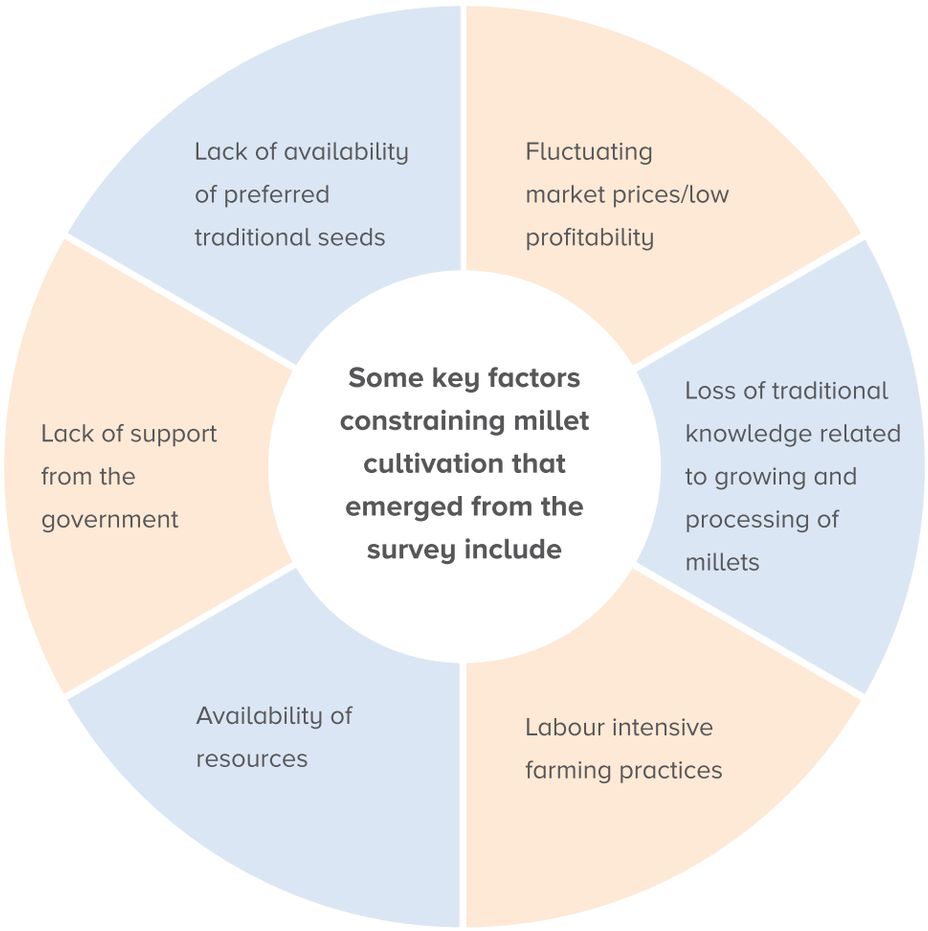
Figure 4.5: Millets as Nutrition supplement

Types of farmers	Preference for crops based on their nutrition				
	No preference	Corn	Millet	Wheat	Rice
Small	2 (1.1)*	35 (18.8)	131(71.5)	7 (3.8)	9 (4.8)
Marginal	9 (6.3)	29 (20.4)	91 (62.7)	8 (5.6)	7 (4.9)
Semi-medium	0 (0)	9(8.4)	95 (88.8)	1(0.9)	2 (1.9)
Medium	2 (5.9)	10 (29.4)	20 (58.8)	2 (5.9)	0 (0)
Big	2 (7.7)	5 (19.2)	16 (61.54)	1 (3.8)	2 (7.7)

*Figures given in parentheses indicate percentages

Table 4.3: Preference for crops based on their nutrition

Another interesting finding is that although in Karnataka and Tamil Nadu, farmers prefer consuming millets, they are averse to cultivating them extensively, owing to unprofitability of millet cultivation.



the other hand, it is merely 16% in Tamil Nadu and Rajasthan. Even though millets constitute a significant portion of the daily intake for farmers, they are not perceived much of a nutrition supplement in equal proportions across the states. This might indicate farmers' first priority being sustenance. As for nutrition, there is a possibility that multiple sources of nutrition exist.

In addition to their key role in farmers' diets, the waste that is generated from millet farming (husk) is extensively used as fodder, with 80% of those surveyed across all states in all farmer categories using fodder from millets for their livestock. Millet husk forms 20-50% of the total fodder source, which is substantial. The use of fodder from millet is highest in Tamil Nadu and Karnataka with more than two thirds of farmers claiming the millet fodder proportion to be 50% or more. In Odisha this proportion is only 10-20%.

The farmers surveyed across all states use the leaves and husk that are generated as waste from millet farming for a variety of purposes. Whilst the majority of them use this waste as fodder and a feed supplement for their livestock, a small number of farmers also use it as a fuel for cooking. Additionally, this waste is also used as manure where they either leave it on the field as mulch or use it to make manure.

4.3 Millet Farming Practices

The key millets grown across the surveyed AEZs sites are Finger Millet, Pearl Millet, Sorghum and Foxtail Millet. By region, finger millet is largely grown in Andhra Pradesh, Tamil Nadu and Odisha, whereas in Karnataka, Foxtail Millet is the most cultivated and in Rajasthan Pearl Millet is the most prevalent (Figure 4.6). Additionally, Karnataka also showed a higher proportion of the variety of millets grown when compared to other states where one or the other millet was predominant. These millets are known by more than fifty names across the surveyed landscapes (Table 4.4).

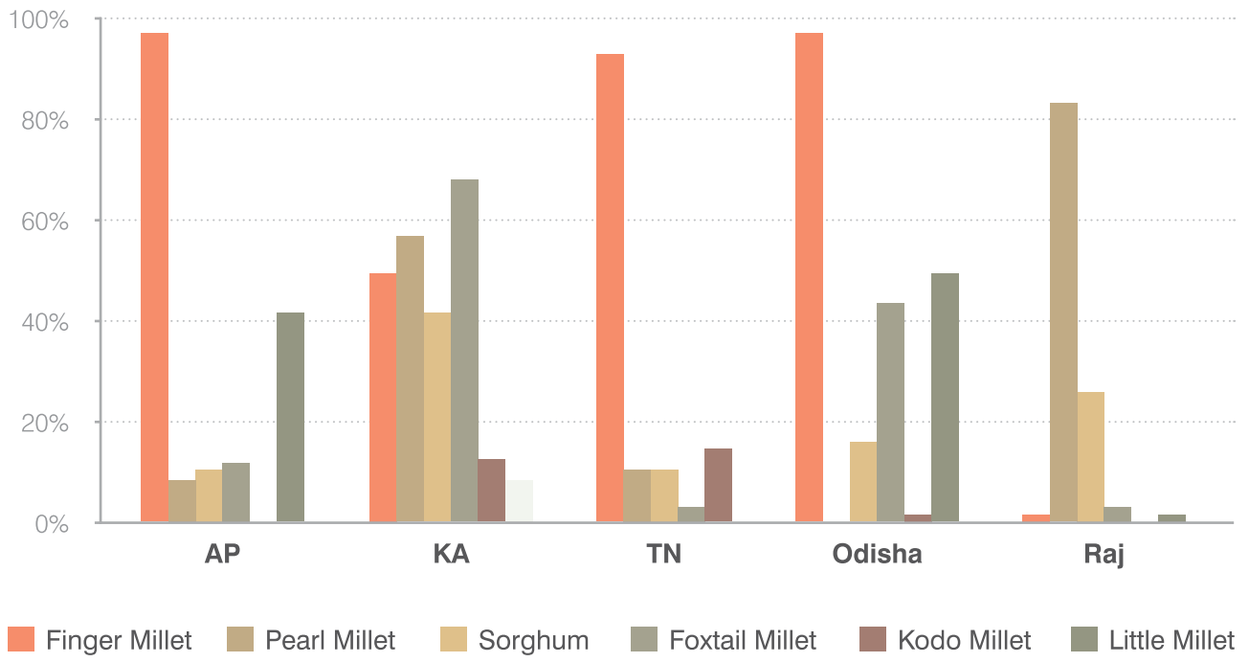


Figure 4.6: Millets grown across states

English Millet Variety	Hindi	Telugu	Kannada	Tamil	Oriya
Pearl	Bajra	Sajjalu	Sajje	Kambu	Bajra
Finger	Nachani, Mundua, Mandika, Marwah	Ragula, Ragi, Chodi	Ragi	Kezhvagu	Mandia
Foxtail	Kangni, Kakum, Rala	Korra	Navane	Thinnai	Kanghu, Kangam, Kora
Kodo	Koden, Kodra	Arikelu, Arika	Harka	Varagu	Kodua
Little	Kutki, Shavan	Sama, Samalu	Saame, Save	Saamai	Suan
Barnyard	Jhangora, Sanwa	Udalu, Kodisama	Oodalu	Kuthravali	Khira
Sorghum	Jowar	Jonna	Jola	Chola	Juara

Table 4.4: Regional names of millets

Intercropping of millets with other millets is widespread, especially in Karnataka, where it is almost the norm. In other regions, millets are grown alongside other crops as well, such as rice and corn (Figure 4.7). The proportion of farmers growing rice in Tamil Nadu and Odisha was very high when compared to those growing corn in spite of most farmers considering this crop to be more nutritious that rice. Additionally, a small proportion of farmers in Rajasthan and Tamil Nadu also grow wheat and groundnut respectively (Figure 4. 7).

On an average, the farmers surveyed cultivate three types of crops each. This trend was similar across each of the farmer categories and the size of the landholding appears to not make a 24 difference in the cropping patterns followed (Table 4.5). However, large varieties of crops were grown across the different geographies with those in Andhra Pradesh growing fewer crop types compared to those in Odisha.

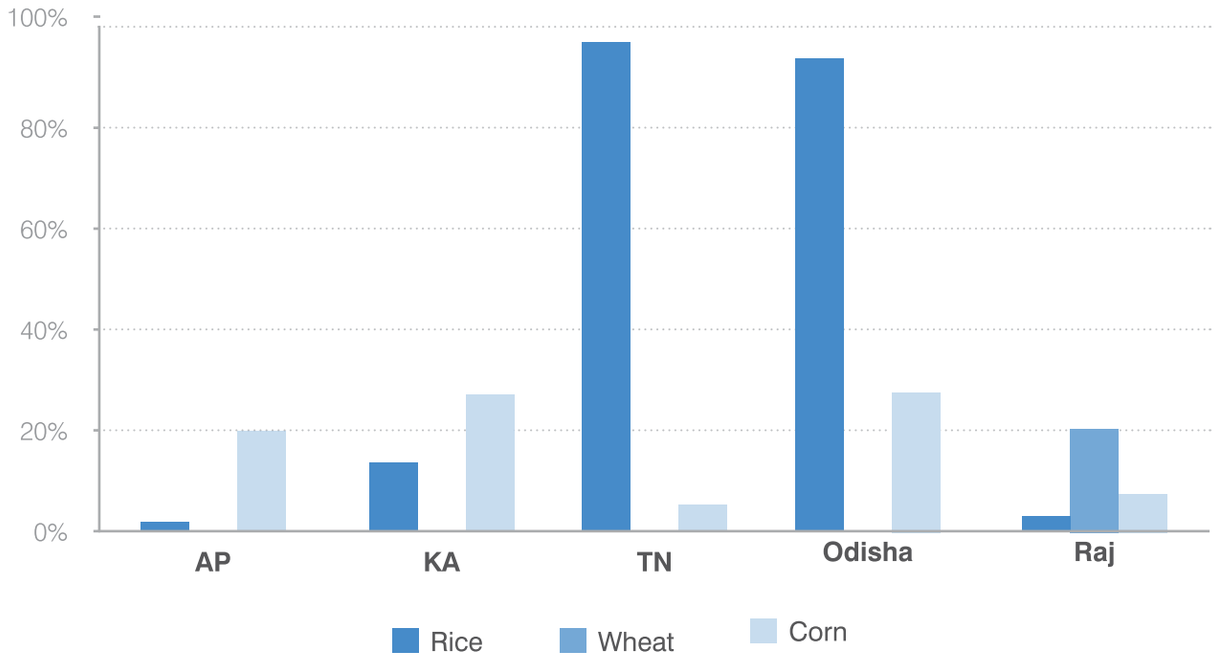


Figure 4.7: Crops grown across states

Across Farmer type		Across States	
Small	3.0	AP	2.2
Semi Medium	3.0	KA	3.0
Marginal	2.9	TN	3.5
Medium	3.5	Odisha	3.9
Big	3.1	Raj	2.7

Table 4.5: Average number of crops per farmer

The figure below shows the most common cropping practices across the survey AEZs

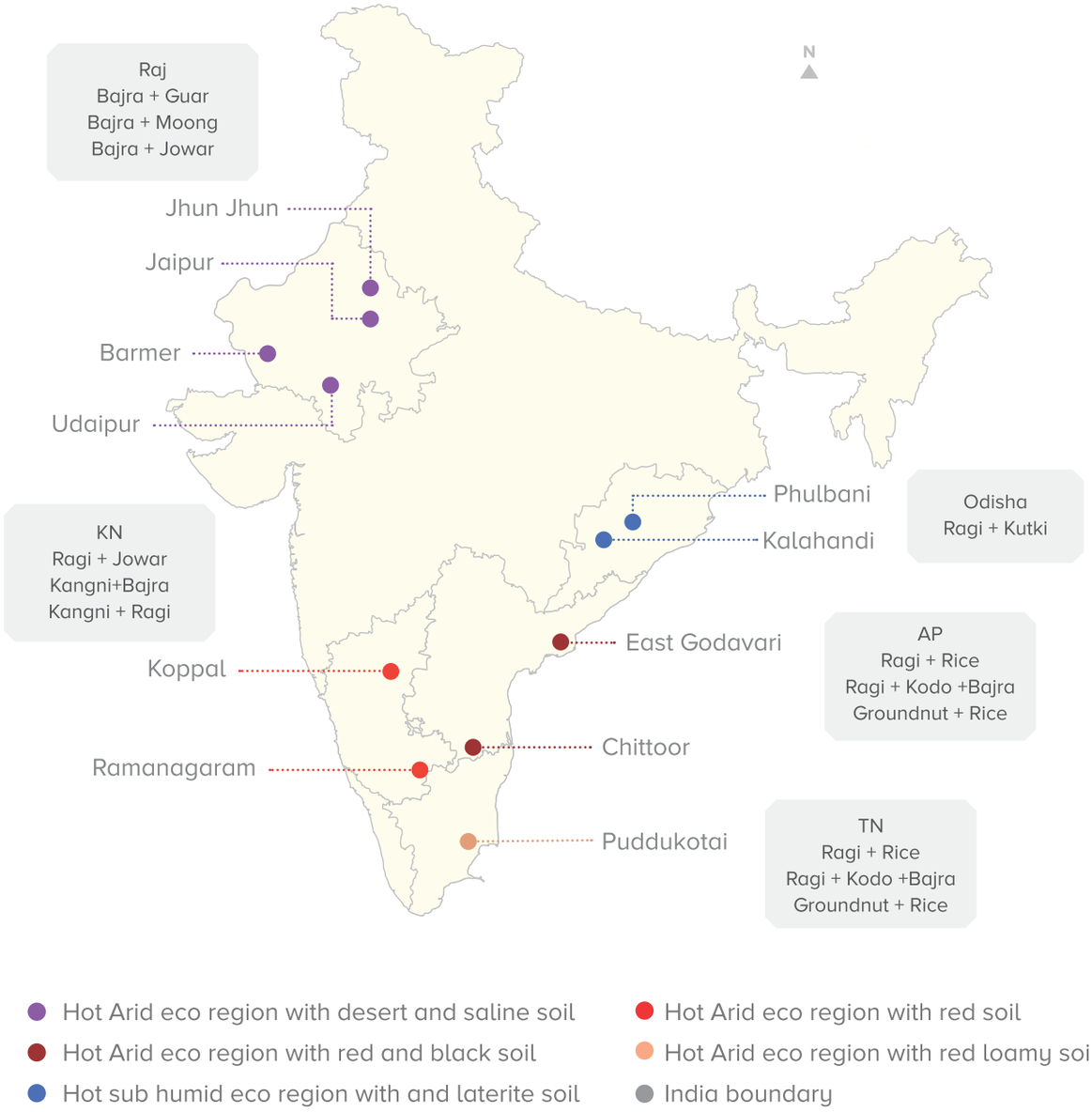


Figure 4.8: Millet cropping system across AEZs

Overall, an average of 75% farmers practice intercropping and include millets in this practice. This number was highest in Karnataka with 99% farmers practising intercropping with millets, followed by Odisha at 82%, Andhra Pradesh at 73.3%, Tamil Nadu at 65% and lowest in Rajasthan with only 42% farmers practicing intercropping. There seems to be little variance in the practices of intercropping across farmer types and it is similar with almost 70-80% farmers practising it across all categories.

In Andhra Pradesh, intercropping is practised mainly with Finger Millets (72%) followed by Little Millet (51%). In Karnataka, Pearl Millet is most commonly used in intercropping (89%) along with Red gram (71%). Intercropping with

pulses like red gram, black gram, green gram is also common in Tamil Nadu. Finger Millet is used almost universally in intercropping in the state of Odisha. The other millets used in intercropping include Little millet, Foxtail millet and Sorghum. In the case of Rajasthan, intercropping is majorly done with Pearl millet (85%) followed by green gram and Gwar beans.

Whilst millets have traditionally been a rainfed crop, under the current scenario of changing weather patterns and decreased rainfall, there has arisen a need for irrigation for millet farming. This reduction in rainfall was mentioned as one of the main barriers to millet cultivation and the reasons for its decline amongst the farmers surveyed. Additionally, studies have also shown that under rainfed conditions farmers receive a negative return to their invest in millet farming whereas this has a positive return in an irrigated situation (Sakamma et al., 2017). Overall, only one third of the respondent farmers had access to sufficient irrigation during the cropping period. This was relatively higher in Andhra Pradesh and Tamil Nadu but almost negligible in Odisha (Figure 4.9). Access to irrigation during crop period was marginally better for medium and big farmers compared to those in the small and marginal categories. Although there seems to be little variation in irrigation access across gender, considerable differences existed in the states of Andhra Pradesh and Rajasthan.

Traditionally millets have been grown organically across the country, however this is now changing in some areas with the younger generation of farmers following more intensive farming practices. The awareness of the difference between organic and chemical farming was overall higher amongst female farmers compared to their male counterparts. This difference of awareness rates between the two genders was considerable in Andhra Pradesh, Odisha and Rajasthan whilst being marginally lower in Karnataka and Tamil Nadu (Figure 4.10). The majority of respondents were aware of the health benefits of organic farming, and the fact that it reduces their input costs considerably. A small number of farmers also mentioned that using chemical fertilisers reduces soil fertility. However, they also

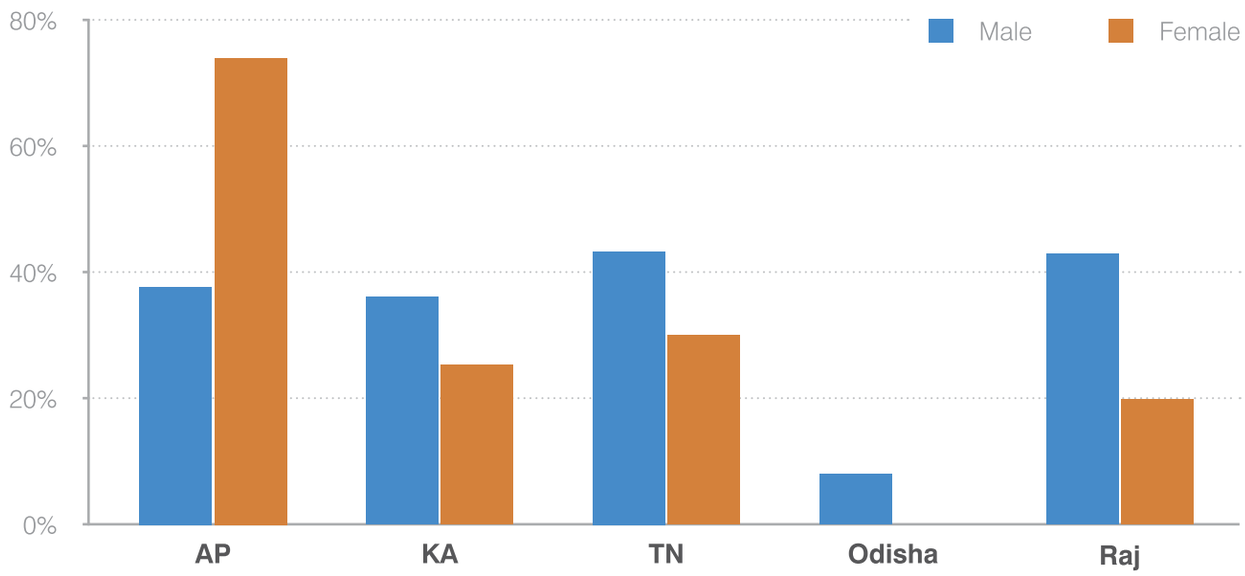


Figure 4.9: Percentage of farmers with access to irrigation

expressed concerns about organic farming potentially resulting in lower yields and in increasing their workload. The use of bio fertilizers was predominant in Rajasthan (71%), followed by Tamil Nadu (55%) and Odisha (50%) while it was less than 10% in Andhra Pradesh and Karnataka (Figure 4.11). Among those using bio fertilizers, a high proportion was from the marginal and small farmer categories.

In addition to the use of biofertilisers, farmers were also practising integrated plant nutrient management (IPNM), however, overall this number was relatively low (22%). The majority of those who practise IPNM were in Tamil Nadu, Rajasthan and Andhra Pradesh (Figure 4.12). There was no significant variation in the spread of this practice across farmer types or gender, except in Andhra Pradesh where more female farmers practice this compared

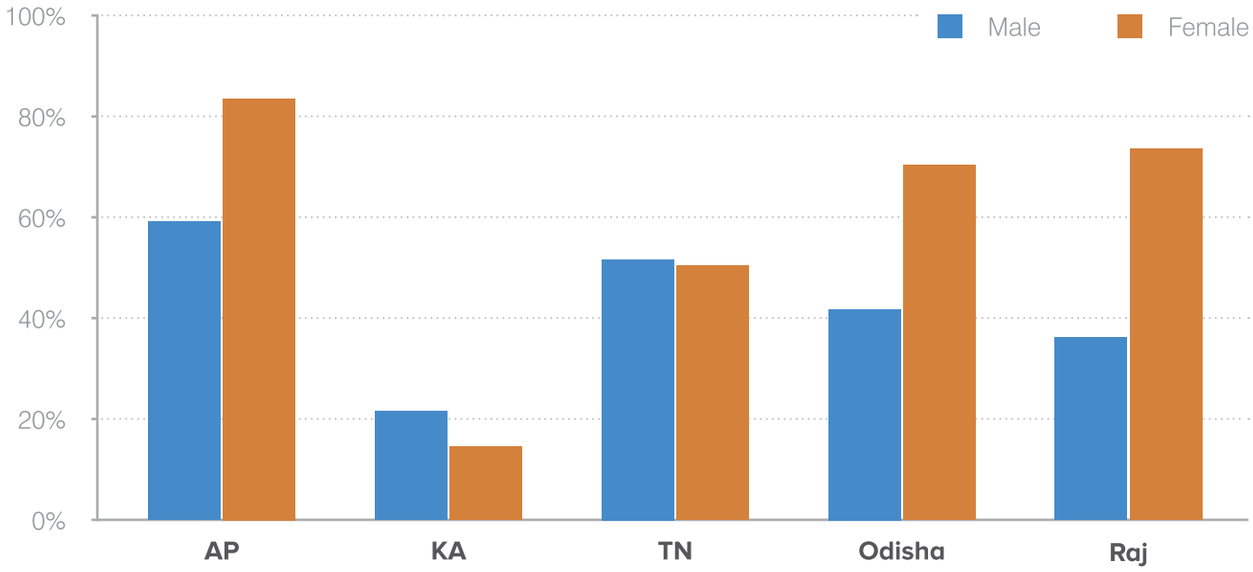


Figure 4.10: Awareness of organic farming

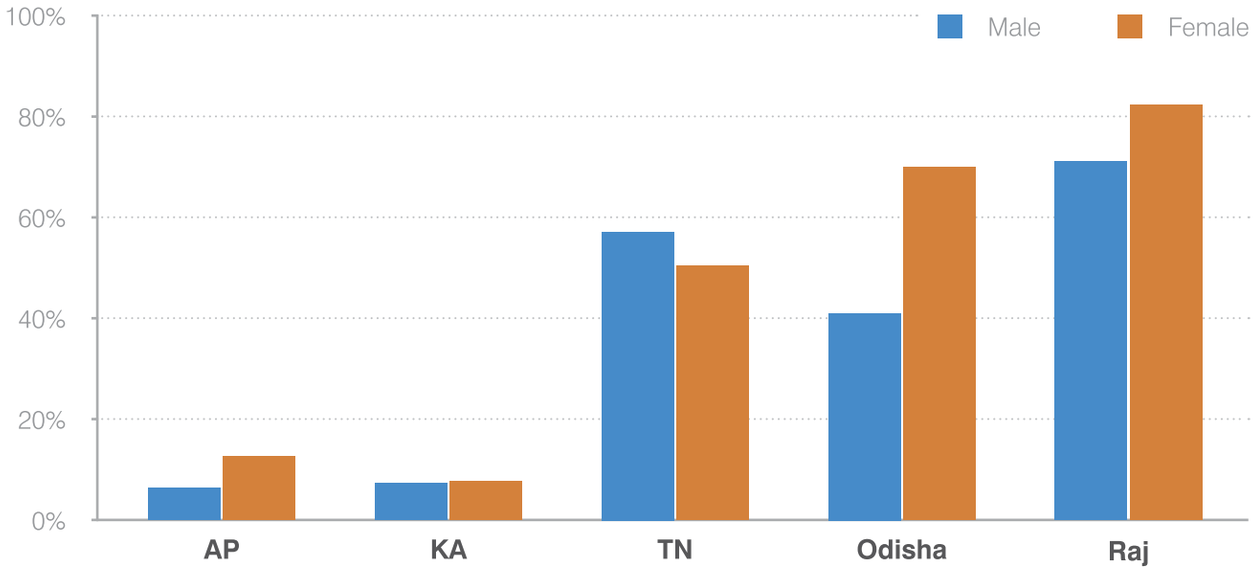


Figure 4.11: Use of Biofertilliser

to males. In Odisha, no farmers appear to be practising IPNM however this could be an indication of the lack of understanding of the question rather than an indication of their farming practices.

Millets are prone to fewer pest and disease attacks compared to other cereals and this was also reported by the farmers surveyed here. However, as with other issues arising due to climate change, pest and disease attacks on millets are also on the rise. Amongst all millets, Pearl millet seems to be most commonly affected by diseases and pests, especially in Rajasthan. The pests and diseases mentioned were aphids, jassids, stem borer, leaf borer, leaf spot and termites (Table 4.6).

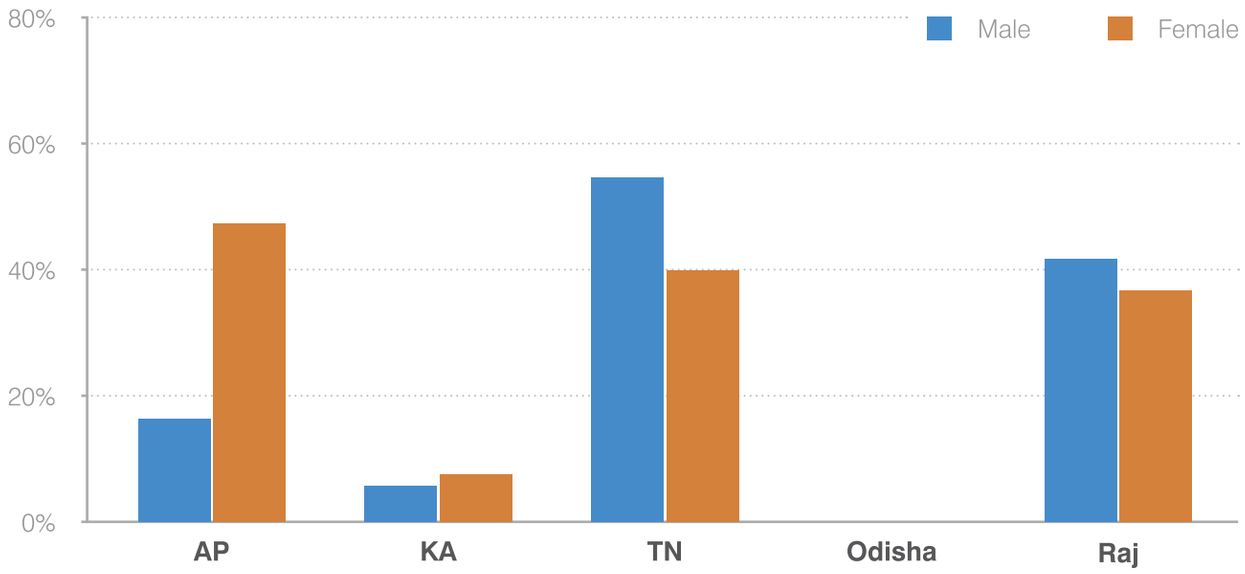


Figure 4.12: Use of integrated plant nutrient management

Millet Type	Diseases	Pests
Finger Millet	Leaf Spot	Aphids & Jassids, Stem Borrer, Asuvini
Pearl Millet	Fungus	Aphids and Jassids, Termites
Little Millet		Aphids & Jassids, Stem Borrer,

Table 4.6: Pest & Diseases in Millets

4.4. Millet Economics

This section seeks to capture the economics of growing millets from a farmer's perspective. This includes trends of millet sale, income from millets etc. Income from millets as ratio of total farming income ranges from 10- 50%. The average proportion of income is highest in Karnataka (52%) followed by Rajasthan (42%) (Figure 4.13). As mentioned above, the proportion of income from millet farming was the lowest in Tamil Nadu and this was also the state with the fewest farmers who were below the poverty line (Figure 4.14).

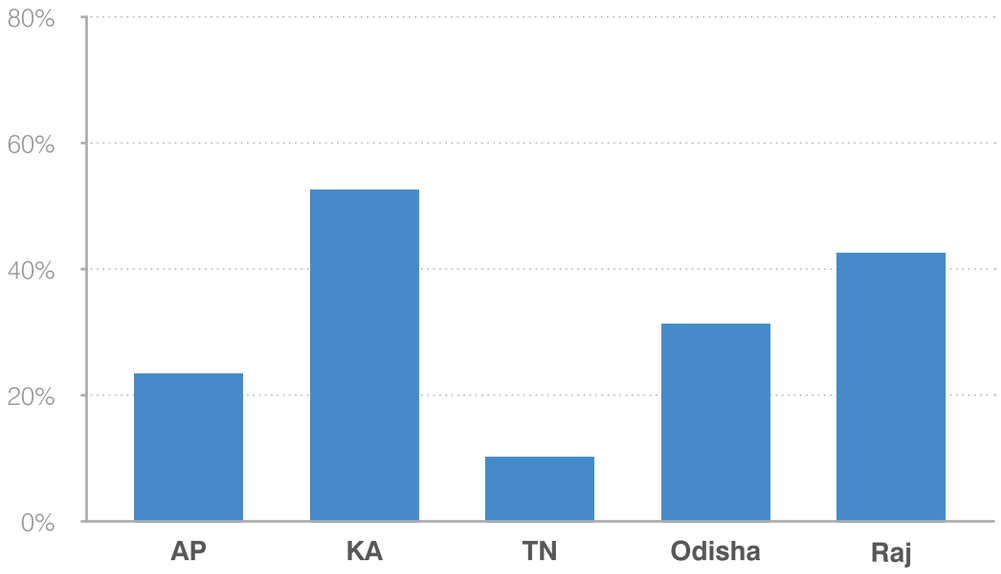


Figure 4.13: Millet Income Proportion

Among the farmers surveyed, millets were widely grown for their own consumption with a higher percentage of farmers growing each millet for consumption than for sale (Figure 4.14). There wasn't much variability across farmer types in sale and consumption pattern, however, farmers were selective in choosing the type of millet for consumption and sale. For example, in Odisha, Finger millet was grown by more farmers than Little millet but the sale of Little millet was higher, while Finger millet was used mostly for consumption.

When comparing the proportion of farmers that grow millets only for sale to those that grow them only for their own consumption, again a similar pattern was observed for each of the millets grown (Figure 4.15). It is interesting to note that more than 80% of farmers are consuming the millets grown by them and more than a third of them are growing millets only for consumption and not for sale. This indicates that the farmers are dependent on millets for food security. This dependency was observed to be higher in states of Odisha, Andhra Pradesh and Karnataka.

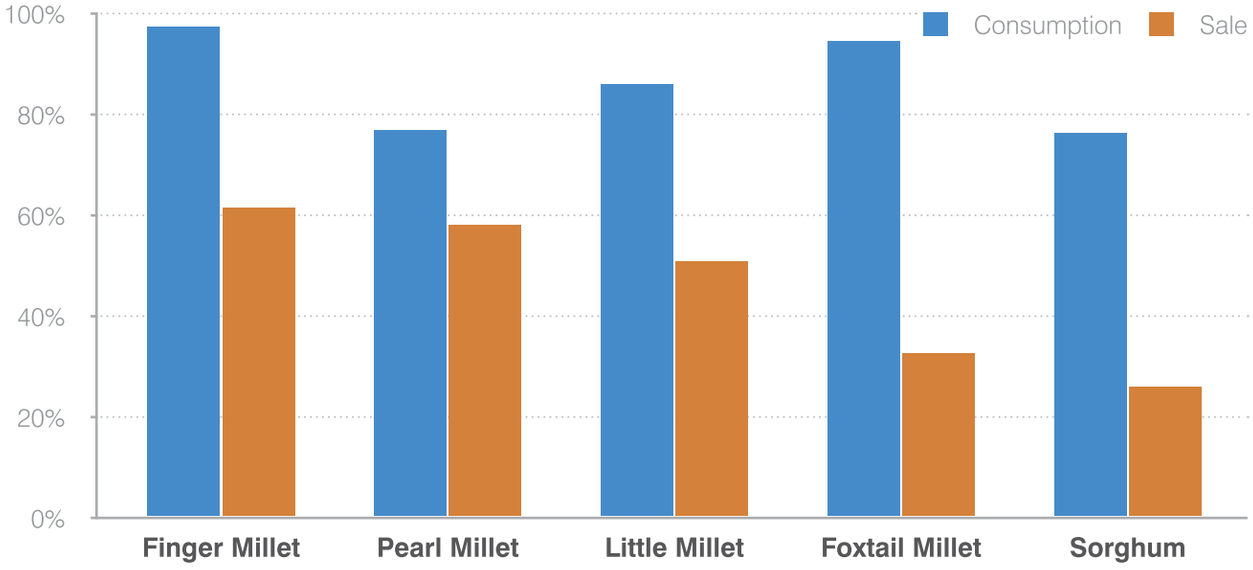


Figure 4.14: Millets for consumption vs sale

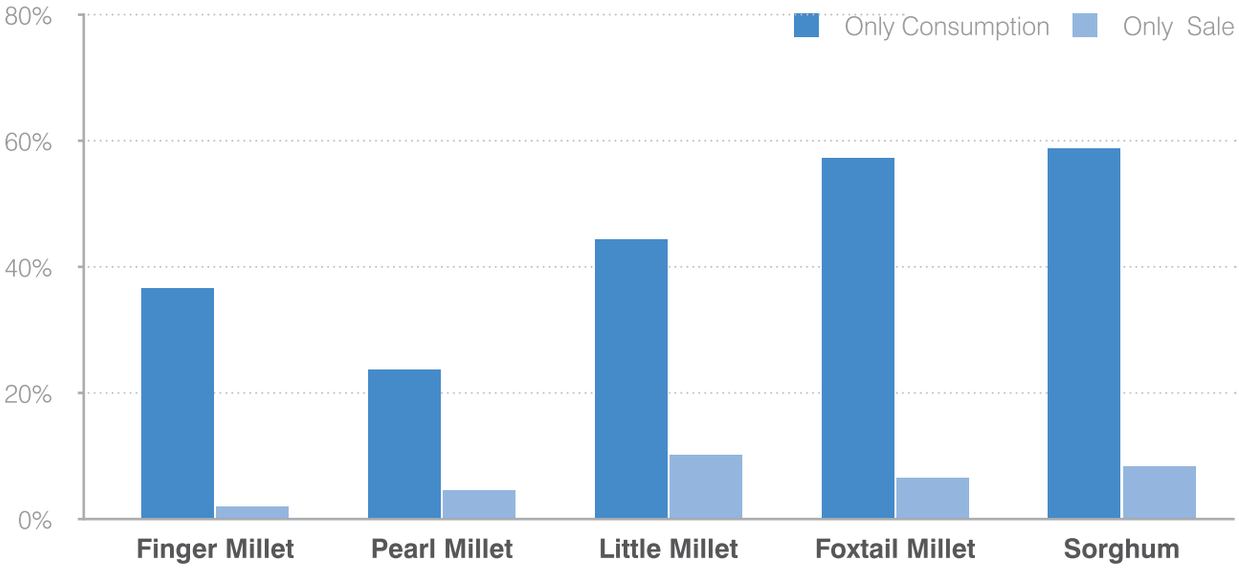


Figure 4.15: Millets for Consumption vs sale – 2


“More than 80% of farmers are consuming the millets grown by them and more than a third of them are growing millets only for consumption and not for sale.”

Finger millet is the most consumed millet across all states except in Rajasthan with it being consumed by a similar proportion of farmers across all categories (Figure 4.16).

Majority of the farmers across categories (>70%) indicated their preference for millets over corn, wheat and rice because of their high profitability. This indicates the versatility of millets in providing high profit while catering to household nutritional security.

The farmers obtain one third of their total crops income from millets. As the small and marginal farmers retain their produce for their own consumption and seed, the medium and big farmers sell their produce to get higher income from millets (> 33%) (Figure 4. 17).

To understand the profitability of millet cultivation, return on investment was taken as a surrogate measure and this was calculated as a proportion of income from millets to the total input cost for growing millets. It is worthwhile to mention here that the input costs might be grossly undervalued in most cases since the farmers account only for limited cost heads. Cost of labour, land, seeds (domestically stored) are not included in many cases. Additionally, prevalent millet practices do not make use of other inputs like irrigation, fertilisers and pesticides.

The results obtained showed that a higher proportion of marginal famers were making losses, as compared to small or semi medium farmers, majority of whom are profitable (Table 4.6). Among those making a profit, most were getting a return of up to five times. There were a few getting 5-20 times as well. However, this high profitability is not a driver of higher cultivation since the demand of millets is much lower than other cereals. Additionally, farmers stated the following during a FGD in Koppal, Karnataka,

> “Prices of millets fluctuate heavily over the years and in many cases farmers do noteven recover their cultivation costs.”

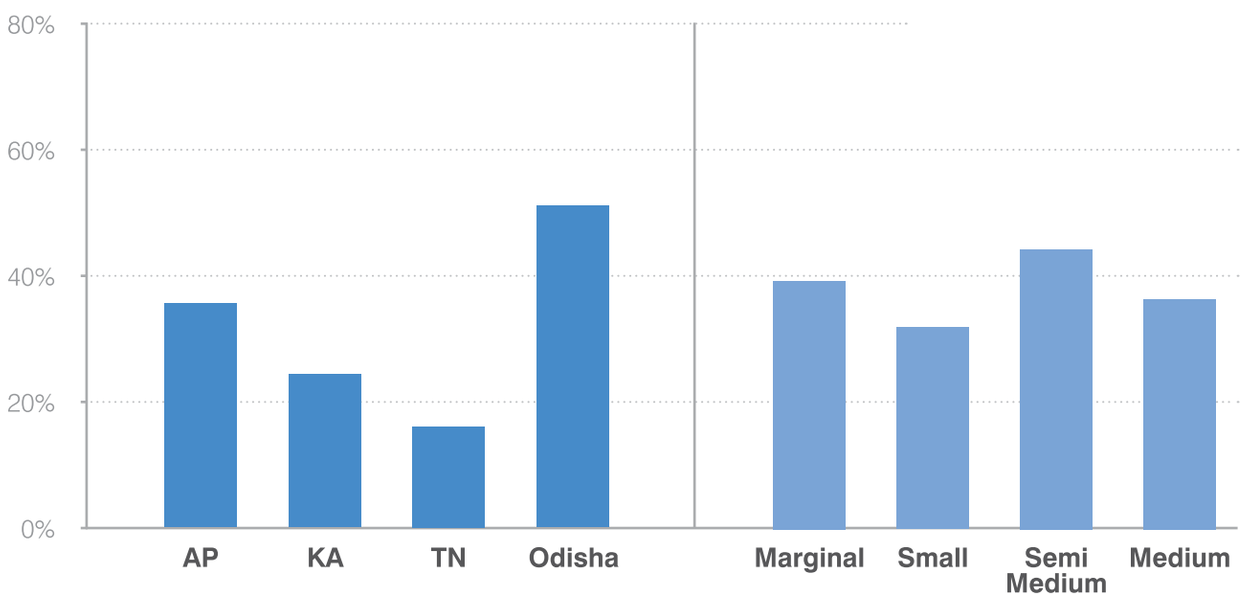


Figure 4.16: Consumption patterns of Finger millet

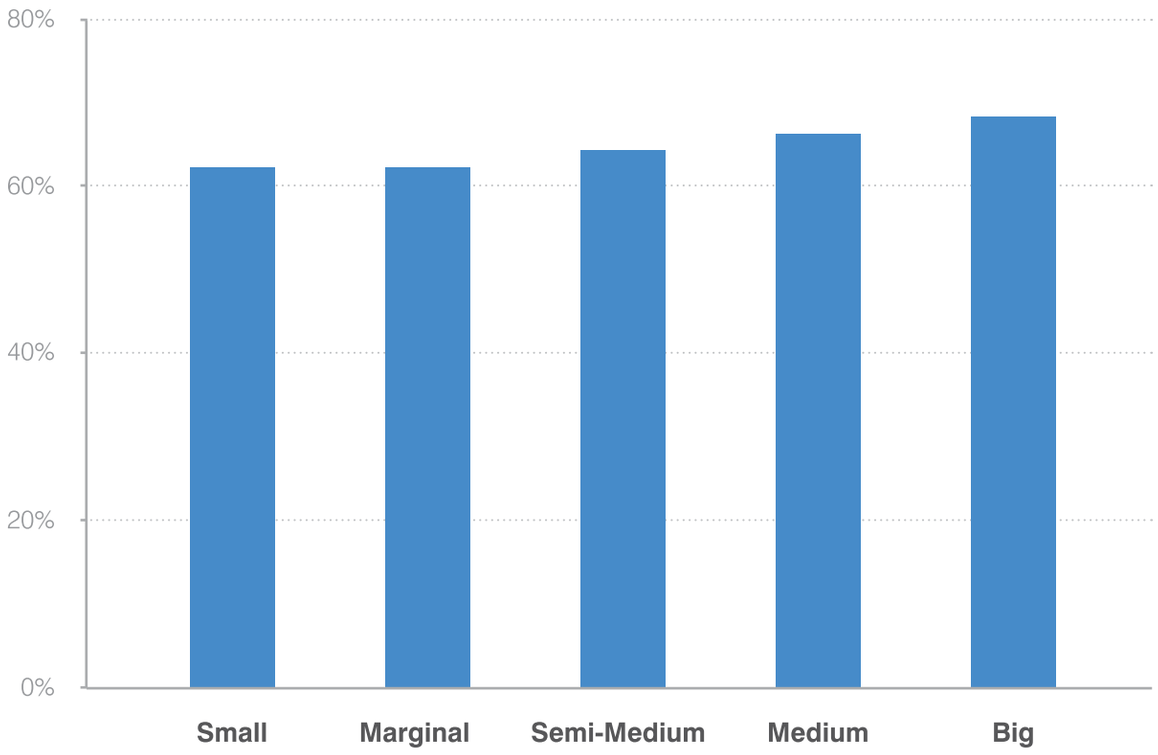


Figure 4.17: Proportion of income from millets to the total income from crops

Profitability	Marginal	Small	Semi Medium	Medium	Big	All Total
Loss	33%	18%	20%	30%	32%	25%
1-5 Times	34%	39%	63%	43%	41%	42%
5-10 Times	13%	22%	6%	4%	0%	13%
10-20 Times	12%	12%	2%	4%	9%	9%
>20 Times	7%	10%	10%	17%	18%	10%
Sample Size	99	111	51	23	22	306

Table 4.7: Return on Input Cost

When profitability was compared between farmers with and without access to irrigation during the cropping period, a big contrast was seen. In the marginal and small categories, only 18% of those with access to irrigation showed a loss as compared to 32% of those who have no access to irrigation. Additionally, overall 40% of those with access to irrigation were making five times return on their investment as compared to 25% of those without irrigation, highlighting the ever-increasing importance of irrigation to millet farming.

4.5 Market Linkages

Information on whether farmers are able to sell their produce at higher profit markets showed a contrasting trend in the five states. Whilst in Karnataka and Tamil Nadu the majority of farmers have access to high profits markets (Figure 4.18), this is not the case in Andhra Pradesh, Odisha and Rajasthan. One of the biggest challenges for small and marginal farmers is an effective means of marketing their produce. Over the last few years, co-operatives have been formed to organise the sale of non-cereal foods, proving to be a profitable initiative for small and marginal farmers providing them better access to both input and output markets (Praveen, 2008). Similar models could be set up for millet farmers, especially those in remote areas to help them access high profit markets.

Farmers in Karnataka and Tamil Nadu did not respond on being asked whether they clean and grade their produce, whilst in the remaining three states, 62% of farmers said they do not clean and grade millets. Additionally, farmers in these three states also indicated not receiving a premium price for their clean and graded produce. Whilst this number was lowest in OdishaAdditionally, farmers in these three states also indicated not receiving a premium price for their clean

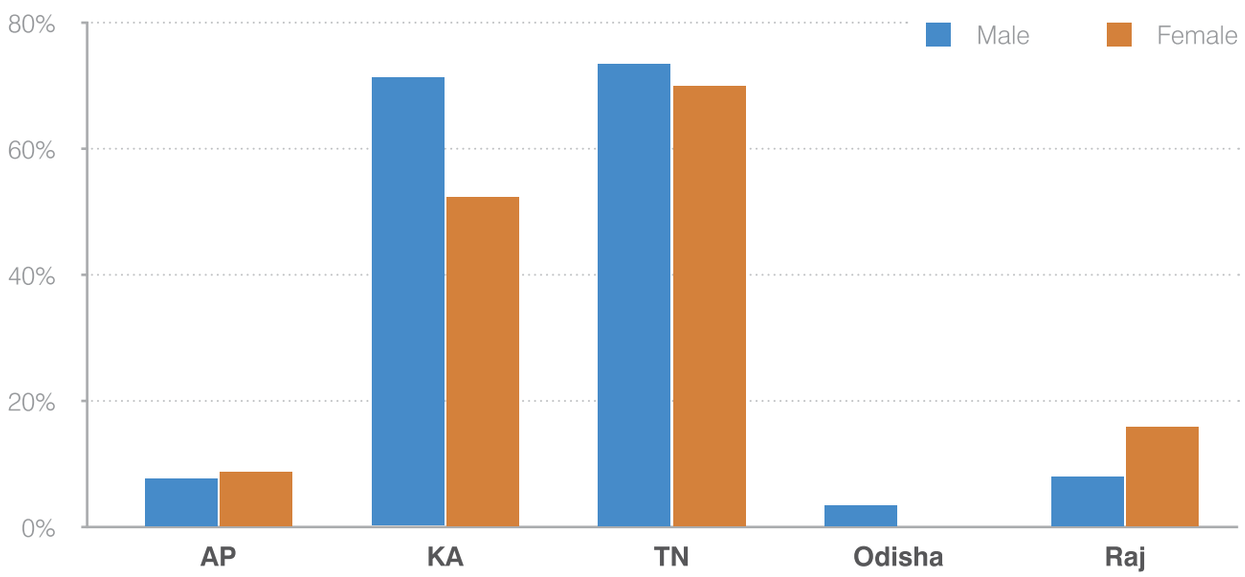


Figure 4.18: Access to high profit markets

and graded produce. Whilst this number was lowest in Odisha with only 18% of farmers receiving a premium price for cleaned and graded produce, it was the highest in Tamil Nadu at 90% (Figure 4.19).

In Tamil Nadu, the main buyer (Table 4.8) for the majority of farmers (97%) is the block level trader (BT) whereas for farmers in Odisha (58%) it is the village level trader (VT) and this is similar across all farmer categories. However, in case of finger millet the buyer profile is widespread. Farmers of finger millet sell mostly to block traders followed by village traders and at local haats. The selling prices were variable across states, ranging from ₹15-25/kg for Finger millet and ₹10-20/kg for Pearl millet.

Taken together, these results indicate that farmers in the districts surveyed in Karnataka and Tamil Nadu might have better market linkages and are able to sell their produce in different markets in order to receive a premium price, whereas those in Odisha, Andhra Pradesh and Rajasthan might not. In Andhra Pradesh, only 23% of farmers answered when asked whether they sell their entire produce at once or partly as and when the need arises, with a majority responding that they sell as the need arises. In Karnataka, 98% (Figure 4.18) of farmers sell their entire produce altogether rather than partly, whereas the opposite trend was seen in Odisha (5%).

Farmers also displayed a predominant trend of storing millets over a 6-12 month period, usually in mud pots, aluminium cans, iron boxes and plastic bags and keeping them above ground to prevent moisture and other damage. Whilst the key drivers behind this practice were reported as seed inputs for the next season (69%) and preservation for self-consumption by maintaining food reserves (56%), nearly a third of the respondents also mentioned better prices in off season as a reason for storing. However, as the above figure (Figure 4.20) shows farmer behaviour regarding storage is contrasted across the states surveyed. In Karnataka and Tamil Nadu the majority of farmers do not store large quantities of their produce possibly as they receive a premium price for it (Figure 4. 19). Whereas, in Rajasthan even though they

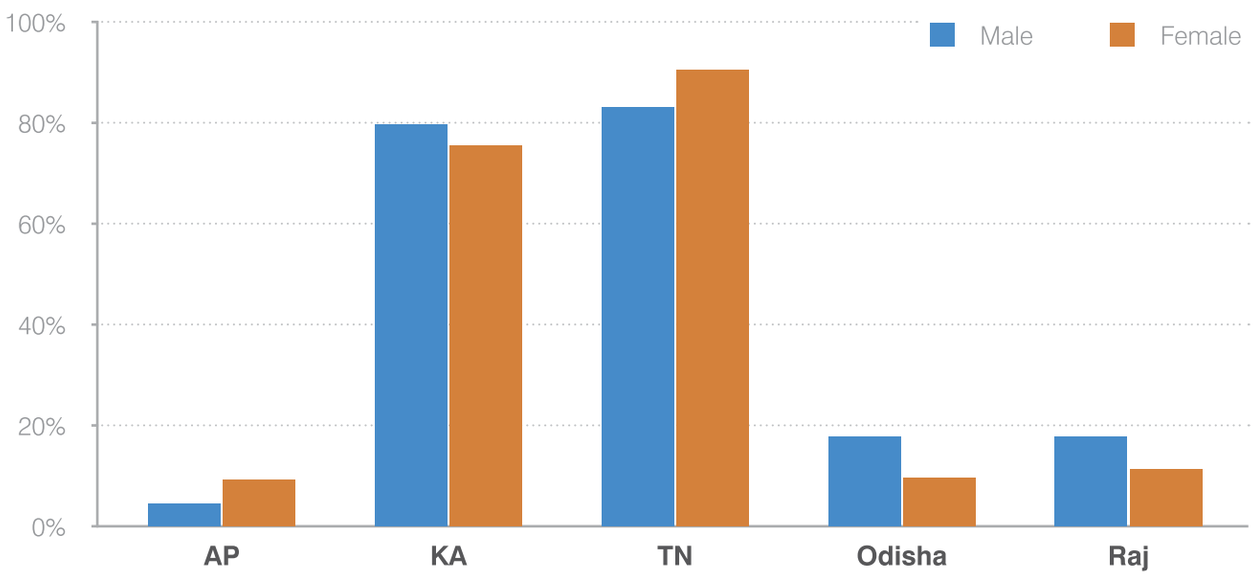


Figure 4.19: Premium price for clean and graded produce

do not receive a premium price, the majority are choosing not to store their produce. One of the possible reasons for this could be the lack of adequate storage facilities resulting in the farmers selling their entire produce as and when it is harvested.

In order to provide a fair price to farmers for millets, the government has set a minimum support price (MSP) for Pearl Millet, Finger Millet and Sorghum which has been hiked this year to provide a profit margin of at least 50% over their cost of production (MSP of 14 kharif crops hiked, millet growers to benefit, 2018).

Millets have also been included in the public distribution system (PDS) with the intent of procuring these at their MSP (Millets to be procured at MSP for public distribution system: Agri minister, 2018). However, in the districts surveyed here, only 23% of farmers were

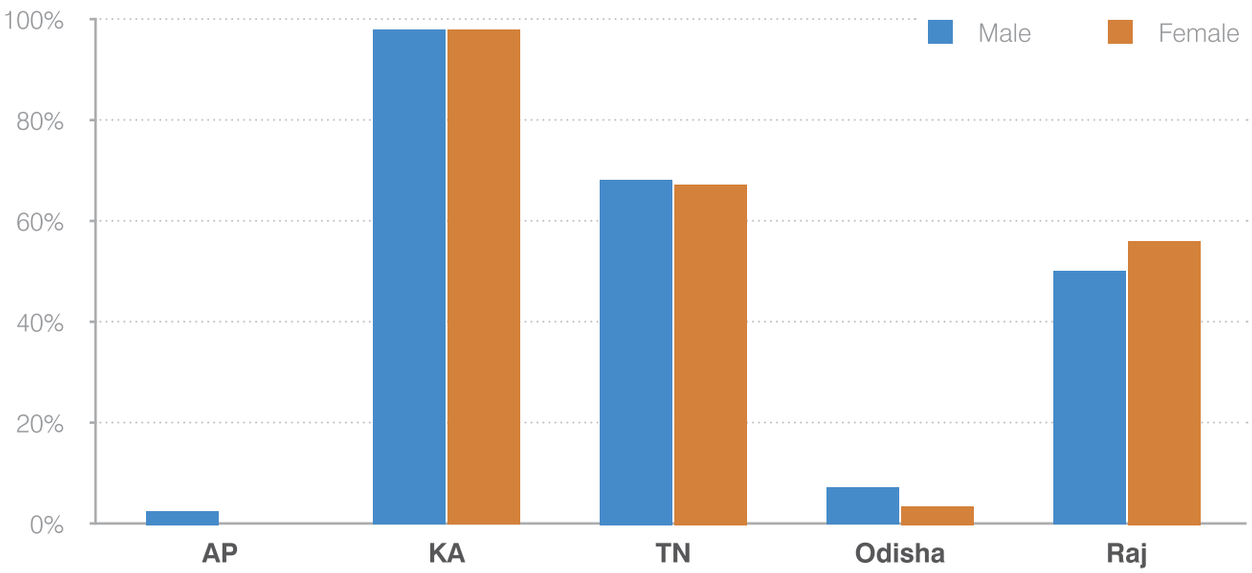


Figure 4.20: Sale of whole produce

aware of there being an MSP for millets and only 8% were aware of them being a part of PDS. Other studies have also shown a low level of awareness of MSP for minor cereals among farmers (Aditya et al., 2017).

In Andhra Pradesh the awareness of MSP of millets was highest with about 65% female and 46% male farmers (Figure 4.21) receiving this information from block level traders, local NGOs, agriculture department or TV and newspapers. However, in the remaining four states most of both male and female farmers did not have knowledge of their being an MSP for millets, which results in farmers selling their produce to local traders at the price they quote. One of the reasons stated for this lack of awareness of MSP was the lack of information passed on from extension workers. Additionally, many farmers also stated that since they cultivate these millets for personal consumption rather than for sale, they are not motivated to avail information on MSPs.

Female farmers in Andhra Pradesh had the highest awareness of millets being in PDS, followed by male farmers in Rajasthan (Figure 4.22). However, these numbers were extremely small with the majority across all states being unaware of this and thus not selling millets to the government. The small number of farmers who do sell to the government receive their information about purchase of millets from the agriculture department, local NGOs or the newspaper and are paid through various means such as cash, bank transfers and cheque. There was also mention of the fact that selling to the government was a very lengthy process and that the prices were often declared a long while after harvest, sometimes even after the farmers had already sold their produce.

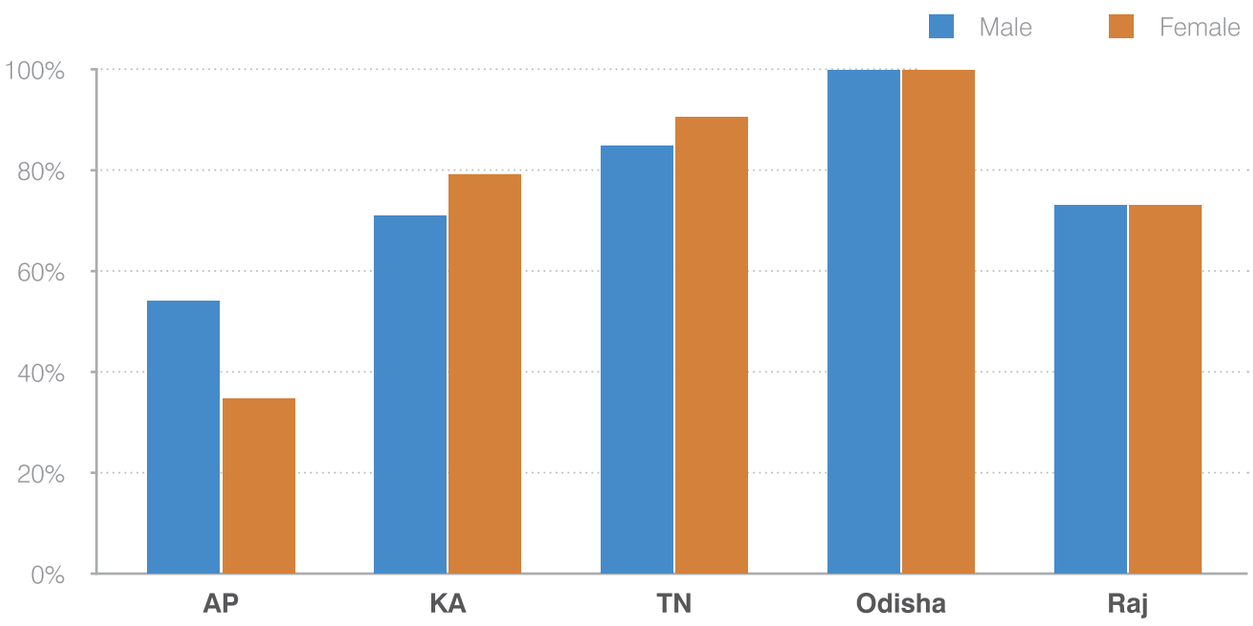


Figure 4.21: Lack of Awareness of MSP

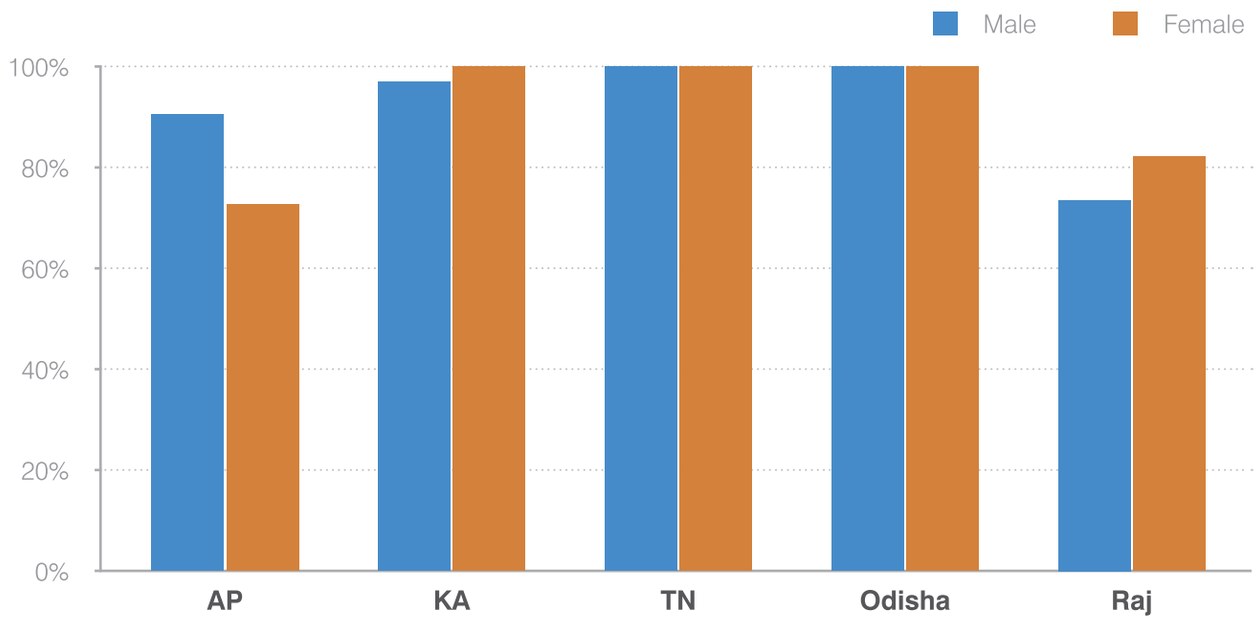


Figure 4.22: Lack of Awareness of PDS

4.6 Payments

The majority of farmers (91%) in all states have a bank account, however, they still receive their payment through cash transactions (96%). Majority of farmers were unaware of online payments through their bank accounts or mobile payments through their phones. However, those that were aware of these options expressed concerns about their safety. Majority of respondents showed a willingness to use both these methods of payments if additional information was provided on them and they were made easier to use. In Karnataka, Tamil Nadu and Odisha 100% of respondents receive cash payments, whilst in

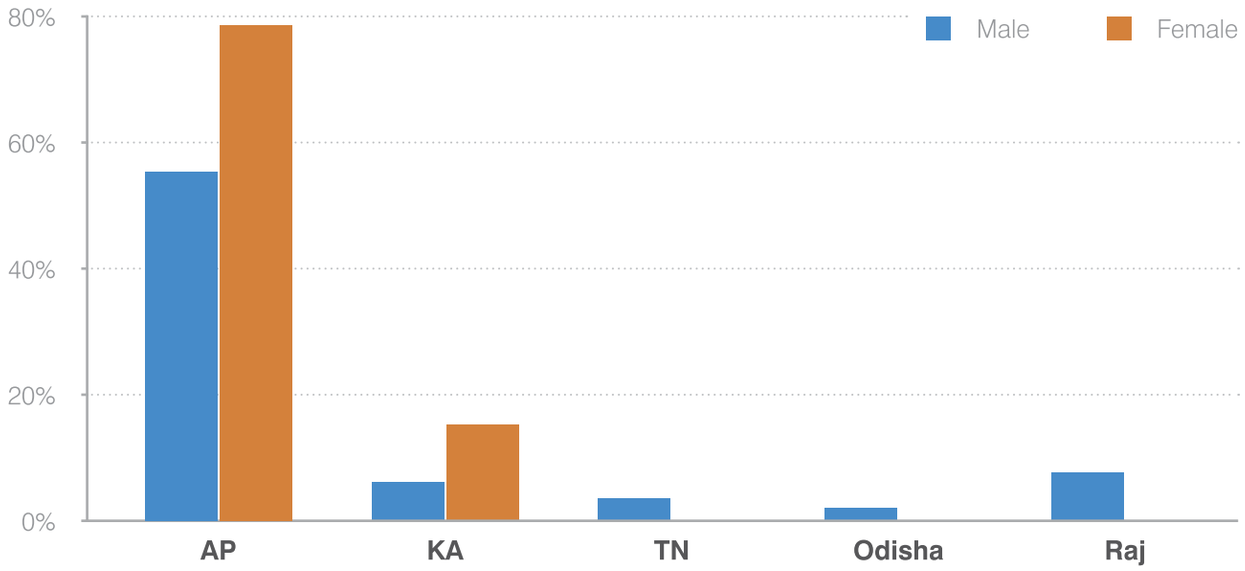


Figure 4.23: Method of Payment – Exchange of goods

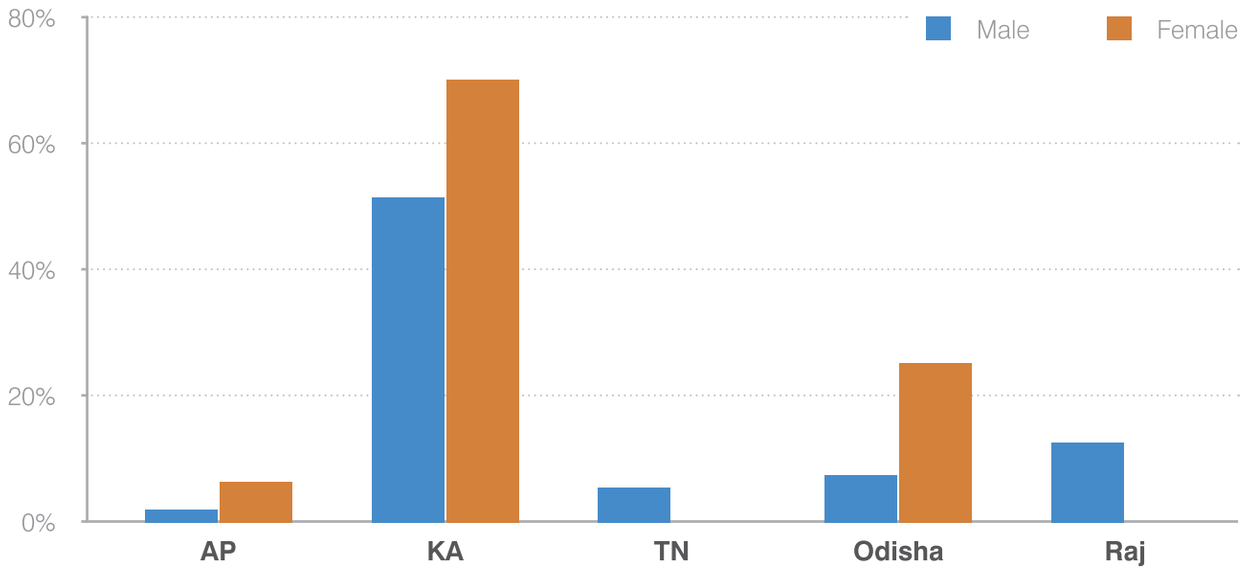


Figure 4.24: Method of Payment – Partially on the spot, rest after 15 days

Rajasthan this number falls marginally to 93%. Andhra Pradesh was the only state where 13.1% of farmers reported receiving payments through bank transfers.

When asked about the nature of transactions for their millet crops, again a contrast was seen between the various states. Whilst the majority of respondents in Andhra Pradesh (Figure 4.23, Figure 4.24 & Figure 4.25) exchange their produce for other goods, in Karnataka they sell it and receive payments in two instalments, one on delivery and one after 15 days. However, in Tamil Nadu, Odisha and Rajasthan the majority sell their produce and receive 100% of their payment on delivery.

Andhra Pradesh, where the majority of millet produce is bartered for other goods also has the lowest number of farmers who receive a premium for their clean and graded produce or have the means to sell at high profit markets. Their main trade centres are their local haats where they sell the produce as and when required. Farmers in Odisha and Rajasthan also do not receive premiums for clean and graded produce and do not have access to high profit markets. However, in both these states, farmers choose to sell their produce rather than exchange it for other goods. Whilst in Rajasthan there is a higher percentage of farmers who choose to sell their entire produce at once, this number is very low in Odisha with farmers opting to sell as and when needed. In Odisha, the majority of trade occurs with the village level trader and in Rajasthan with the block level trader. In Karnataka and Tamil Nadu as well farmers choose to sell their entire produce at once to the block level trader. However, in these two states farmers do receive a premium for their clean and graded produce. Thus, while in Karnataka and Tamil Nadu a block level trader represents a high profit market for farmers, paying a premium for cleaned and graded produce, this is not the case in Rajasthan. Additionally, farmers selling to block level traders showed a trend of selling their entire produce at once rather than storing it to sell as and when needed.

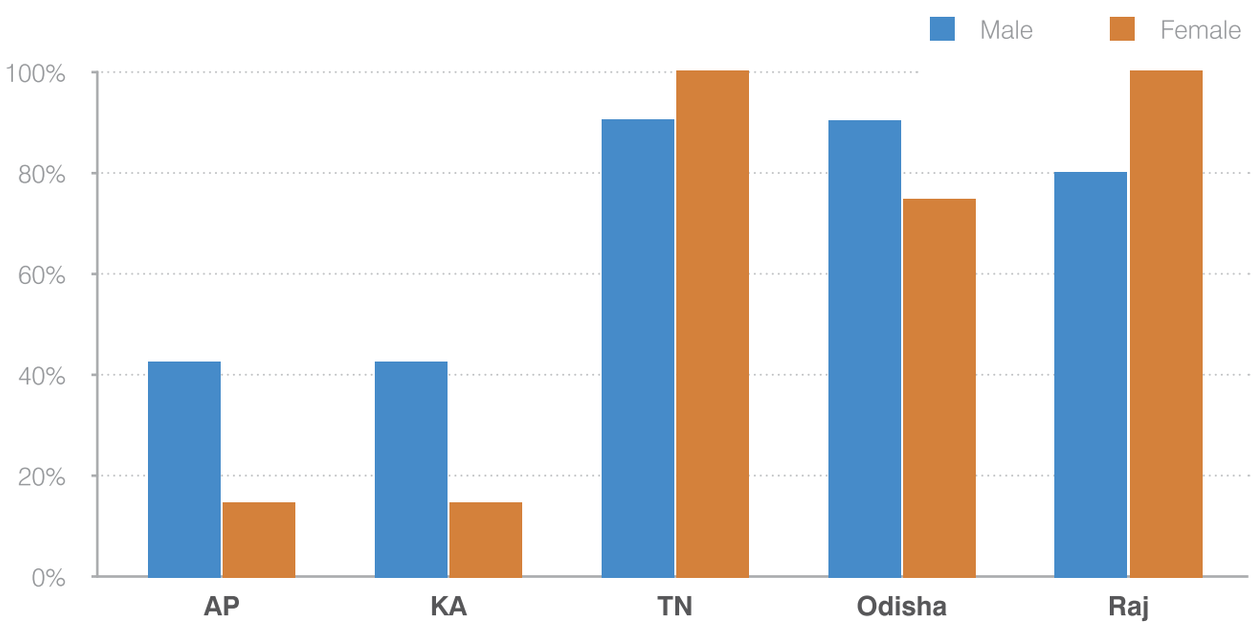


Figure 4.25: Method of Payment – Payment on delivery

4.7 Digital Connectivity

Majority of the farmers interviewed were not aware of digital connectivity for e-commerce or market transactions - a question asked specifically to understand the efficacy of the emerging ICT landscape in agriculture to benefit the farmers. Overall, 95% of the respondents were not familiar with mobile payment facilities. As mentioned above farmers prefer to transact with hard cash only, and skip bank transactions in favour of cash or exchange of goods. Additionally, to meet their daily needs, e-payments are not viable and cash is the only option in these village.

Figure 4.26 shows that majority of the farmers use non-android phones and only a few (8%) have access to android smart phones. Since most of the information apps are developed on the Android platform, the systems for distributing information through these apps is not reaching the majority of the smallholder farmers in the country.

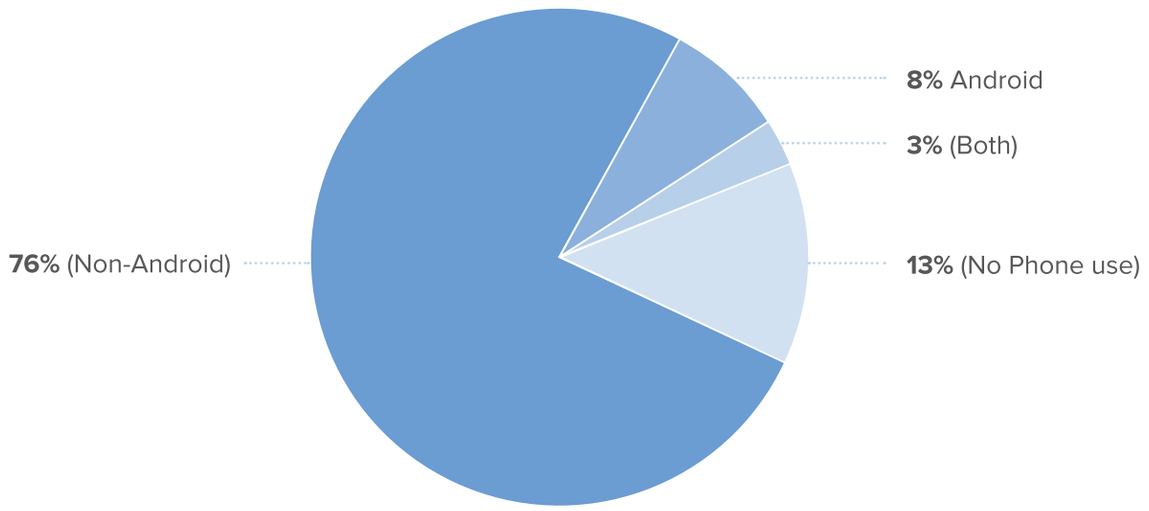


Figure 4.26: Type of Phone Usage

Traders	Andhra Pradesh	Karnataka	Tamil Nadu	Odisha	Rajasthan
Block level trader	36.7	77.5	96.8	7	40.2
Village level trader	5	16.7	3.2	58	17.4
Government	9.2	3.3	0	0	5.4
Local Haat	37.5	1.7	0	22	5.4

Table 4. 8: Key Buyers

Percentage of farmers who sell their millet produce to different traders

4.8 Information Sources

Farmers in all states showed a strong preference for wanting information on pricing of millets during the harvest period, as opposed to when sowing. Whilst they access this information from several different sources in Andhra Pradesh, Karnataka, Tamil Nadu and Rajasthan the largest numbers depend on their fellow farmers. Farmers in Odisha mentioned that they receive this from their local haats. Across all states, the number of farmers who depend on kisan call centres, e-mandis, mandi advisors or KVKs for this information was negligible. Apart from pricing, farmers also require information on several different parameters that can help them during the growing season. For each of the factors enquired about, the majority of farmers revealed not receiving any information before they begin cultivation (Table 4. 9).

Whilst farmers do not receive much information on pricing from KVKs and Kisan Call Centres, some did show a dependence on them for other information. KVKs were considered a good source of information for rainfall data along with the metrological department and the Kisan Call Centre for seed availability. Apart from the options provided in Table

Information	Source of information (Number of Farmers)				
	KVK	Kisan Call centre	Met dept.	Agriculture university	Receive no information
Rainfall	84	21	60	2	137
Temperature	18	21	62	2	165
Soil fertility data	45	18	0	56	164
Seed availability	33	76	1	17	136
Pest control / weeding methods	25	15	1	9	161
Post harvesting facility	15	12	2	1	140
Market price and location	12	5	1	3	115
Loan availability information	6	3	1	3	166

Table 4.9: Source of information

Source of information	Farmers (%)
Farmer association	3.6
Fellow farmer	82.3
TV/Newspaper	10.9
Village extension worker	3.2

Table 4.10: Most reliable source of information

4.9, farmers also mentioned several other sources that they depend on for information before they begin cultivation. According to a large portion of respondents across all states they considered their fellow farmers as the most reliable source of information for all parameters considered (Table 4.10).

4.9 Seed Quality and Availability

Quality seeds play a crucial role in assuring food security of smallholders. For millets being food security crops, adequate availability of quality seeds is essential at the farmers level.

The survey indicated that all farmers across categories have adequate access to quality millet seeds. However, over 50% farmers preferred seeds of traditional varieties than improved cultivars.

Farmers across all the surveyed districts stated that they have access to high quality seeds. They determine the quality of seeds based on the germination rate, yield and in some cases the colour. Some farmers also mentioned consulting their neighbouring farmers on the quality of the seeds. Whilst the majority of farmer in all states had access to high quality seeds, this number was low in Andhra Pradesh (8%) (Figure 4.27). Also in the case of Andhra Pradesh, a majority of the farmers had access to traditional varieties but not HYVs, and a similar pattern was seen in Odisha. However, in the case of Karnataka this trend was reversed. In Tamil Nadu and Rajasthan, the majority of farmers had access to both HYVs and traditional seeds. The sources of seeds for farmers were reported as village seed banks, seed exchange melas, domestic storage and in an odd case, local markets. However, the number of farmers getting seeds from seed banks or melas was extremely small. This is unlike other key crops such as rice, wheat and maize.

Literature states that the presence of formal and informal local seed markets are known to enhance millet productivity in farming communities (Nagarajan, Smale and Glewwe, 2007) and research efforts should focus on identifying the diversity of material available and understanding local variety choices. Access to local seed markets could also help improve the biodiversity and pool of genetic resources available to farmers enhancing their ability to cope with climate change.

The majority of farmers in Andhra Pradesh, Tamil Nadu and Odisha showed a strong preference for using traditional seeds for millet cultivation (Figure 4. 28). Whereas, the opposite was seen in Karnataka and Rajasthan. Its notable to mention that in Rajasthan only 30% of farmers responded to this question. States where farmers prefer growing traditional seeds responded with varying interest in HYVs if made easily available.

It's worth noting that since 1965, 136 hybrid varieties of pearl millet have been developed in India, however their availability still remains an issue (Singh, Satyavathi C and Sankar S, 2014). In Andhra Pradesh, farmers have

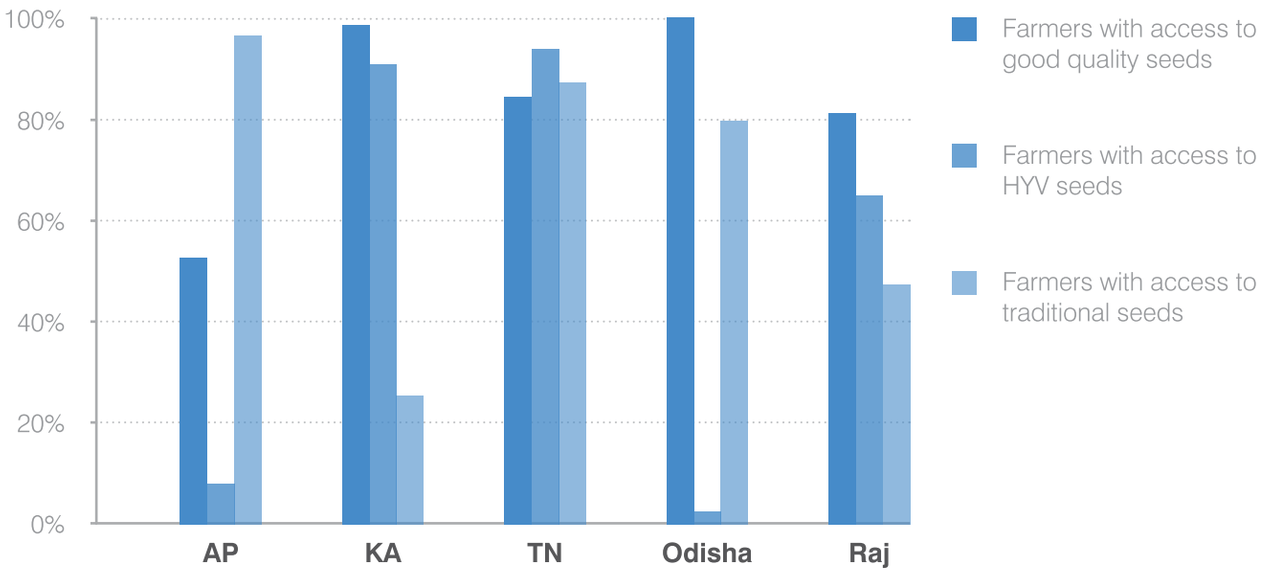


Figure 4.27 Availability of seeds

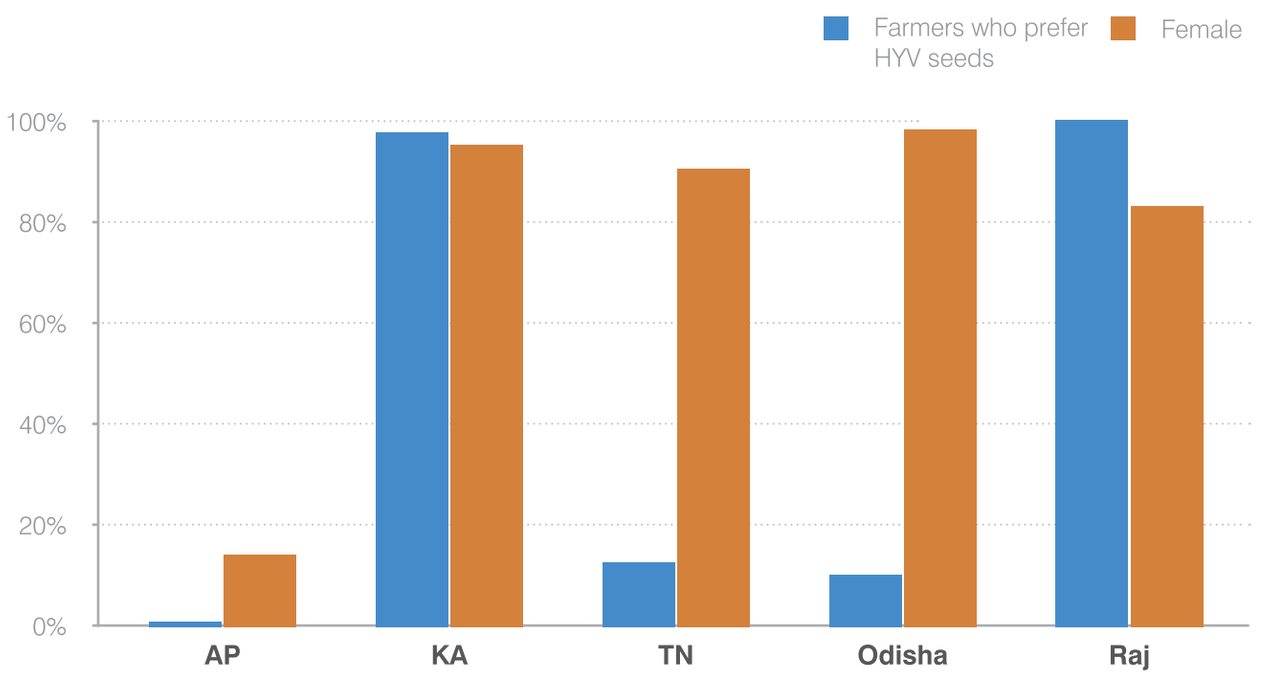


Figure 4.28: Prevalence of HYV seeds

limited access to HYV seeds and displayed marginal interest in using them if available whereas in Odisha, while they currently do not have access, they are willing to try HYV seeds if made available. In Tamil Nadu, farmers have access to good quality seeds of both traditional and HYV varieties and whilst they have a strong preference for growing traditional, they are willing to use HYV seeds given the right economic drivers.

Farmer type	Availability of quality seeds		
	Not applicable	Yes	No
Small	2 (1.1)	145 (78)	39 (21)
Semi-medium	2 (1.9)	69 (64.5)	36 (33.6)
Marginal	2 (1.4)	126 (88.7)	14 (9.9)
Medium	0 (0)	30 (88.2)	4 (11.8)
Big	0 (0)	22 (84.6)	4 (15.4)

*Figures given in parentheses indicate percentages

Table 4.11 : Availability of quality seeds of millet varieties

Farmer type	Varietal preference	
	High yielding variety	Traditional
Small	53 (28.5)	133 (71.5)
Semi-medium	25 (23.4)	82 (76.6)
Marginal	58 (40.8)	84 (59.2)
Medium	15 (44.1)	19 (55.9)
Big	16 (61.5)	10 (38.5)

*Figures given in parentheses indicate percentages

Table 4.12: Varietal preference of farmers across categories

The main reasons for preferring HYV varieties was the low yields of traditional seeds and the belief that they may not adapt to changes in climatic patterns. However, from our FGDs we got the insight that farmers grow traditional varieties for their own consumption, as they prefer their taste and consider them more nutritious, and HYVs are grown for sale.

In India about 60% of Pearl millet and Sorghum cultivation is of HYVs, with these adopted more widely for Pearl millet than Sorghum (Pray and Nagarajan, 2009). The most popular HYV seeds sown by farmers surveyed were Ganga Kaveri, Pioneer and Kaveri Super Boss varieties of Pearl millet and MR1 and MR6 varieties of Finger millet.

4.10. Millet Cultivation – Preference, Resources and Demand

The post-harvest processing of millets is labour intensive and difficult, and the younger generation of farmers lack the knowledge of processing. Most processing is still performed manually with very little use of machines due to their unavailability—one of the reasons for a lower preference for millet cultivation among farmers. Approximately 65% of the farmers interviewed, expressed a need for improvement in the current post-harvesting techniques that they follow and the majority of the mentions were related to need of machines (23%).

In the districts surveyed, more than three fourths of farmers stated a preference for growing millets compared to other crops. As previously mentioned the respondents universally also consider millets more nutritious than other crops such as rice, wheat and maize. In Karnataka, 100% of both male and female farmers prefer growing millets to other crop (Figure 4.29). In Andhra Pradesh, Tamil Nadu and Odisha slightly more female farmers showed a preference for growing millets whereas in Rajasthan it was the opposite with this being slightly higher for male farmers. As mentioned above, female farmers also showed a higher likelihood of including millets in their diets as a nutritional supplement to other grains.

Whilst the majority of farmers surveyed show a strong preference for growing millets from both an agricultural and a nutritional perspective, we know that millet cultivation is on the decline in India. Over the last few decades, there has been a decline in area under cultivation of about 23% for pearl millets, 59% for sorghum, 46% for finger millet and 80% for small millets. Along with this decline in area under millet cultivation, there has also been a 76% decrease in the production of small millets whilst their productivity has remained stagnant (Dhan Foundation, 2012; Behera, 2017).

Cultivation of millets is labour intensive and its post-harvest techniques are difficult. Additionally, traditional knowledge of these techniques has been lost through the generations. There has also been a change in dietary habits over the last 20 years where millets have been replaced by rice as a staple. Along with this, decreased rainfall and changing weather patterns due to climate change have together resulted in the decline of millet production. Farmers also mentioned millets not being a profitable crop for them due to a lack of processing units, inadequate links to markets, increasing costs of labour and their demand being low and irregular. However, the majority of farmers surveyed in all states showed a willingness to increase their millet production provided they were given assistance in terms of agricultural inputs and technical guidance for improved millet production and an assured regular demand of these millets at better prices.

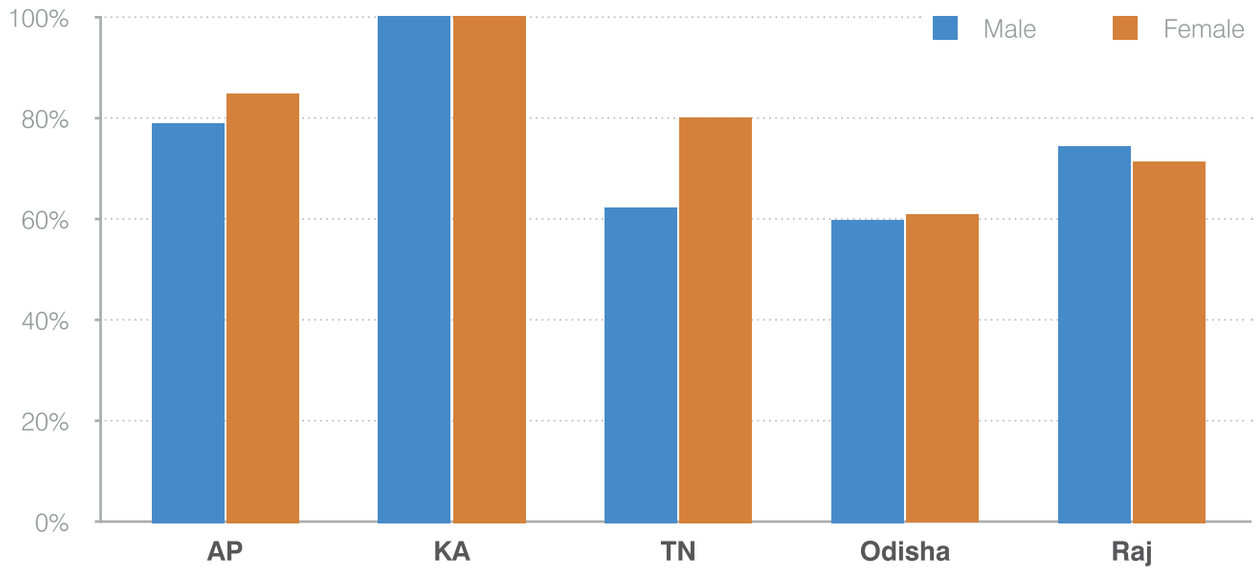


Figure 4.29: Crop preferences

4.11. Transportation

Farmers use several different modes of transport to get millets to market across the five states surveyed. Farmers in Karnataka had the best access to transport facilities (Figure 4. 30) and use a combination of autos, jeeps and tractors. In Andhra Pradesh and Tamil Nadu, whilst majority of farmers do have access to transport, these are accessible to only a small proportion of female farmers. In these two states as well, farmers use tractors, autos and Tata Ace to transport millets. In Odisha and Rajasthan, only 12% and 2% of farmers respectively responded to the question about availability of good transport facilities in their village. Whilst in Rajasthan farmers have mentioned hiring trucks as a group with other farmers in order to move millets, in Odisha they carry the bags on their shoulder. This lack of access to transport could be the reason why farmers in Odisha mainly sell their millet produce to village level traders and at their local haats.

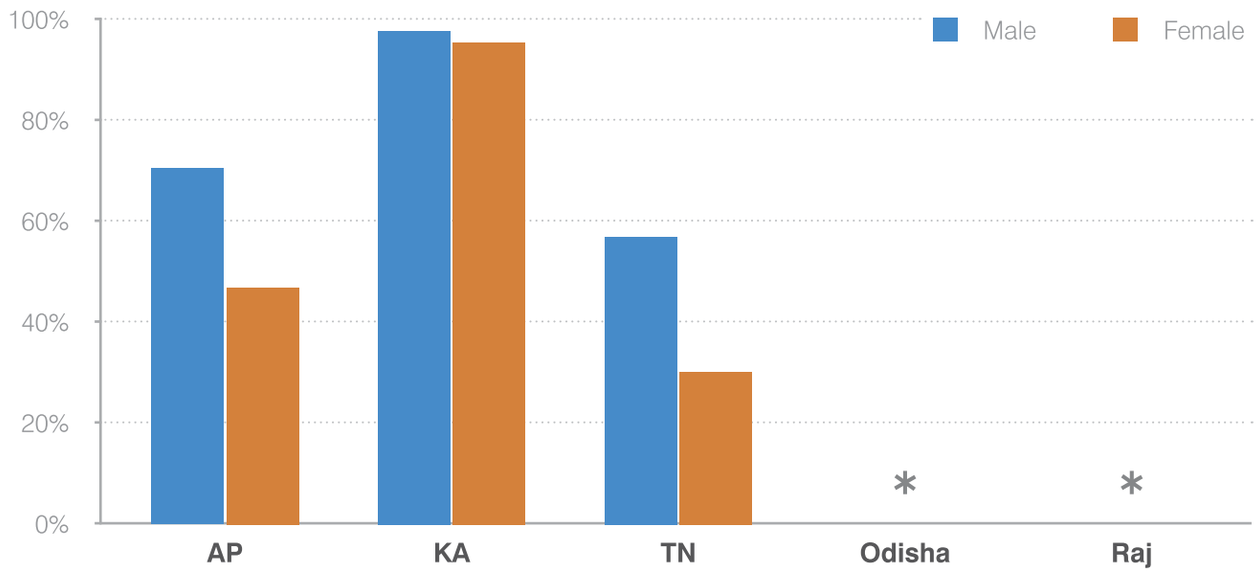


Figure 4.30: Transport facilities
* **:** no response

Saurav022 / Shutterstock.com

4.12. Climate change/Weather impacts

Over the past 20 years, the majority of farmers have observed a change in cropping patterns where shifting cultivation is no longer practiced as widely. There has also been a decline in mixed cropping practices and organic farming, which has resulted in increased input costs. Declining rainfall and changing weather patterns have also resulted in lowering the yields of traditional varieties and an increase in pest and disease attacks. This has brought about the change of more farmers now growing hybrid varieties instead of traditional. Along with this, a large number of farmers have also moved into growing other crops such as sugarcane, maize, cashew, mango, groundnut and pulses. A few farmers in Karnataka also mentioned a shift towards growing sunflowers. Apart from the change in crops grown, the changing weather pattern has also resulted in farmers observing a fall in the ground water levels and an increase in the type of pests and insects attacking millets. A review of relevant literature supports this finding (Kambrekar, Guledagudda and Katti Mohankumar, 2015) and states that climate change is expected to further effect the outbreaks, migration patterns and biodiversity of plant pests and lead to emergence of new pests and biotypes. Whilst a large number of farmers mentioned not having the knowledge to identify the new types of pests and insects, as mentioned previously (Table 4.6) there were mentions of attacks by desert locust, grasshopper, aphids, jassids, stem borrer and termites.

Most farmers surveyed did not want their children to take up agriculture as a profession due to low incomes, no profitability and the uncertainty involved in it due to changing climate.

4.13. Gender Component

This section of the survey focused on obtaining disaggregated information for agriculture activities based on gender. As Figure 4.31 indicates, women's participation in labour-intensive activities such as transplanting, weeding, harvesting, threshing and cleaning was higher than that of men. Conversely, activities that link to markets such as transportation, storage and sale are shown to be male dominated which aligns with findings from secondary literature reviews on farming. Female drudgery associated with these labour-intensive activities of millet farming must be addressed through mechanization and specialized training including enabling women to connect to markets at fair profits.

Additionally, Table 4.10 indicates that women also play a much larger role in managing and upkeep of livestock than men. Our interviews also indicate that in most states, especially in Andhra Pradesh, livestock contributes substantially to the income of the household. Figure 4.32 & Figure 4.33 indicate the difference in responses in who performs these duties from a male and female farmer perspective, showing that while men ascribed a lower percentage value to female contribution to livestock upkeep, women acknowledged playing a much larger role in this activity. Millet farming has a direct relationship to livestock as many farmers grow millets such as sorghum and pearl millet solely as livestock feed and when determining a woman's role in the millet value chain, their role as primary caretakers of livestock must be kept in mind when considering their need for ready sources of fodder.

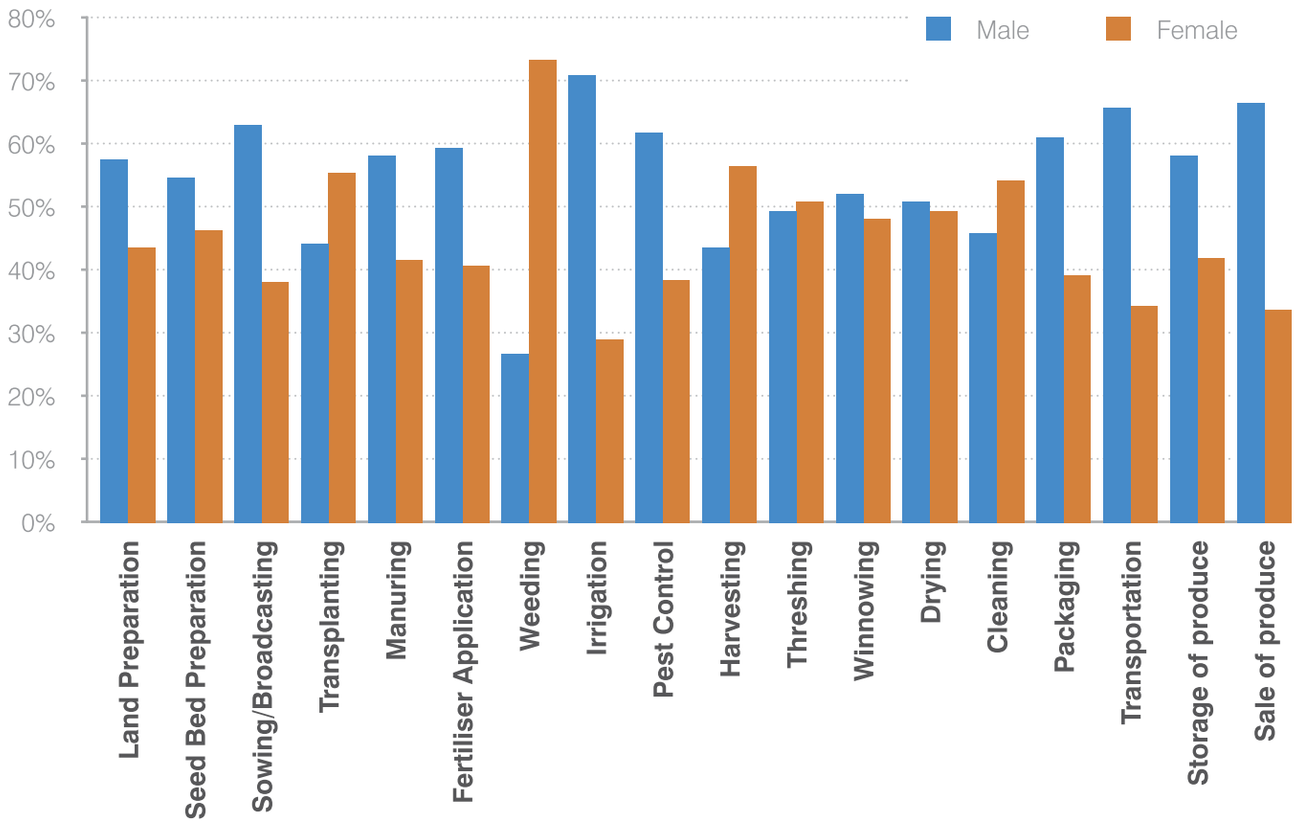


Figure 4.31: Agriculture activities involvement by gender

Gender	Participation (%)
Male	24.5
Female	49.3
Both	26.2

Table 4. 13: Primary caretaker of livestock

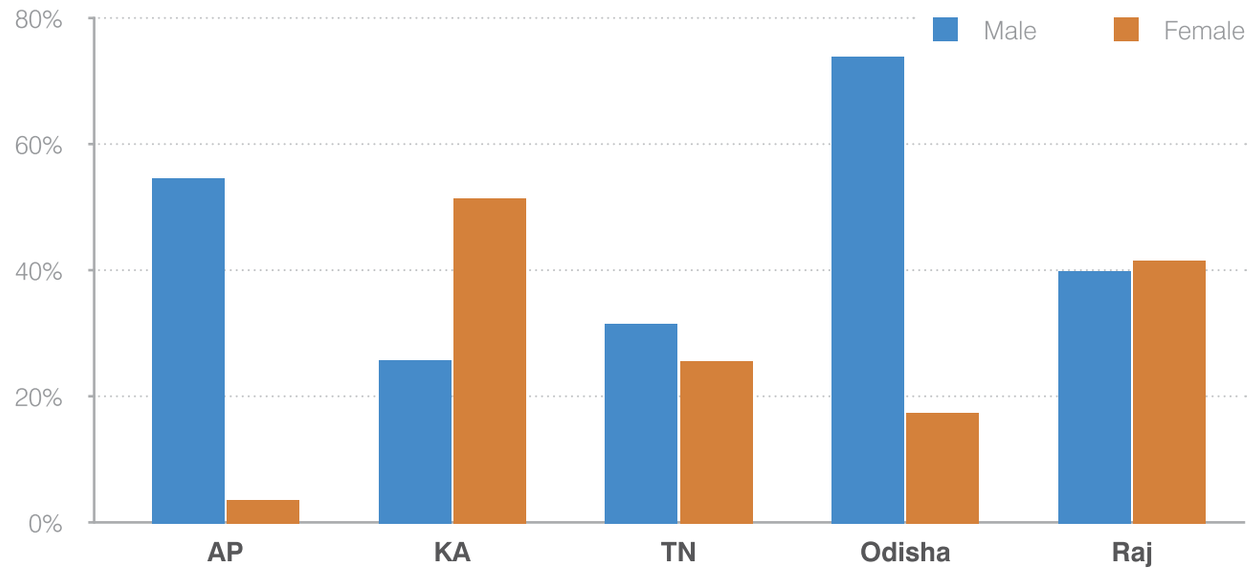


Figure 4.32: Primary caretaker of livestock - Male farmers

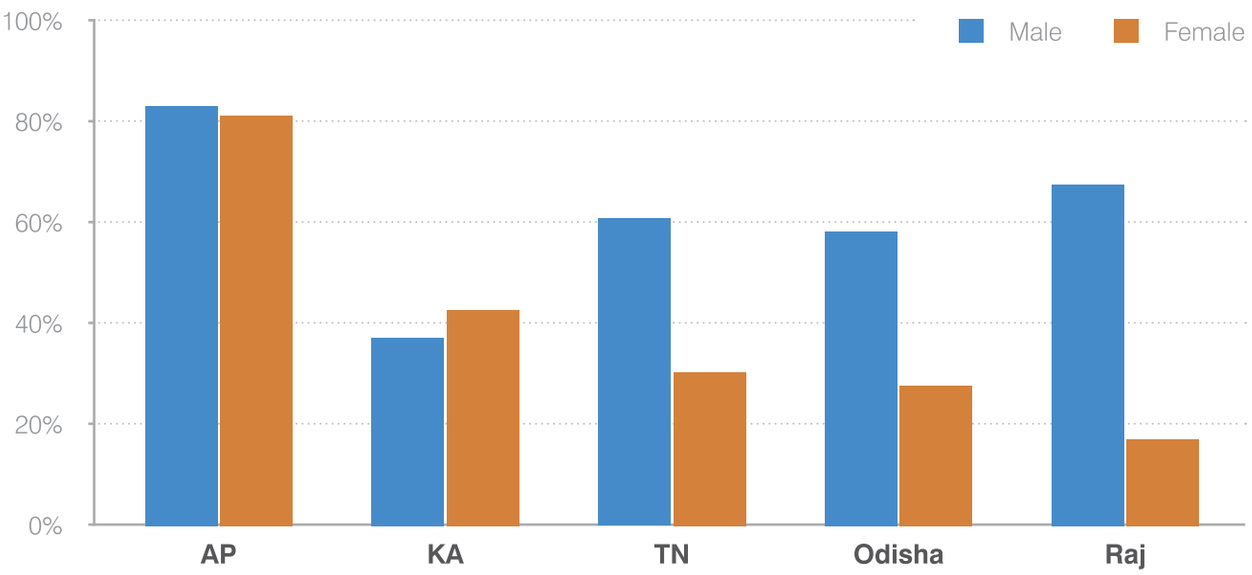


Figure 4.33: Primary caretaker of livestock – Female farmers

4.14. Trader Survey

Over 40 traders from different categories were interviewed across the five states and they included 11 village level aggregators, 20 traders and 12 wholesalers across the selected AEZs. The three major millets (Pearl millet, Finger millet and Sorghum) were the more traded millets in each category compared to minor millets (Kodo millet, Little millet, Foxtail millet and Barnyard millet). Karnataka and Tamil Nadu were the only states where all seven millets were being traded, whilst in Andhra Pradesh in addition to the three major millets, Little millet was also bought. However, in Odisha only Finger millet and Foxtail millet were traded and in Rajasthan only Pearl millet and Sorghum. Additionally, a large number of traders mentioned a decline in the quantity of millets they buy due to a reduction in supply. They attribute this to farmers producing lower quantities due to fluctuating prices, changing weather and a low demand.

4.14.1 Village Level Aggregators

As most of the farmers surveyed were small and marginal, the quantity of their produce is usually small and they sell to village level aggregators who are local shopkeepers or other farmers. In some states like Odisha, there are door to door collectors, locally called kuchias who collect the produce from small tribal settlements and sell on to village level aggregators. These aggregators operate at a small scale and have certain quality-led criteria for buying the produce from farmers. The parameters are size and colour of the grain, being free of impurities and moisture, etc. Brokers often play the role of providing the quality parameters and pricing information to the aggregators. The purchase terms are based on the quality of produce and market demand.

On a daily basis, these traders collect about 5-30 kg of millets and the annual collection ranges from 15-80 quintals. These traders either buy with their own money or borrow from banks. Often, the produce collected is stored in bags and sold to brokers or wholesalers. Only in Chitoor district, the produce was being cleaned and graded before being sold further at the village level.

4.14.2. Traders

They are block level traders who receive the produce from village aggregators or from farmers directly. Many of them sell to district level traders or wholesalers. Some of them also sell directly to customers. According to these traders, the prices of millets vary significantly across the year, sometimes due to variable demand, rainfall or low yield. Most common millets traded by them are Finger millet and Pearl millet.

4.14.3. Wholesalers

The wholesale traders are based at mandis and buy the millet produce from block level traders. Some of these wholesalers, clean and process the produce and sell to retailers, consumers and even institutional buyers like biscuit manufacturers, beverage companies, poultry farms etc. The dealing in terms of quantities ranges from 30-150 tonnes annually.

Table 4.14 shows the average prices at which farmers sell millets to different traders and the price increase between them. In Odisha, the price of both Finger millet and Foxtail millet increases steadily from the local kuchias to the village (VT), block (BT) and district level traders (DT) with the DT showing the biggest increase. A similar pattern was seen across all states with the bigger traders giving a higher price for all millets compared to the smaller traders. Overall, the trade is more organised in the southern states with most of the farmers in Tamil Nadu, Andhra Pradesh and Karnataka having direct accessibility to block level traders.

Odisha Trader type	Millet	Avg. Qty. (kg)	Average price/kg (`)	Price variation (%)		
				Kuchias to VT	Kuchias to BT	Kuchias to DT
Kuchias	Finger millet	500	14.00			
	Foxtail millet	400	12.00			
Village level	Finger millet	7500	16.00	13		
	Foxtail millet	1500	13.50	11		
Block level	Finger millet	2400	19.00		22	
	Foxtail millet	9300	17.50		31	
District Level	Finger millet	39600	22.00			36
	Foxtail millet	29600	18.00			33

Rajasthan Trader type	Millet	Avg. Qty. (kg)	Average price/ kg (`)	Price variation VT to DT (%)
Village level	Pearl Millet	2400	12.50	22
District level		7500	16.00	

AP, KA and TN Trader type	Millet	Average price/kg (`)	Price variation VT to DT (%)
Block level trader	Pearl Millet	18.00	22
District level trader		23.00	
Block level trader	Finger Millet	22.70	12
District level trader		25.90	
Block level trader	Foxtail Millet	12.50	14
District level trader		14.50	
Block level trader	Kodo Millet	15.00	12
District level trader		17.00	
Block level trader	Sorghum	15.70	22
District level trader		20.00	

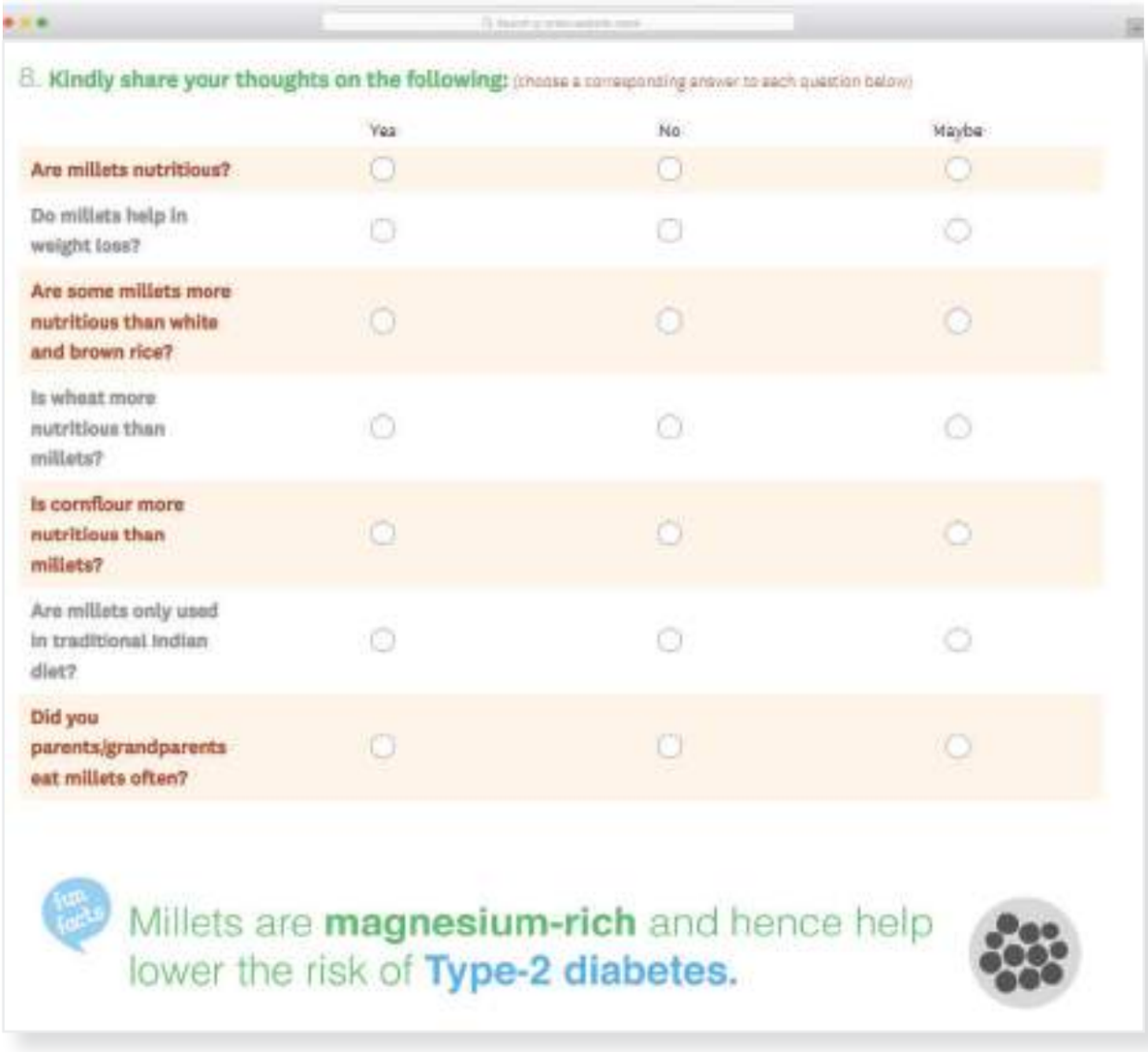
Table 4.14: Market Prices between traders across states

4.15 Consumer Survey

In order to arrive at a comprehensive understanding of the demand side of the millet value chain and identify constraints and intervention points, the online consumer survey described in the methodology chapter was undertaken. The survey exercise was intended to assess the perception of millets amongst urban consumers, triggers and barriers to millet use, pattern of consumption and to understand factors that drive demand. This survey was created and conducted online through web-based data collection platform tool, Survey Monkey. Consumers from around the country responded to the survey, prominently from metros Delhi, Bengaluru and Mumbai and a number of other Tier I &II cities. A total of 250 responses were collected over a period of 5-6 weeks during the months of July and August. As the base of consumers of millets is much smaller than staples like rice and wheat, snowball sampling was chosen as the sampling technique that helped cover the target segment and achieve a reportable sample size.

4.15.1 Respondent Profile

The sample included 58% male and 42% female respondents. Most of the respondents were from the age group 35-54 years (44%)



and 21-34 years (32%). More than 75% of the sample covered was from metros including Delhi-NCR, Bangalore, Mumbai, Chennai, Hyderabad and Pune. The remaining was from Tier I and Tier II cities across the country. Majority of the respondents were from two to four-member family.

The sample covered almost all the ranges of income distribution from annual income of less than five lakhs to more than 20 lakhs. There was an equal distribution of Vegetarians and Non-Vegetarians in the sample with Eggetarians and Vegans also part of the sample (Figure 4.34).

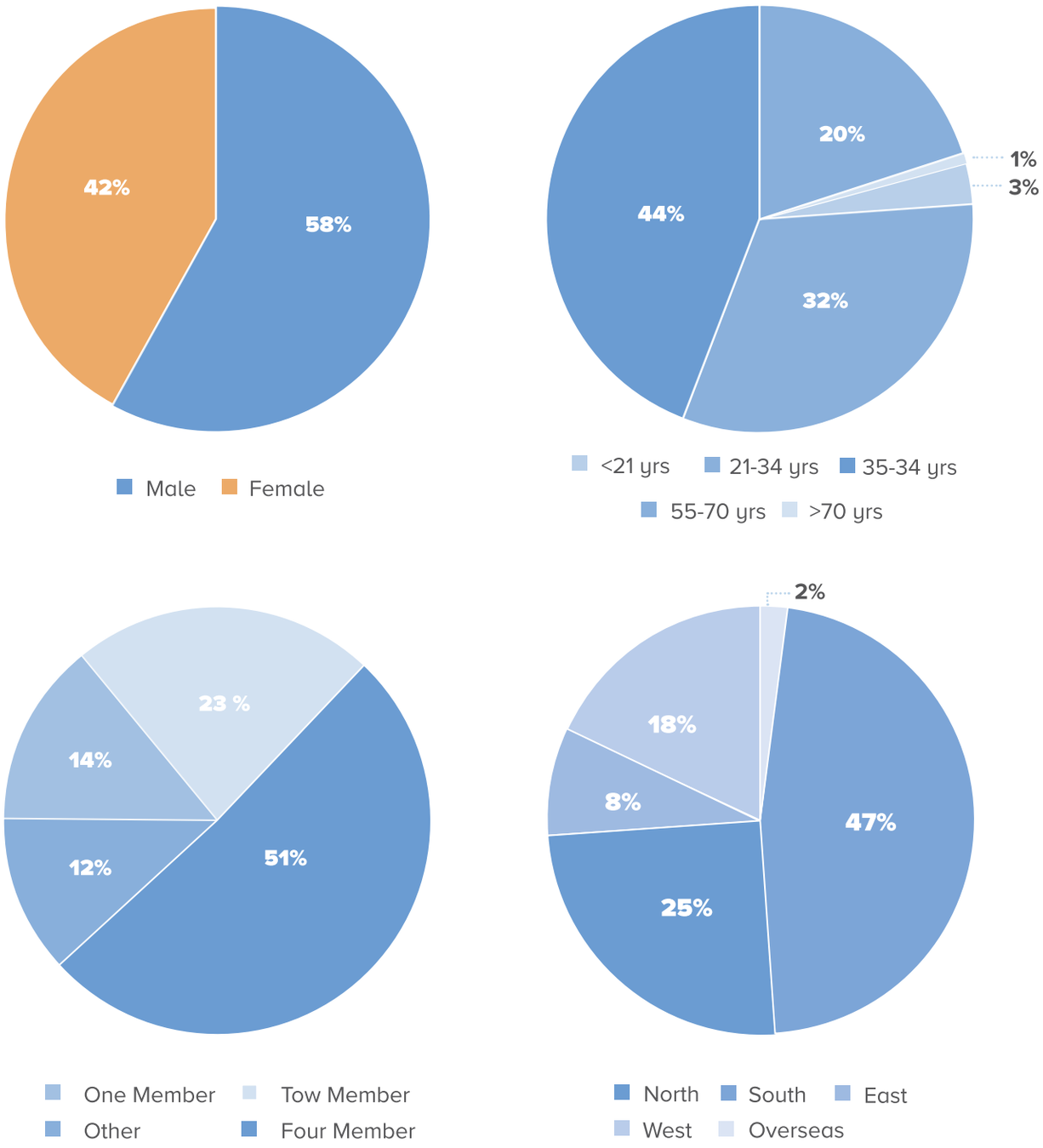


Figure 4.34: Consumer Profile

4.15.2 Consumer Perception about Millets

Consumers primarily associate millets with traditional customs. These small grain cereals are perceived to be traditional food, which was once part of the staple diet. Consumers universally equate millets with good nutrition (88%) and almost a third associated it with “rural food” (Figure 4.35).

4.15.3 Consumption of Millets

Although millets are not as popular as wheat or rice, more than half of the respondents mentioned that they preferred millets in some form of food or the other. More than two thirds of the respondents ate Finger millet, Pearl millet and Sorghum. Unlike rice or wheat, respondents mentioned that they do

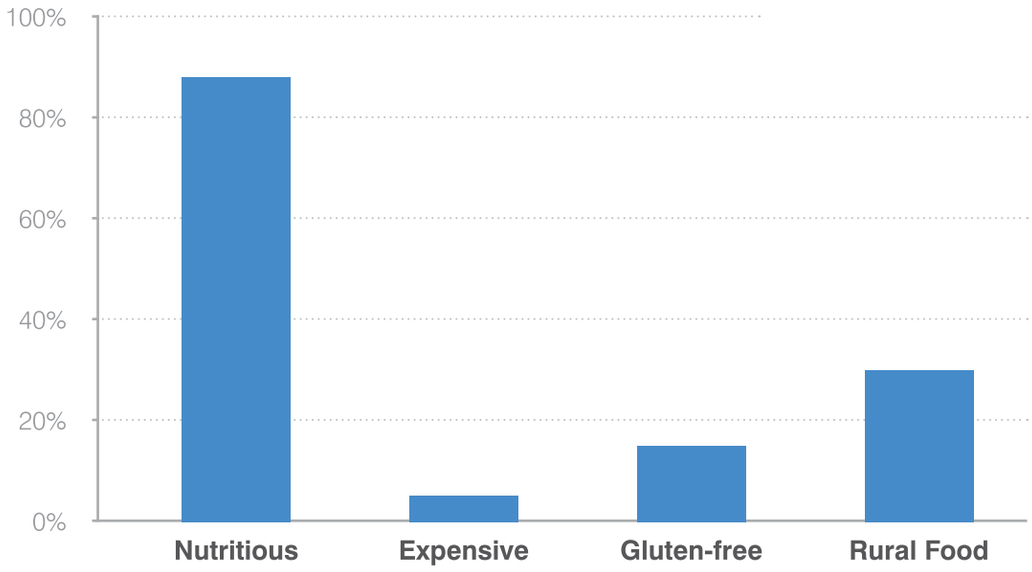


Figure 4.35: Millet Awareness among Consumers

not consume millets on a daily basis and the consumption varied from few times a week to once a month. 72% consumers ate wheat and 58% ate rice daily while only 20% consumed millets on a daily basis (Figure 4.36).

The most popular form of millets appeared to be roti followed by biscuits. Among the millets, Sorghum and Pearl Millet were mostly eaten as roti and khichdi. Vegetables and Lentils were most preferred accompaniments to millets, with 56% and 42% respondents respectively.

Among Millet based snacks, frequency of consumption was the highest for biscuits with most of the people eating these daily (33%) (Figure 4. 37). While choosing snacks, most consumers attributed their decision to taste (62%) and health 58% (diet/non-fried).

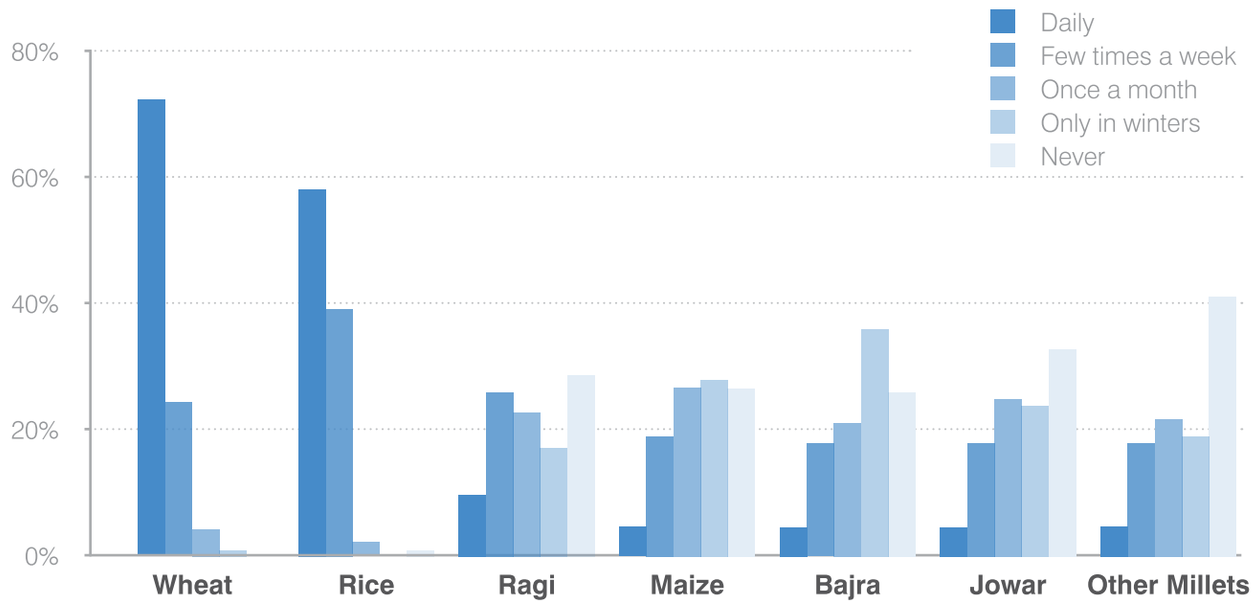


Figure 4.36: Frequency of Consumption-Cereals and Millets

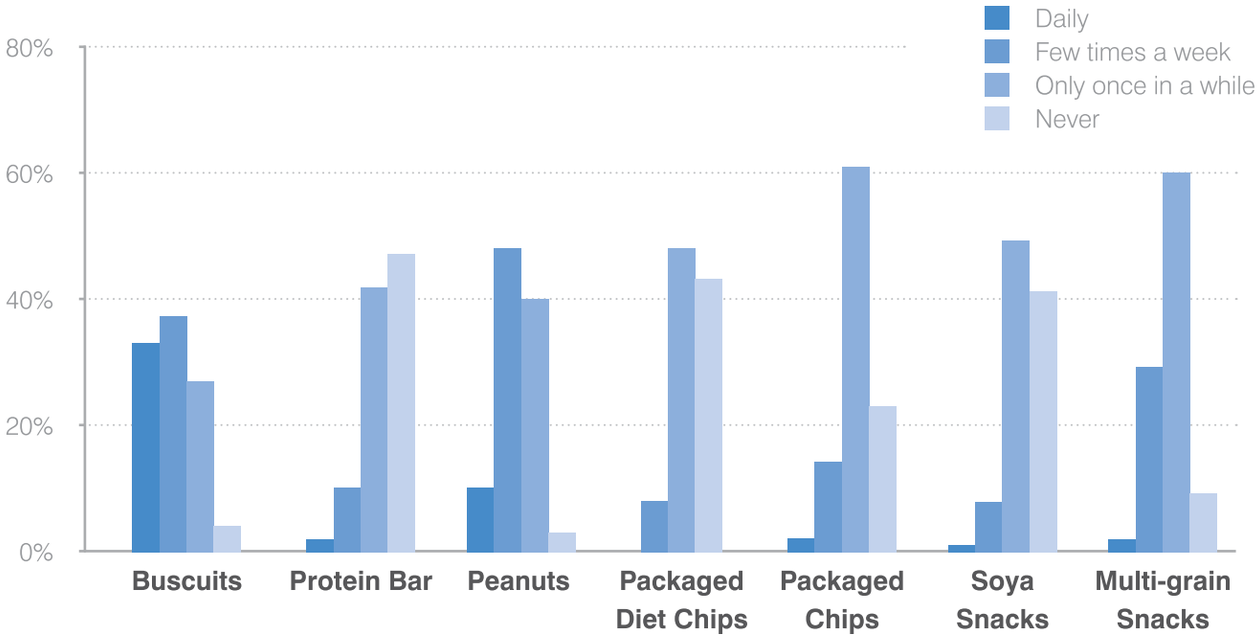


Figure 4.37: Frequency of consumption of snacks

Additionally, Finger millet was the most versatile millet and was cooked and eaten in various forms (Figure 4.38).

Biscuits were the most popular form of processed millet food snacks. Multi-grain biscuits and Ragi cookies being the most popular. The responses indicate that processing millets into tasty and healthy snacks might be a sound strategy to promote consumption.

Nearly half of the respondents reported their local grocery store (48%) as the point of purchase for millets. The others being local chakki (21%), online retailer (12%) and speciality/nature stores (11%) (Figure 4.39)

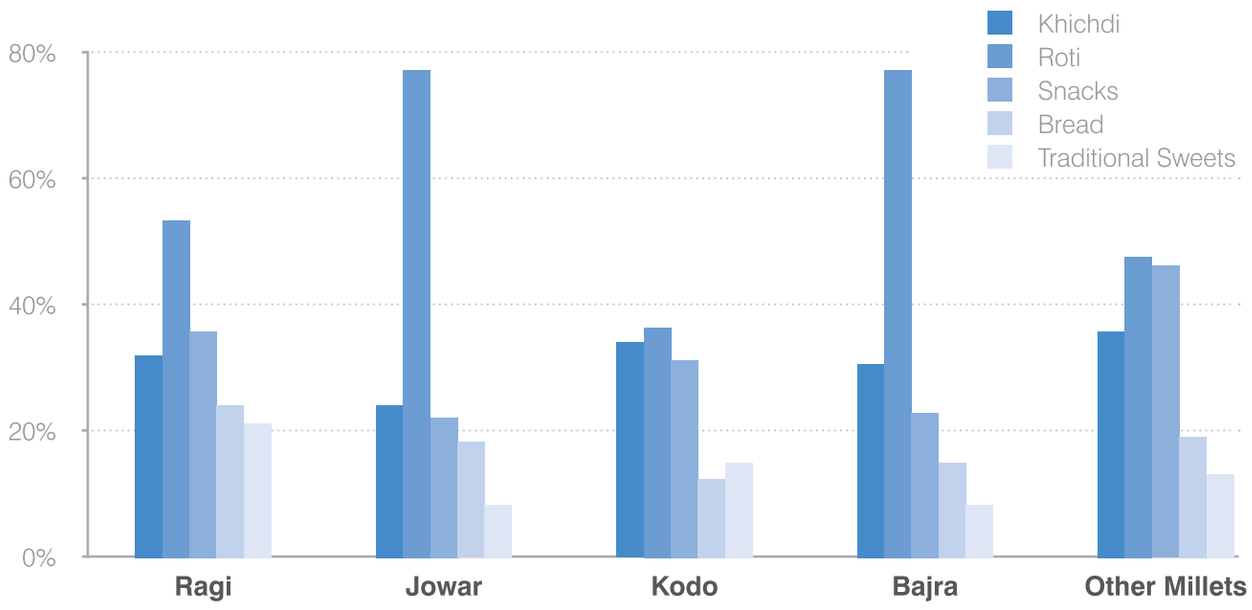


Figure 4.38: Preferred form of millets' consumption

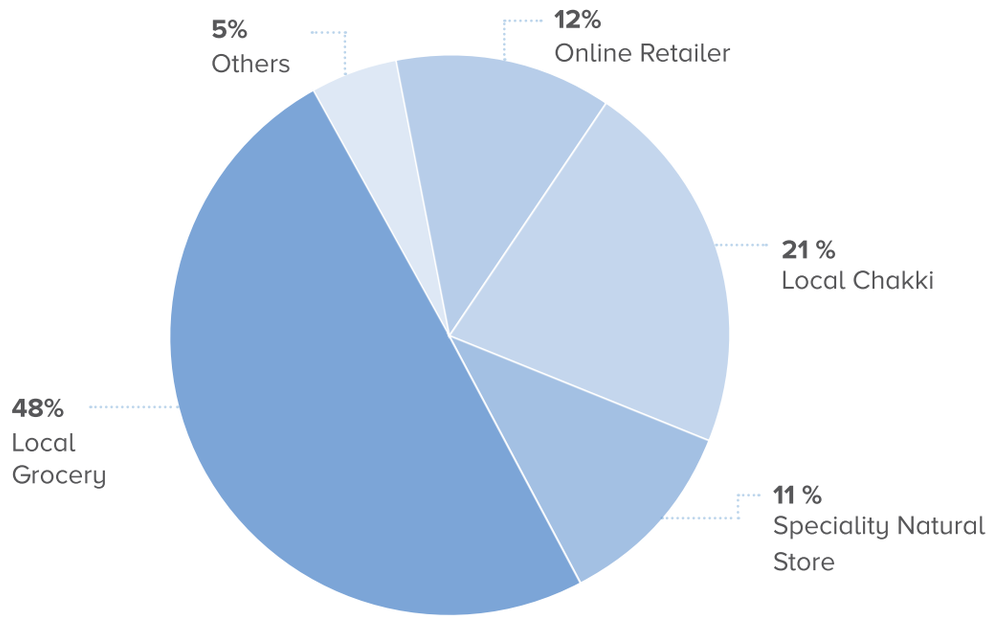


Figure 4.39: Point of Purchase for Millets

4.15.4. Triggers and Barriers to Millet Consumption

Most of the people (85%) had eaten millets at some time in their lifetime. Only 11% respondents had never eaten millets, and a small proportion of 3% were not aware of millets alltogether. Nearly half of the respondents (46%) mentioned choosing millets for a healthier diet as the key driver for consumption. Taste and texture was the other major reason (28%). Among others, losing weight and traditional food habits also find a mention (Figure 4.40).

Poor availability of millets emerged as the biggest barrier (61%) towards increased consumption (Figure 4.41). Additionally, half of the respondents mentioned that tastier product choices could be a key driver for more consumption. A third of the respondents found millets difficult to cook (Figure 4.42). A quarter of respondents said that the environmental footprint of food was an important criteria for people to select what they consumed.

It is evident from the survey results that consumers appreciate the benefits of millets and there is existing demand and preference for millet-based foods. However, lack of availability and lack of options in the product basket act as a barrier to increased intake of millets. Additionally, the supply chain needs to be strengthened to improve availability at points of purchase. Improved positioning as a health food could help increase millet demand as well. Literature states that development of health foods and their commercialization should receive focused attention to promote millets among the urban elite, which would lead to reduction in life-style related disorders (Bommy, 2016) This could help create a win-win situation for both farmer and consumer by addressing the factors affecting consumption.

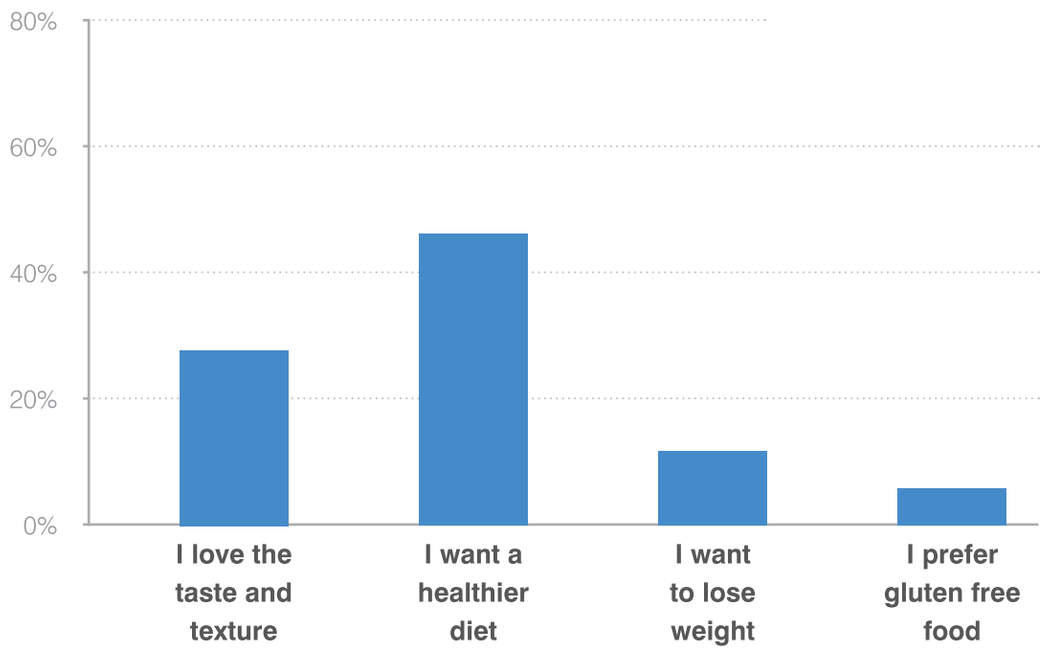


Figure 4.40: Reasons for eating millets

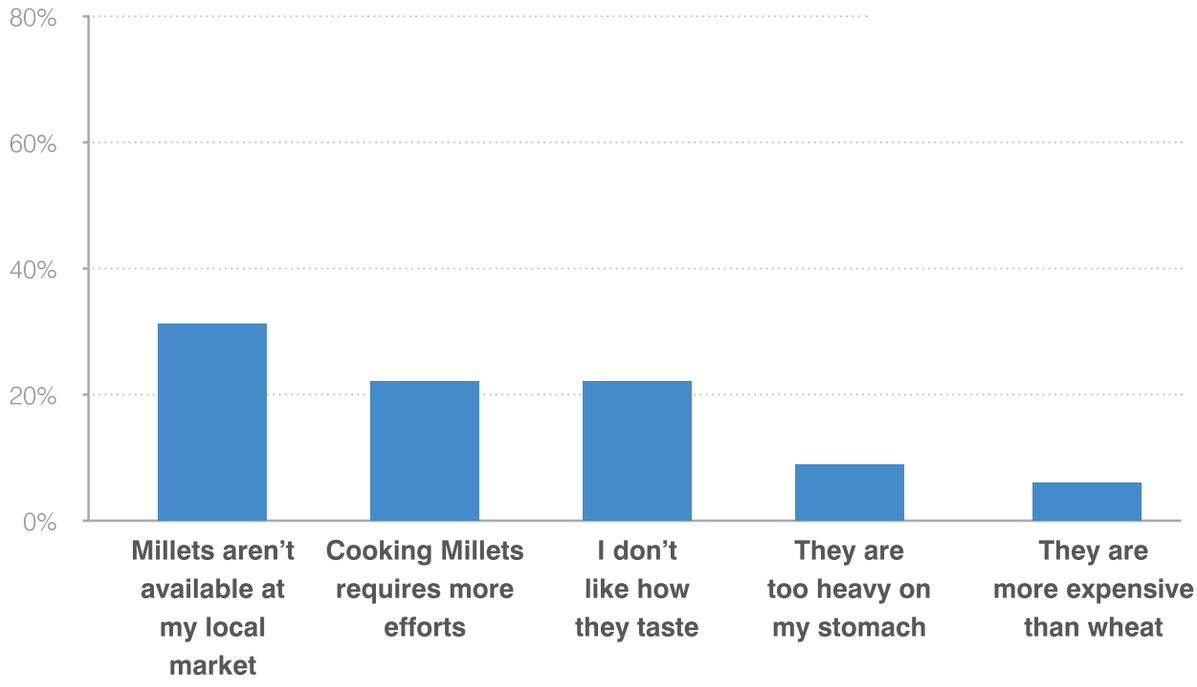


Figure 4.41: Barriers to consumption of millets

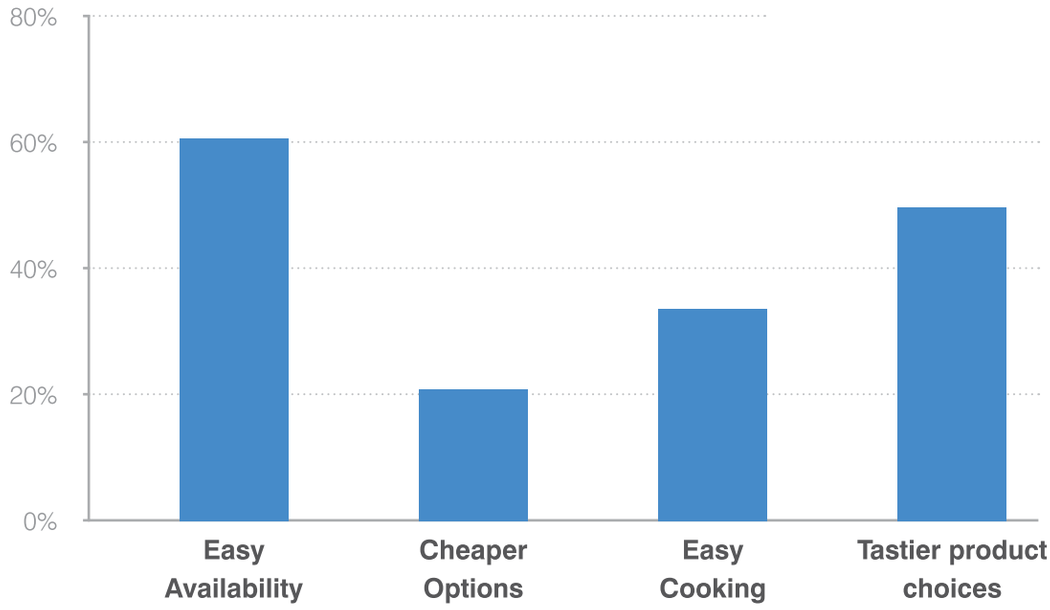


Figure 4.42: Reasons for improving millet consumption

5. Recommendations

The key goal of this research was to collect information and insights that support the design and research of potential interventions under the **TIGR²ESS programme** towards strengthening the millet value-chain for farmers in India.

The findings from the primary survey are in alignment with the findings from various studies mentioned earlier

> “In this report, **some of which include; that farmers need better linkage to markets; that better access to processing facilities can improve farmer incomes from millets; that consumer preference for millet consumption is increasing;** lack of convenient access to millets in urban markets keeps the demand low.”

Some new insights that emerged from the survey were that although 2018 has been an important year for millets in India, with the government having increased the MSP for millets and included them in the PDS, almost all farmers interviewed remained unaware of this. Farmers continue to sell primarily to the Village and/or Block traders.

In Western Rajasthan farmers stated **a strong preference to grow and consume Bajri—a traditional variety of Pearl Millet, as its taste and texture is better than the commercial variety of Pearl Millet grown, however its production is waning fast due to government promoting other commercial varieties.**

Farmers in all landscapes expressed dissatisfaction with poor quality extension services and stated the need for better information and training to improve livelihoods from agriculture. Seed banks were not formally present in the districts surveyed and farmers primarily relied on each other to source seeds.

All farmers said that weather variability remains a challenge, especially for rain fed millets and that adequate land type is not available for scaling up millet farming. All farmers unanimously agreed that millets have higher nutritional value over other cereals and a majority of them grown millets for their personal use for or for their livestock. All farmers stated a need to connect to more profitable markets and a need to enhance processing facilities in their districts. Farmers stated a need for more mechanisation in millet processing, much like what has happened for other crops.

Our recommendations based on these findings are as follows:

- **Improve Millet Productivity Through Farmer Training Programmes:** Since input costs for millets are lower than for other cereals and the increasing demand in urban markets is creating a larger market, millet production can provide a reliable source of income. Training programmes that enable farmers to increase their yields with a mix of major and millet millets potentially intercropped with other crops should be designed and implemented in pilot landscapes where patches of land can be used as 'proof-of- concept.'

- **Value Addition from Millets:** Since our value chain analysis shows that in the end retail markets, millets fetch a high multiplier of the price of what a farmer sells to a trader, many opportunities for value addition from millets must be explored including branding, packaging, enhanced processing as well as productizing at a decentralised level. The lack of processing facilities has also been highlighted by farmers as a constraint. The consumers also expressed need for more product choices to increase consumption. Therefore, the need is to plug the gap related of value addition existing in the value chain.

- **Improve Seeds and Seeds Sources:** Since most farmers stated informal systems of procuring seeds and fragmented sources of various seed varieties, improving farmer knowledge and awareness of seed varieties including and especially those of minor millets can significantly strengthen the local base for better millet yields. Identifying the right variety of seeds that farmers can use for personal nutrition as well as for commercial purpose is also a need that should be addressed.

- **Strengthening the Value Chain:** Programmes that make farmers aware of the MSP for millets and their inclusion in PDS can motivate farmers to scale up millet production. Work must also be done to fill the gap between MSP on paper and MSP implemented. The example of Karnataka which is giving subsidized seeds and buying millets back at MSP plus bonus should be encouraged to be adopted in all millet-growing landscapes in India. Helping set up local cooperatives, SHGs, FPOs etc. can also help provide farmers improved returns by linking to higher profit markets. Providing farmers price information through automated advisory through a platform such as DBT's FarmerZone, could further empower farmers.

- **Integrated Nutrient Management:** Currently most farmers do not practice integrated nutrient management and receive information about nutrient inputs from product suppliers. Creating training programs and pilot demonstration about improved nutrient management will help improve farmer yields.

- **Improved Health through Millet Consumption:** Many farmers are shifting to rice and wheat as replacement for millets they used to eat. This is either due to the shift away from the perception of millets as "poor man's food" or possibly because the low profits from millets and high labour requirement discourages them to grow millets for personal use. Setting up awareness programmes that teach farmers of the value of millets to personal nutrition is key to bringing farmers back to their traditional diet.

• **Train Women in Millet Marketing:** Survey findings show that while women are involved in many of the more labour-intensive aspects of millet farming, they are not engaged in connecting with markets, leaving them vulnerable to lower incomes. Developing millet-specific SHG networks and other ways of giving women secure access to higher profit making networks will be key to giving them security. As many men leave agriculture and migrate to urban areas for jobs, women left back in the farms must be trained in all aspects of millet farming especially those of mechanization and marketing to improve their livelihoods.

• **Improve Processing Technologies and Access:** Secondary literary reviews suggest that while there are various processing technologies for millets, many of them are not dynamic enough to process various varieties of millets, and many are difficult to use and maintain. Innovation in processing technologies and creating systems that enable farmers to access them close to their farmers is a key need to address.

• **Study of Climate Resilience of Millets by Landscape Type:** Most secondary literature points to the lower risks faced by millet farmers to vagaries in weather especially to that of drought and low rainfall. Research on the right mix of major and minor millets that can be grown in specific areas that have become or may become most vulnerable to climate change would give a specific roadmap for policy makers to follow for implementing climate resilient agriculture plans.

• **Increasing Consumer Demand through Millet Demonstrations:** This is a key recommendation found in most millet studies and our own consumer survey, showing that while consumers are willing to consume more millets in their diet, they need more 55 access and more information to increase their demand. Demonstrating innovative millet recipes, creating culinary competitions, engaging a 'celebrity chef' brand ambassador for millets are some ways in which consumer demand can be increased. Nutrition Kitchens can be ideal demonstration projects that can be run like mobile training and demonstration units to increase awareness and demand for millets.

These are some of the many recommendations that can be followed to contribute to enhancing the millet value chain in India through scientific and social science research and implementation under the TIGR2ESS programme.

6. Bibliography

- Adekunle, A. et al. (2018) 'Helping Agribusinesses—Small Millets Value Chain—To Grow in India', Agriculture. Multidisciplinary Digital Publishing Institute, 8(3), p. 44. doi: 10.3390/agriculture8030044.
- Aditya, K. S. et al. (2017) 'Awareness about Minimum Support Price and Its Impact on Diversification Decision of Farmers in India', Asia & the Pacific Policy Studies. Wiley-Blackwell, 4(3), pp. 514–526. doi: 10.1002/app5.197.
- Amadou, I., Gounga, M. E. and Le, G. W. (2013) 'Millets: Nutritional composition, some health benefits and processing - A review', Emirates Journal of Food and Agriculture, 25(7), pp. 501–508. doi: 10.9755/ejfa.v25i7.12045.
- Balasubramanian, S., R, V. and Sharma, R. (2007) Post harvest processing of millets: an appraisal, Agricultural Engineering Today.
- Bantilan, C. (2013) 'Sorghum and Pearl Millet Economy of India', Economic and Political Weekly, pp. 74–81.
- Behera, M. K. (2017) 'Assessment of the State of Millets Farming in India', 2(1), pp. 1–5. doi: 10.15406/mojes.2017.02.00013.
- Bellon, M. R. and Etten, J. Van (2013) 'Climate change and on-farm conservation of crop landraces in centres of diversity', Plant Genetic Resources and Climate Change, pp. 137–150.
- Bhat, B. V., Rao, B. D. and Tonapi, V. A. (2018) 'The Story of Millets'.
- Camacho-Villa, T. C. et al. (2005) Defining and identifying crop landraces, Plant Genetic
- Resources: Characterization and Utilization. doi: 10.1079/PGR200591.
- Ceccarelli, S. (2011) Landraces: Importance and use in breeding and environmentally friendly agronomic systems, Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces. doi: 10.1079/9781845938512.0103.
- Chand, R. (2017) 'Doubling farmers' income: Strategy and prospects', Indian Journal of Agricultural Economics, 72(1), pp. 1–23.
- Dhan Foundation (2012) 'Supporting Millets in India Policy Review & Suggestions for Action Revalorising Small Millets in Rainfed Regions of South Asia (RESMISA)'.
- FAO (2010) The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture. Rome.
- Govt promoting millets on mission mode: Minister (2018) The Hindu Businessline. Available at: https://www.thehindubusinessline.com/economy/agri-business/govt-promoting-millets-on-mission-mode-minister/article23325572.ece (Accessed: 30 August 2018).
- Gulati, A. and Kelley, T. (1999) Trade liberalization and Indian agriculture: cropping pattern changes and efficiency gains in semi-arid tropics. New Delhi: Oxford University Press.
- Heal, G. et al. (2003) Genetic Diversity and Interdependent Crop Choices in Agriculture, Resource and Energy Economics. doi: 10.1016/j.reseneeco.2003.11.006.
- ICAR - IIMR (2017) Millets Annual Report.
- Iliger, P. et al. (2017) 'Reduction in the area of little millet and crop replaced in place of little
- millet in Haveri district of Karnataka', pp. 217–219.

- Kambrekar, D., Guledagudda, S. and Katti Mohankumar, A. (2015) 'Impact of climate change on insect pests and their natural enemies', Karnataka Journal of Agricultural Sciences, 28, pp. 814–816.
- Khyade, V. B. and Khyade, S. V (2016) 'Indian Women in Agriculture', 3(12), pp. 1–8.
- Kumar, A. et al. (2018) 'Millets: a solution to agrarian and nutritional challenges', Agriculture &
- Food Security, 7(1), p. 31. doi: 10.1186/s40066-018-0183-3.
- Millets to be procured at MSP for public distribution system: Agri minister (2018) Hindustan Times. Available at: https://www.hindustantimes.com/india-news/millets-to-be-procured-at-msp-for-public-distribution-system-agri-minister/story-cMQiSpeWBubIYTqy9EDVdK.html (Accessed: 30 August 2018).
- Ministry of Rural Development (2011) Socio Economic and Caste Census 2011. Available at: http://secc.gov.in/reportlistContent (Accessed: 4 September 2018).
- Ministry of Statistics and Programme Implementation (2017) Women and Men in India-2017. Available at: http://www.mospi.gov.in/publication/women-and-men-india-2017 (Accessed: 4 September 2018).
- MSP of 14 kharif crops hiked, millet growers to benefit (2018) The Times of India. Available at: https://timesofindia.indiatimes.com/business/india-business/govt-announces-new-msp-of-kharif- crops-nutri-cereals-millets-got-substantial-hike/articleshow/64854455.cms (Accessed: 30 August 2018).
- Nagarajan, L., Smale, M. and Glewwe, P. (2005) Local Seed Markets and the Determinants of Crop Variety Diversity in Marginal Environments: The Case of Millet in Semi-Arid India.
- Nagarajan, L., Smale, M. and Glewwe, P. (2007) 'Determinants of millet diversity at the household-farm and village-community levels in the drylands of India: the role of local seed systems', Agricultural Economics, 36(2), pp. 157–167. doi: 10.1111/j.1574-0862.2007.00195.x.
- Narayanamoorthy, A. (2013) Profitability in crops cultivation in India: Some evidence from cost of cultivation survey data, Indian Journal of Agricultural Economics.
- Padulosi, S. et al. (2009) 'Food Security and Climate Change : Role of Plant Genetic Resources of Minor Millets', Indian Journal of Plant Genetic Resources, 22(1), p. 1.16.
- Pant, M. and Srivastava, S. K. (2014) Economics of finger millet cultivation in hills of Kumaon region of Uttarakhand, Journal of Hill Agriculture. doi: 10.5958/2230-7338.2014.00831.3.
- Pay parity sought for women in agriculture (2012) The Times of India. Available at: https://timesofindia.indiatimes.com/city/pune/Pay-parity-sought-for-women-in- agriculture/articleshow/12843399.cms?referral=PM (Accessed: 31 August 2018).
- Prakash, D. (2003) 'Rural Women, Food Security and Agricultural Cooperatives', 4th Asian-African International Conference on Women in Agricultural Cooperatives in Asia and Africa, (February), pp. 1–15.
- Praveen, K. V. (2008) 'Linking Small Farmers to the Market', Development Outreach, 10(3), pp. 31–44. doi: 10.1596/1020-797X-10_3_31.
- Pray, C. and Nagarajan, L. (2009) 'Pearl millet and sorghum improvement in India', International Food Policy Research Institute, (November), p. 36.
- Priyam, S. (2017) 'Current use of minor millets , trends , and potentials for enhanced consumption in central India'.

- Ragupathy, S. et al. (2016) 'DNA record of some traditional small millet landraces in India and Nepal', 3 Biotech. Berlin/Heidelberg: Springer Berlin Heidelberg, 6(2), p. 133. doi: 10.1007/s13205-016-0450-6.
- Rao, B. ., Reddy, S. and Seethrama, N. (2007) 'Reorientation of investment in R&D of millets for food security: The case of sorghum in India', Agricultural Situation in India. Rao, B. D., Mukherjee, D. N. and Tonapi, V. A. (2017) 'Strategies for Doubling Farmers' Income in Nutri-Cereals by 2022: Impact of Reduction of Yield Gaps and Inclusion of Fallow and Wasteland under Cultivation', Agricultural Economics Research Review, 30(conf), p. 183. doi: 10.5958/0974-0279.2017.00033.7.
- Rao, D. R. (2004) 'Women in Agriculture', DARE/ICAR ANNUAL REPORT 2003–2004, 39(17), p. 19743.
- Sahu, R. K. and Sharma, M. L. (2018) 'Small Millets Production and Marketing Trends of the Tribal Farmers in the Bastar Plateau Zone', (7), pp. 4078–4089.
- Sakamma, S. et al. (2017) Finger Millet (Eleusine coracana L. Gaertn.) Production System: Status, Potential, Constraints and Implications for Improving Small Farmer's Welfare, Journal of Agricultural Science. doi: 10.5539/jas.v10n1p162.
- Saleh, A. S. M. et al. (2013) 'Millet Grains: Nutritional Quality, Processing, and Potential Health Benefits', Comprehensive Reviews in Food Science and Food Safety, 12(3), pp. 281–295. doi: 10.1111/1541-4337.12012.
- Satyavathi, C. T., Bharadwaj, C. and Brahmanand, P. S. (2010) 'Role of Farm Women in Agriculture: Lessons Learned', Gender, Technology and Development. SAGE Publications India, 14(3), pp. 441–449. doi: 10.1177/097185241001400308.
- Singh, E. (2016) 'Potential of Millets: Nutrients Composition and Health Benefits', Journal of Scientific and Innovative Research JSIR, 5(52), pp. 46–50.
- Singh, S., Satyavathi C, T. and Sankar S, M. (2014) 'Hybrid breeding in pearl millet past and present status'.
- Swaminaidu, N., Ghosh, S. K. and Mallikarjun, K. (2013) 'International Journal of Pharma and Bio Sciences ISSN', International Journal of Pharma and Bio Sciences ISSN, 4(2), pp. 821–830. doi: 10.1039/b313104a.
- The World Factbook (2018). Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/in.html (Accessed: 29 July 2028).
- Trivedi, T. . (2010) 'Degraded and Wastelands of India: Status and Spatial Distribution', Indian Council of Agricultural research, p. 167. doi: www.indiawaterportal.org/.../degraded-and-wastelands-india-status-and-spatial-distrib...
- Vinoth, A. and Ravindhran, R. (2017) 'Biofortification in Millets: A Sustainable Approach for Nutritional Security', Frontiers in Plant Science. Frontiers Media S.A., 8, p. 29. doi: 10.3389/fpls.2017.00029.
- YOURSTORY (2017) What's stopping India's urban population from adding millets to its diet? Available at: https://yourstory.com/2017/05/whats-stopping-indias-urban-population-adding-millets-diet/ (Accessed: 31 August 2018).

7. Annexures

Name of NGO	Survey Region	About NGO
SAMUHA	Koppal District, Karnataka	SAMUHA is a development organisation working in the South Indian state of Karnataka since 1986. SAMUHA currently works with 94,000 families in over 500 villages in 6 districts of North Karnataka. SAMUHA works with vulnerable people to improve their quality of life as a group process. SAMUHA is committed to building communities of people, who will identify issues, find solutions; and ultimately walk on their own. People's ownership remains a priority in the projects. So far, SAMUHA has facilitated 18 people's organisations to register as formal societies. As of now 18,335 women have been organised into 1669 women's thrift Self Help Groups (SHGs). These have been facilitated to apex themselves into four women's cooperatives under the Mutually Aided Cooperative Societies Act.
LAYA	East Godavari District, AP	LAYA Resource Centre, an NGO working for the tribal communities in East Godavari, Visakhapatnam, West Godavari and Khammam for the past 25 years. LAYA's work on climate change is focused especially on its impacts on vulnerable tribal communities. Initiatives on the energy front took momentum after the insights gained as part of a study on decentralized energy options undertaken in the tribal region of the Eastern Ghat regions of India.
Bharath Environment Seva Team (BEST)	Pudukkottai District, Tamil Nadu	Bharath Environment Seva Team (BEST) is located in Pudukkottai District of Tamil Nadu State. BEST has been working in Pudukkottai District since 1987. It works on improving the status of women in the rural areas and promotes ecological farming, environment conservation, income generation and social awareness programmes
Social Animation Center for Rural Education and Development (SACRED)	Ramanagara District, Karnataka	Social Animation Center for Rural Education and Development (SACRED) is a Non-Governmental Organization (NGO) located in Ramanagara District of Karnataka State, India. Established in 1988, SACRED aims to empower women and mould a new generation through gender sensitization and environmental awareness, aiming for human justice and equality. Skill training is also part of the programme towards achieving economic development. Recently NGO has taken up awareness on millet cultivation in Ramanagara district.

Table 7. 1: Survey partner institutions

Name of NGO	Survey Region	About NGO
Community Reconstruction of Social Service (CROSS)	Chittoor District, AP	Community Reconstruction of Social Service (CROSS) is located in Chittoor District of Andhra Pradesh State. Established in 1994, they work for the upliftment of economically backward section of the district. CROSS have programs for economically backward communities, especially for women and children focussing on education, environment, heath, human rights, gender justice, and women and youth empowerment. Skill training is also part of the programme towards achieving economic development.
Udaipur School of Social Work with Research Support from Sanjhi Sansthan	All Rajasthan Survey	Dr. Veena Dwivedi from the Udaipur School of Social Work conducted all surveys with her team of PhD students with the support of Ex-Principal and founder of Sanjhi Sansthan, Dr. Raj Bhanti. Together they have over forty years of experience working in rural development, leading research projects
KARRTABYA	Kalahandi and Kandhamal Districts of Odisha state	KARRTABYA was formed by a group of youths of Kalahandi, who were the members of the local youth club; They believed that social transformation could be brought through dedicated work. Pursuing this, the youths worked single mindedly to build up strength within the people of the locality and mobilizing them to fight for social justice. This involvement gradually spread to other villages and became more comprehensive in nature. With the growth of understanding, their involvement became more matured and targeted towards various issues of the region. In due course this involvement, KARRTABYA was conceptualized and finally on the first day of 1990 the organisation took the form. KARRTABYA concentrated its works in the interior pockets of Junagarh block initially. But gradually it spread to other villages of Dharmagarh and Koksara blocks of the district

Designed by: vertiver.com

TIGR²ESS

Vertiver
enabling sustainability

IORA
Ecological Solutions