Women with kodo millet in Mandla district, Madhya Pradesh, India. Credit P. Mathur/ Bioversity International

Underutilized crops in the livelihoods, diets, and adaptation practices of Gond farmers in Eastern Madhya Pradesh

Baseline results from the programme "Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk"

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Contributors

This analysis and report were prepared in the context of the Project "Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk" supported by the International Fund for Agricultural Development (IFAD), the European Union, and the CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS) from 2015-2018. The analysis has been made possible by the efforts of the Project coordination and implementation teams from Bioversity International and Action for Social Advancement (ASA), as well as many contributors to the design of the survey tools.

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The questionnaires were designed in a consultative process starting with working groups on best indicators at the Project launch conference, followed by rounds of comments on the questionnaires by the Project coordination team and conference participants (Padulosi et al 2016).

Citation

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Abbreviations

ASA	Action for Social Advancement
CGIAR	Consultative Group for International Agricultural Research
EU	European Union
Excl	Excluding
FCS	Food Consumption Score
Ha	Hectares
HFIAS	Household food insecurity and access scale
IFAD	International Fund for Agricultural Development
Incl	Including
INR	Indian Rupees
Man	Mandla block, Mandla district, Madhya Pradesh
Meh	Mehandwani block, Dindori district, Madhya Pradesh
NGO	Non-governmental organization
PPI	Progress out of Poverty Index
Project	The IFAD and EU supported initiative “Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk”
rCSI	Reduced coping strategies index
Sha	Shapura block, Dindori district, Madhya Pradesh
SHG	Self-help group
USD	US dollars

Executive summary

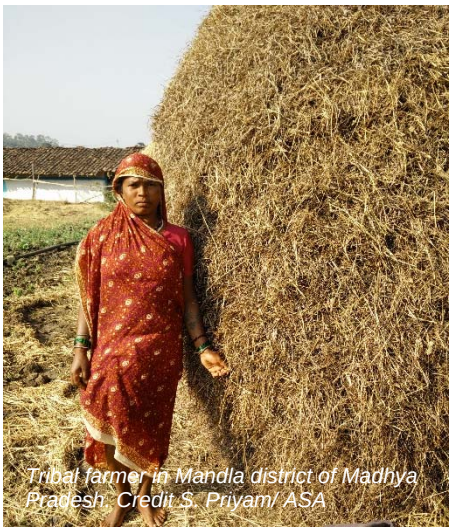
The programme “Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk” funded by IFAD and the European Union from 2015 to 2018 aims to strengthen the capacities of farmers to manage risks associated with climate change, poor nutrition status, and economic disempowerment through agrobiodiversity-based solutions. Enhancing productivity and promoting use of nutritious and climate-hardy underutilized species is the core of the initiative, which is focusing on minor millets and native vegetables in Madhya Pradesh. The approach is two-prong, involving on one hand targeted value chain activities for the minor millets, which are widely recognized for their important role in supporting climate change adaptation and food security in India and which show growing market potential, and on the other hand, exploratory work on native vegetables that aims to document and identify high potential species that can fill nutrition gaps in critical seasons. A holistic approach addressing multiple bottlenecks in supply and demand is being applied for the minor millets (and later for promising native vegetables), engaging consultation and participation of multiple stakeholders to ensure the interventions are pro-poor and gender-sensitive and to advocate for supportive policies.

This baseline household assessment provided an overview of the production and livelihood systems of 297 households in 30 target communities of the Project in eastern Madhya Pradesh (Mandla, Shahpura, and Mehandwani blocks). The results reveal useful insights to guide project actions and provide a snapshot of the systems prior to intervention that can help document the impact of the Project actions. The survey documented the level of cultivation, commercialization and consumption of minor millets and vegetables, revealed how these species contribute to the livelihoods of the surveyed communities and the roles they could have in further improving food security, nutrition, and incomes. Kodo and kutki millet stood out as key staples and income sources. These minor millets have potential to increase farmers’ revenues through enhanced production and sale, increasing the price obtained per hectare through value-addition and increasing their yields. Enhancing their yields could also contribute to reduce staple cereal shortage. Fruits and pulses stood out as key foods for addressing nutrition gaps for the focal communities. Vegetables were consumed less commonly by households with a poor diet in Dindori district and may be in shortage at different points of the year.

This analysis is a beginning point for more detailed analysis on the value chains of our target species, the varieties cultivated and their unique characteristics, the relevance of these species in the livelihoods of men and women, and their adaptation to the threats of climate change. Further work on documenting the value chains of minor millets and the seasonal calendars of local fruits, vegetables and pulses will be carried out in the Project, along with promotional activities for enhancing the contributions of these crops to farmers’ livelihoods.

Introduction

India is the country with the largest number of undernourished people in the world (Upadhyay & Palanivel 2011), where 70% of children suffer from grave nutritional deficiencies (2012 NAAS report in Ray 2016). There is notable regional variation in the level of malnutrition in India, as well as strong disparities among social groups. Madhya Pradesh is among the States with the poorest levels of nutrition: Sixty percent of children under five years of age are underweight in the State as compared to 43% at the national level (IIPS & Macro International 2007). Scheduled casts and tribes are disproportionately affected by malnutrition throughout India (WFP & IHD 2008; Das & Bose 2015; Jain et al 2015; Kapoor & Dhall 2016) and Madhya Pradesh has the largest population of scheduled tribes in the country (15.3 million composing 24% of the State population; Pandey & Tiwary 2000; Das & Bose 2015).



Tribal farmer in Mandla district of Madhya Pradesh. Credit S. Priyam/ ASA

Poor economic conditions are a major cause of malnutrition in Madhya Pradesh as 37% of the population lives under the poverty line (WFP & IHD 2008). Low education and poor awareness of good feeding practices among mothers are other critical issues underlying poor nutrition status in the State (Upadhyay & Palanivel 2011; Goyal & Agarwal 2015). Gender bias in nutrition is striking: The body mass index (BMI) for men in Madhya Pradesh is more than twice that of women and men have notably higher consumption of nutrient-dense foods such as dairy, eggs, and chicken (WFP & IHD 2008). Poor access to health services, low agricultural productivity from marginal lands, and degradation of forests are factors that contribute to higher food insecurity and risk of malnutrition among indigenous populations in the State (Ghosh-Jerath et al 2013, Menon 2016).

Roles of agriculture for better food and nutrition security

Although it is not the only solution, agriculture can play an important role in improving nutrition and food security in India since it is a primary source of food and income for rural communities and because the practices used by farmers influence the amount of time women have for childcare (Kadiyala et al 2014). Agriculture is the primary source of employment for 58% of the national workforce (Kadiyala et al 2014). In Madhya Pradesh, more than two-thirds of the rural workforce in each district is involved in subsistence production or agricultural labor (WFP & IHD 2008). Most of agriculture in Madhya Pradesh is rainfed and despite having higher rainfall than some parts of India, yields are considerably lower than their potential due to poor irrigation, low cropping intensity, and use of lower-yielding crops (WFP & IHD 2008). Fluctuations in precipitation levels and frequent drought lead to high interannual variability of production. Moreover, rainfall has been declining in recent decades, bringing even greater risk for agriculture in the State (Mishra et al 2016). A 2.6% decline in annual precipitation has been recorded in Madhya Pradesh over the last century (Duhan & Pandey 2013) and further warming is projected to increase the severity, frequency, and extent of drought as climate change progresses (Mishra et al 2016).


Little millet growing in Mandla. Credit G. Meldrum / Bioversity International

India has a rich diversity of agricultural plants that have many potentials to improve nutrition and food security. The South Asian region is a center of origin and diversity for many crops, including millets (*Panicum sumatrense*, *Paspalum scrobiculatum*), pigeon pea (*Cajanus cajan*), taro (*Colocasia esculenta*), yam (*Dioscorea esculenta*), eggplant (*Solanum melongena*), cucumber (*Cucumis sativus*), dates (*Phoenix dactylifera*), figs (*Ficus* sp.), ginger (*Zingiber officinale*), citrus (Citrus sp.), mangoes (*Mangifera*), and sesame (*Sesame indicum*) (Khoury et al 2016). In addition, over 1,000 wild plants are used by communities throughout the country that provide an important nutritional complement to local diets, among which some have been partially domesticated (Joshi et al 2002). Agricultural development has made dramatic improvement in the yields and value chains of rice, maize (*Zea mays*), wheat (*Triticum* sp.), and a handful of other commodities since the Green Revolution. However, much of the diversity of crops in India has been neglected by these research and development efforts. Local crops, which are vital to the food traditions of many communities in India have received scant attention from breeders and extension programmes to improve their yields and develop their markets. As many of these plants are rich in nutrients, more stress-tolerant, and better performing on marginal lands as compared to the major commodities, more effective use of these neglected and underutilized crop species could be key to better nutrition and improving the resilience of farming systems to climate change (Ebert 2014). Some examples of underutilized crops with potential to improve nutrition and resilience of production systems in Madhya Pradesh and other parts of India are minor millets and native vegetables, which are discussed in the following paragraphs.

Minor millets


Kodo millet in Dindori. Credit G. Meldrum / Bioversity International

Small grained minor millets are a traditional staple of rainfed farming systems of indigenous peoples in Madhya Pradesh but their production area has declined more than 50% in the State in the last 20 years (Jain & Singh 2008-2010; FAOSTAT). Minor millets are generally suitable for dry and marginal lands. They have low water requirements, low input requirements (Upadhyaya et al 2016) and early maturation, which helps them escape drought. Small millets are less sensitive to temperature and precipitation variability than other common staples (De Friesa et al 2016). They play an important role in mitigating household exposure to climate risk by diversifying production portfolios and acting as a contingency crop to cope with delayed rains at planting time (De Friesa et al 2016). Grains of small millets are highly resistant to storage pests and can be stored for indefinite periods (Yenagi et al 2010 in Saha et al 2016). Minor millets have high fiber content, good protein quality, mineral composition, and nutraceutical values (Deshpande et al 2015). They are good sources of many essential

amino acids – especially cysteine and methionine (Seethram, Riley & Harinarayana 1990, Deshpande et al 2015). Low glycemic index makes these cereals valuable for addressing increasing incidence of diabetes and other secondary metabolic diseases (Deshpande et al 2015). Although they have a high nutrient content gram per gram, due to their low yields, minor millets have a lower nutritional yields per area as compared to the major cereals (De Friesa et al 2016). It is noted however that this difference may be less distinct under stressed conditions. Closing the yield gap for minor millets can enhance their nutritional value and improve productivity and stability of yields on rainfed farms under increasingly drought-prone conditions. Aside from their low productivity, weak market channels and difficult processing are other constraints that should be addressed to upscale use and leverage the benefits of these hardy and nutritious traditional cereals (Padulosi et al 2015, De Friesa et al 2016, Fischer et al 2016).

Native vegetables

Ivy gourd in Mandla. Credit G. Meldrum / Bioversity International

Daily intake of micronutrients is less than 50% of recommended levels for 70% of the Indian population (Ray 2016). Fruits, vegetables, pulses, nuts, milk, eggs, healthy oils, and fish have been recognized as key foods to reduce undernutrition in India, along with millets (Thow et al 2016). Households tend to have greater deficiency of non-grains than grains (Krishnamurthy et al 2014). In Madhya Pradesh, consumption of eggs, chicken, fruits, and green leafy vegetables is very low compared to the national average (WFP & IHD 2008). A study of diets of Baiga people in Madhya Pradesh found that intake of cereals was significantly higher than the recommended level, while intake of pulses, vegetables, and milk products was lower than recommended levels (Chakma et al 2014). Awareness is a factor limiting nutrition, as several studies have shown training—especially on child feeding practices—improves diet quality and nutrition (Vazir et al 2012, Bhutta et al 2013, Malhotra 2012). Promotion of home gardening has also been successful in increasing vegetable consumption and availability of micronutrients for families (e.g. Chadha et al 2012, Schreinemachers et al 2015, Tannaz et al 2016). Nonetheless, cultivation of horticultural crops is limited by water availability and where irrigation is sparse increasing vegetable cultivation can be a challenge. Many native vegetables are grown and collected by indigenous communities in India which can offer solutions for increasing vegetable consumption due to their local adaptation and year-round availability (e.g. Misra et al 2013, Singh and Kumar 2016). India is a center of origin and diversity for many vegetables including eggplant, pointed gourd (*Trichosanthes dioica)*, cucumber, ridge gourd (*Luffa acutangula)*, sponge gourd (*Luffa aegyptiaca)*, snake gourd (*Trichosanthes cucumerina)*, bitter gourd (*Momordica charantia)*, amaranth (*Amaranthus* sp.), lamb's quarters (*Chenopodium sp.)*, and savoy beet (*Beta vulgaris* var *bengalensis*) (ICAR 1989). The rich diversity of local cultivars contains varieties that are well-suited to marginal growing conditions that along with wild collected and semi-domesticated vegetables, may be key in addressing nutrition gaps in marginal rainfed farm systems. For example, Jain and Tiwari (2012) examined ten leafy edibles used by indigenous communities in Madhya Pradesh and found that young leaves of *Oxalis corniculata* and *Moringa oleifera* have outstanding nutrition values.

Holistic value chain approach

The programme “Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk” aims to strengthen the capacities of farmers to manage risks associated with climate change, poor nutrition status, and economic disempowerment through agrobiodiversity-based solutions. Enhancing productivity and promoting cultivation and use of nutritious and climate-hardy underutilized species is the core of the initiative, which is focusing on minor millets and native vegetables in Madhya Pradesh. The approach is two-prong: On one hand, targeted value chain activities are being carried out for minor millets, which are widely recognized for their role in enhancing food security under climate change and show growing market potential, and on the other hand, exploratory work is being performed that aims to document and identify other high potential species that can fill nutrition gaps in critical seasons. A holistic approach addressing multiple bottlenecks in supply and demand is being applied for the target crops, engaging consultation and participation of multiple stakeholders to ensure the interventions are pro-poor and gender-sensitive and to advocate for supportive policies (Padulosi et al. 2014, 2015).

Baseline study

Target sites

The Project is targeting three blocks in Madhya Pradesh: Shahpura and Mehandwani blocks in Dindori District and Mandla block in Mandla District (Figures 1 and 2). These areas are facing increasingly unpredictable rains and high levels of poverty and malnutrition as discussed in the paragraphs above. ASA is engaged with a large number of communities in Madhya Pradesh implementing development projects focused on enhancing soil quality, developing water resources for minor irrigation, and linking farmers with the market, credit, insurance, and other services to enhance income, livelihood resilience, and nutrition. Thirty villages were selected from the set of communities ASA was working with in Eastern Madhya Pradesh with which they had established good relations and trust to move forward with activities promoting use of millets and other underutilized species (Figure 3). The selection focused on communities in eastern Madhya Pradesh because of their high use and dependence on millets. The targeted villages are listed in Table 1. The other villages that ASA works with in the region can be used to provide a counterfactual in future assessments (Figure 3).

Household survey

The target villages were surveyed in September 2015. Estimates suggested that the population of these villages was around 4,500 households. A total of 297 households were surveyed, representing about 7% of the local population. The sample sizes were roughly balanced between Mandla and Dindori districts with 147 in Mandla block, 80 in Mehandwani block and 70 in Shapura block (Table 2). The number of villages surveyed was also balanced between the two target districts, with 15 villages surveyed in Mandla district and 15 surveyed in Dindori district. Ten households were surveyed in most villages with some exceptions: Kudopani (N=8), Silpuri (N=9), Magar Mya (N=8), and Salaiya Mal (N=12). It was noted during the analysis that two of the Project villages were not surveyed (Patpar Singarpur and Dobhi) and instead two villages were surveyed that are not targeted by the Project (Kheri and Ghusiya). These villages were included in the current baseline assessment and can serve as controls in later assessments.

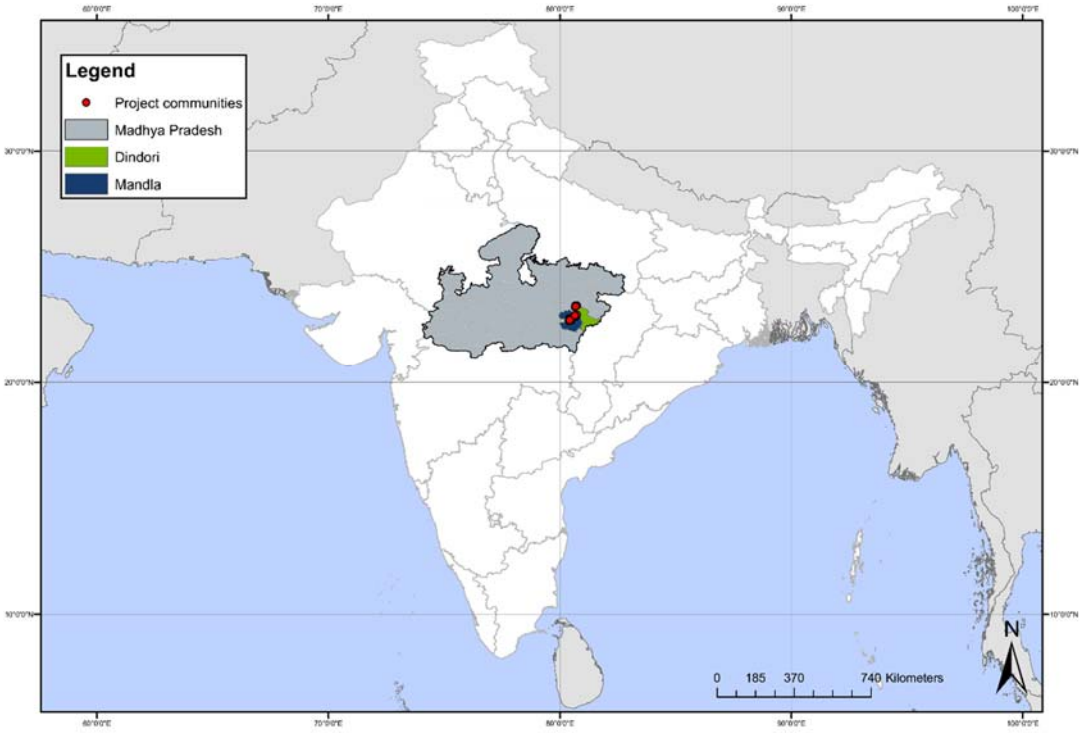


Figure 1. Target sites of the Project in Madhya Pradesh, India.

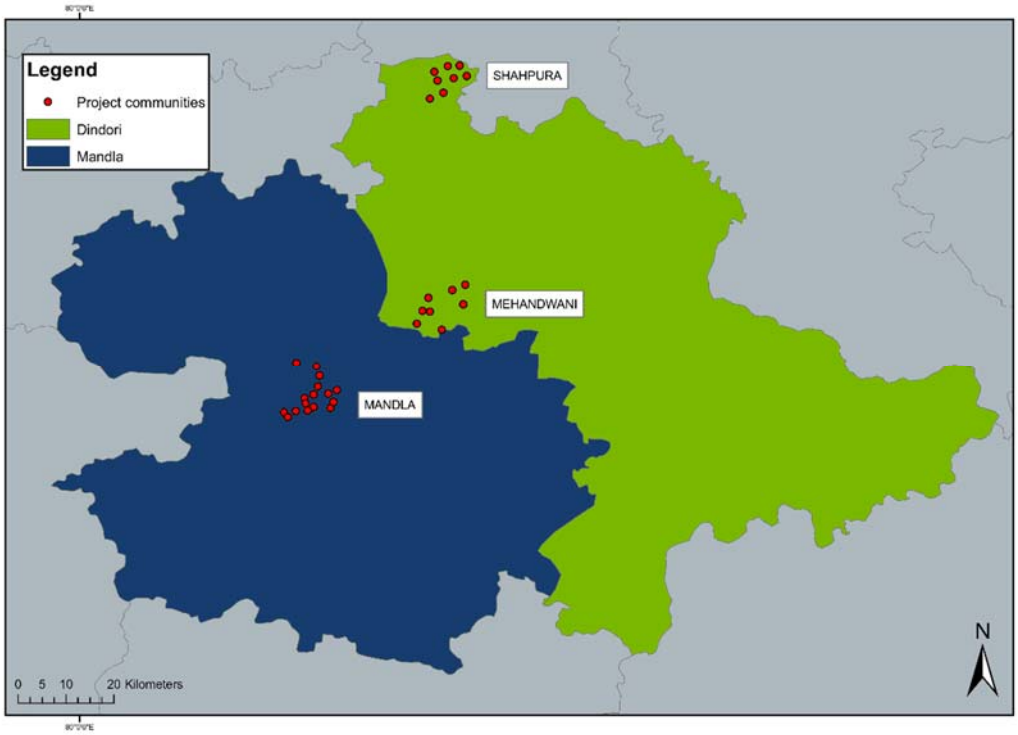


Figure 2. Targeted villages and blocks in Mandla and Dindori districts of Madhya Pradesh, India

Table 1. Villages targeted for the baseline study in the three focal blocks of Madhya Pradesh

District	Block	Villages	# Households
Mandla	Manda	Dungariya	46
		Hardua	148
		Jahpani	75
		Khari	90
		Kheri Mal	123
		Khuksar	121
		Kudopani	242
		Mudadeeh	121
		Piparpani	87
		Salaiya	104
		Silpuri	124
		Singarpur	115
		Tikraberpani	73
		Umardih	166
		Patpar Singarpur	168
Dindori	Mehandwani	Bagli Mal	115
		Barrai	345
		Chatamal	234
		Chirpoti Mal	148
		Dewargar	192
		Kathotiya	663
		Khamhariya	87
		Parapani	167
	Shahpura	Bhilai Mal	230
		Dhirwan Khurd	262
		Khursipar	149
		Magar Mya	257
		Majhgaon	91
		Salaiya Mal	295
		Dobhi	143

Table 2. Blocks targeted and sample sizes for the baseline study in Madhya Pradesh, India

District	Block	Abbrev	# Villages	N
Mandla	Manda	Man	15	147
Dindori	Mehandwani	Meh	8	80
	Shahpura	Sha	7	70
		Total	**30**	**297**

Questions in the household survey pertained to their assets, production system (crops and livestock), income sources, management, income and consumption of kodo and kutki millets, food and nutrition security, dietary diversity, climate change adaptation practices, information received on climate change, and participation of household members in community institutions (see questionnaire in Padulosi et al. 2016). The survey sought responses from the head man and woman of the household. Some questions were directed to the male respondent, particularly those about landholdings, farm production, and sale of the target crops. Other questions were targeted at the female respondent, especially those concerning consumption in the household (e.g. diet, food insecurity, and consumption of the target crops), gender roles in crop management and participation in community institutions. Questions relating to adaptation actions

being applied and information received on climate change were directed to both the male and female respondents.

This document summarizes the main results of the baseline household survey with the aim to guide further investigation and actions in the Project. The analysis focuses on visualizing and identifying key patterns in the data. Comparisons are made between communities and regions for orientation but statistical tests were not performed, so the differences discussed here are not necessarily significant. The analysis was performed in R (Version 3.02 R Foundation for Statistical Computing) and Excel (Microsoft 2013).

It is noted that crop species and varieties were denoted by common name in the surveys so the precise species identification could not be made for every crop. Further work is required for some crops to assess the species name where several species could be associated to one common name and for crops with common names that could not be linked to scientific names by the investigators. More work is also needed to control for synonyms in variety names between households and communities, which is work that is ongoing in the Project.

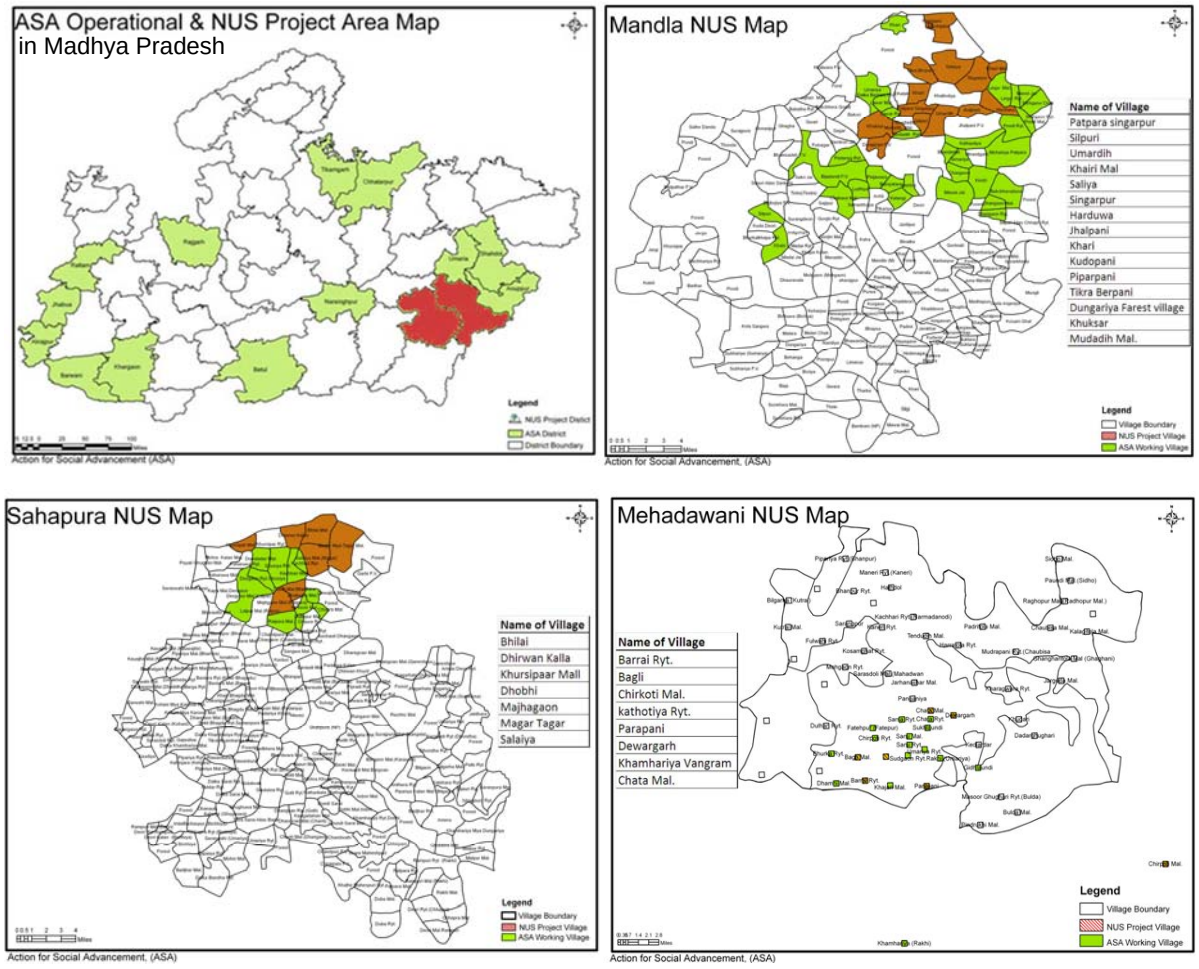


Figure 3. Working districts of ASA in Madhya Pradesh. Villages targeted by the Project in the focal blocks are indicated in red and other working villages of ASA are indicated in green

Respondent and household characteristics

Gender

A man and woman were interviewed in 94% of the 297 households surveyed (Table 3). In most cases, the eldest man or woman were interviewed and in rarer cases, the second eldest man or woman was interviewed. In eleven households, the female respondent was considerably older than the male respondent (between 12 and 44 years) and in one case the male respondent was 26 years older than the female respondent, suggesting that multiple generations were interviewed. Ten households (3.4%) had only one respondent, which in six cases was a female and in four cases was male. In two cases where only a female was interviewed, the eldest people in the household were women of two generations and there were no males of similar age listed in the household roster. In the other four cases where only a woman was interviewed, a male of similar age was part of the household but he was not interviewed because he was not available. In the four cases where only a male respondent was interviewed, there was an elder female in the household and also a secondary female of similar age to the male who were not available to interview. There were eight cases in which two men were interviewed: the eldest male and a younger male. Some of these households should be considered for exclusion in more advanced analyses. For the current assessment, all households have been retained. In total there were 287 households with male respondents and 291 households with female respondents.

Table 3. Summary of male and female respondents interviewed (primary = eldest)

Male respondent	Female respondent	All	Man	Meh	Sha
Yes	*Yes*	*279*	*134*	*77*	*68*
Primary	Primary	260	125	73	62
Primary	Secondary	14	6	3	5
Secondary	Primary	1	1		
Secondary	Secondary	2	1		1
Yes	*No*	*4*	*4*		
Primary	None	4	4		
No	Yes	6	6		
None	Primary	5	5		
None	Secondary	1	1		
Two	*No*	*8*	*3*	*3*	*2*
Primary and secondary	None	8	3	3	2
Total households with men interviewed		291	140	77	68
Total housheolds with women interviewed		285	141	80	70

Age and education

The age and education of the respondents is shown in Table 4. Male respondents ranged from 20 to 72 years of age, with a mean age of 42. Female respondents ranged from 14 to 85 with a mean age of 39. The level of education with generally low, with 52% of male respondents and 72% female respondents having received no formal education. The mean education for female respondents was 2 years and for male respondents was 3 years. Both men and women had received more years education on average in

Mehandwani as compared to the other focal blocks. It is noted that traditional education and literacy in local language was not captured by this assessment.

Table 4. Age and years of formal education of the respondents

	All	Man	Meh	Sha
Male respondent*				
Mean age	42.1	43.3	41.1	41.1
Min age	20	20	24	20
Max age	72	70	65	72
Mean education (years)	3.6	2.9	5	3.4
Min education	0	0	0	0
Max education	12	12	12	12
Female respondent				
Mean age	38.9	40.4	37.5	37.5
Min age	14	22	20	14
Max age	85	85	60	60
Mean education (years)	1.8	1	3.1	1.9
Min education	0	0	0	0
Max education	12	10	12	10

* excluding details on second male respondents from eight households with two male respondents

Ethnicity

All the respondents were from scheduled tribes (100%). The precise ethnicity was only recorded in Mandla block, where almost all were noted to be Gond (N=134, 91%). Different subclasses of Gond were also indicated, with the most common being Maravi (N=24), Varkade (N=13), Kulsate (N=12), Parte (N=12), Parasete (N=10), and Pandaro (N=8). Two households were noted to be Aher. The ethnicity will be captured in the endline survey in Dindori district. To the knowledge of the field teams, all the project villages are composed primarily of Gonds.

Household size and composition

The size of the households ranged from 2 to 9 with a mean of 4.9 inhabitants (Table 5). Households were similar in size in each focal block. The mean ratio of adult women to men was fairly even with a small bias toward males in Mehandwani. The mean number of children (under 15 years of age) per household was 1.3 (Table 5). There were slightly more children on average in households in Mandla block. Households included several generations, with the parents and grandparents of the children present and in some cases even the great-grandparents. The relationships of the household members to the head of household was not captured so it was not possible to discern if the grandparents in the household were the parents of the male or female parents. It was also not possible to distinguish more complex relationships where multiple adults of similar age were present.

Education and labor in the household

Of all the members of the households, on average three had achieved some level of formal education (Table 6). The maximum education achieved by anyone in the household on average was nine years. The level of education in households was similar between focal blocks.

A mean of two household members were available to help with farm labor at any point over year. A higher number of family members were available to help with farm work in Mehandwani, despite having smaller mean household sizes. The ages of farm helpers ranged from 4 to 84, but most were between the ages of 32 and 43 years of age (mean minimum and maximum ages). Fourteen percent of households were hiring laborers from outside the household to assist with farm work, which was more common in Mandla than in Dindori district (Table 6).

Table 5. Size and composition of surveyed households

	All	Man	Meh	Sha
Mean household size	4.9	5.1	4.5	4.9
Mean # of children (<15)	1.3	1.4	1.4	1.2
Mean # adults in age range				
15 to 25	1.1	1.2	0.9	1.2
25 to 35	1.6	1.6	1.5	1.8
45 to 65	0.7	0.9	0.7	0.6
>65	0.1	0.1	0.1	0.1
Mean prop. of adults in the household that are female	0.49	0.5	0.47	0.49

Table 6. Education level and labor availability in the surveyed households

	All	Man	Meh	Sha
Mean # household members with any education	3	3	3	2.9
Mean maximum education of anyone in household (years)	9	6	9	7
Mean # household members available to help on farm at any point of year	2.4	2.3	2.3	2.5
# households hiring workers	27	18	4	5

Wealth

The progress out of poverty index (PPI) was used as an indicator of wealth for the surveyed households (Grameen Foundation 2016). The index is based on 10 country-specific questions, which assess household characteristics and assets. For India, the questions relate to how many household members are under 17 years of age, the education of the male household head, the primary income source for the household, the main source of energy for cooking, whether household possesses casseroles or thermoware, a television, mobile telephone, sewing machine, dressing table, bicycle, motorbike, or car (Schreiner 2012). The answers to each question were matched to defined categories with associated scores. The sum of the scores for each question gives the PPI score, which ranges between 0 and 100 and is linked to a standardized set of poverty likelihoods. Lower PPI scores indicate higher probability of poverty.

The mean progress out of poverty index score for the households surveyed was 21 (Table 7). The scores ranged from a minimum 0 to maximum 51. The mean likelihood that households fell below the national

Tendulkar R66 poverty line was 46% (Schreiner 2010). Households in Mehandwani were a slightly less likely to fall under the national poverty line than in the other blocks (mean poverty likelihood 44% versus 46%).

Table 7. Progress out of poverty index (PPI) score and poverty likelihood of surveyed households

	All	Man	Meh	Sha
Mean PPI score	20.8	20.5	21.3	20.9
Poverty likelihood (probability of falling below national poverty line)				
Mean (%)	45.5	46.1	43.9	46
Min (%)	3.5	3.5	5.5	5.5
Max (%)	86.8	86.8	86.8	86.8

A woman and child in the study region. Credit S. Priyam / Action for Social Advancement

Farm characteristics

Land

The landholdings of the surveyed households are summarized in Table 8. The mean landholding size for all the households surveyed was 1.9 Ha. The smallest landholdings were 0.2 Ha and the largest landholdings were 18 Ha. The mean number of parcels held by households was 3.7, with a mean distance of 1.3 km between the furthest plots. The longest distance between parcels held by a household was 6 km. Households in Shahpura had larger landholdings compared to Mehandwani and Mandla but the number of parcels held and the distance between them was similar (Table 8).

Table 8. Land profile of the surveyed households

	All	Man	Meh	Sha
Mean landholdings(Ha)	1.9	1.8	1.4	2.5
Min. landholdings (Ha)	0.2	0.3	0.4	0.2
Max. landholdings (Ha)	18	15	12	18
# of parcels held	3.7	3.7	3.8	3.9
Mean distance between furthest parcels (km)	1.3	1.4	1.1	1.5
Maximum distance between furthest parcels (km)	6	5	4	6

Table 9. Land ownership of the surveyed households (means with zeros excluded)

	All	Man	Meh	Sha
# owning land	288	146	77	65
Mean area owned (Ha)	1.7	1.6	1.3	2.5
# renting land	58	37	14	7
Mean area rented (Ha)	0.7	0.6	0.7	1.2
# cultivating on communal lands	14	13		1
Mean area of communal land cultivated (Ha)	0.5	0.5		0.4
# renting land to others	5	4		1
Mean area rented (Ha)	2.4	2		4.1

Farmers owned most of their land. Relatively few households were renting land (20%) or cultivating on communal lands (5%) (Table 9). Just six households did not own any land and were cultivating exclusively on rented land (three in both Mehandwani and Shahpura). For three households it was not indicated whether their land was rented or owned, which could be an error in data collection or could indicate their landholdings fell under a different tenure arrangement than those considered in the questionnaire.

Land was allocated to different uses as described in Table 10. The landholdings were predominatly under rainfed cultivation (Figure 4). Most households (93%) had land under rainfed cultivation, while fewer (22%) had any land under irrigated cultivation. It is noted that 15 households (5%) did not provide details on their land use. For those with irrigated land, the area was on average 1.0 Ha. Irrigated cultivation was less common in Mehandwani and was smaller in area on average in this block than in Shahpura and Mandla. Only 23% of households reported having a garden, which was on average 0.3 ha in size.

Table 10. Number of households allocating land to different uses and mean area (excl. zeros)

	All	Man	Meh	Sha
# with rainfed cultivation	276	129	79	68
Rainfed area (Ha)	0.9	0.5	0.7	1.9
# with irrigated cultivation	66	37	10	19
Irrigated area (Ha)	1	1.1	0.6	1.1
# with a garden	67	18	33	16
Garden area (Ha)	0.3	0.3	0.3	0.2
# with a pasture	10	8		2
Pasture area (Ha)	0.6	0.6		0.4
# with area under fallow	58	23	21	14
Fallow area (Ha)	1.3	0.9	1.2	2
# with forest on property	5	4	1	
Area forest	2	2.4	0.2	

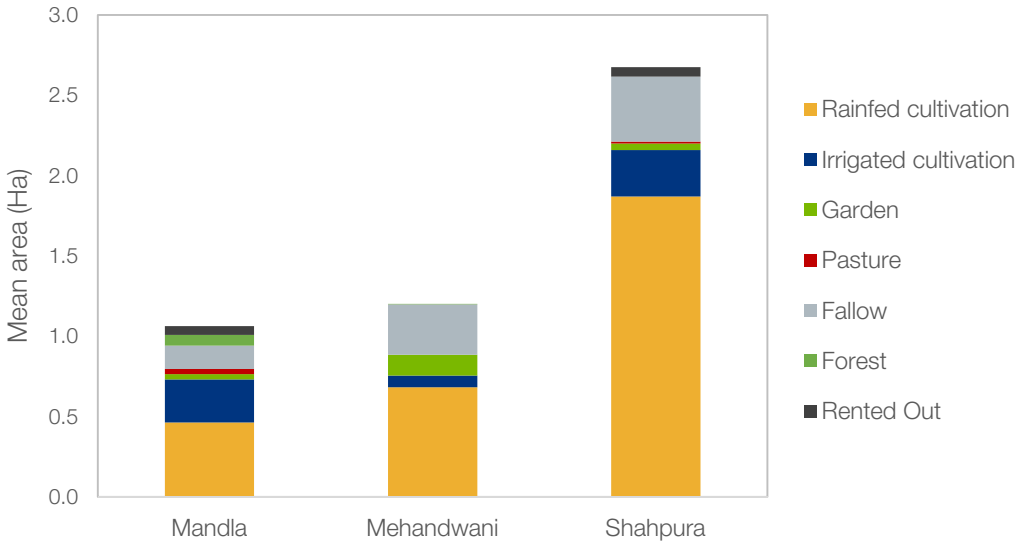


Figure 4. Mean area for different land use types in the three focal blocks (incl. zeros)

Livestock

Ninety-three percent of the surveyed households were keeping livestock. The most common type of livestock maintained overall was cattle (*Bos taurus*; 92%). Chickens (*Gallus gallus domesticus*; 27%) and goats (*Capra aegagrus hircus*; 18%) were also kept by many households (Table 11). Less common livestock were pigs (*Sus scrofa domesticus;* 1.7%), mules (*Equus asinus* × *Equus caballus;* 0.3%) and rabbits (*Oryctolagus cuniculus*; 0.3%). Looking closer at cattle, 86% of households were maintaining bulls, 57% cows, 40% calves, and 1% oxen (Table 12). There was not a big difference in the livestock kept between districts (Figure 5). Chicken were more common in Mandla and a larger number were kept on average in this block compared to the others. In total six livestock species were kept across the sites. Households maintained a mean of 1.4 livestock species.

Table 11. Number of households keeping livestock species and livestock richness

	All	Man	Meh	Sha
Cattle	273	140	72	61
Chicken	81	51	20	10
Goat	54	26	18	10
Pig	5	4	1	
Mule	1	1		
Rabbit	1	1		
Total # species	6	6	4	3
Household species richness	1.4	1.5	1.4	1.2

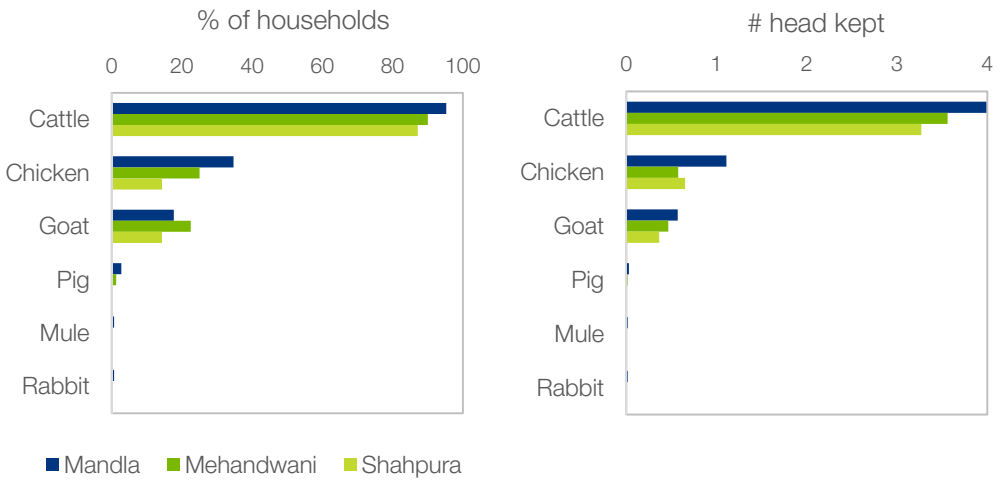


Figure 5. Percent of households maintaining species of livestock and the mean number of head maintained (incl. zeros)

Table 12. Number of households keeping different cattle types

	All	Man	Meh	Sha
Bulls	254	127	69	58
Cows	170	98	47	25
Calves	118	69	29	20
Oxen	3	3		

Table 13. Mean head of livestock maintained by those who kept the species (excl. zeros)

	All	Man	Meh	Sha
Cattle	3.8	4.0	3.6	3.4
Chicken	3.0	3.1	2.1	4.1
Goat	2.6	3.1	1.9	2.3
Pig	1.0	1.0	1.0	
Mule	2.0	2.0		
Rabbit	2.0	2.0		

Table 14. Mean head of different cattle maintained by those who kept the cattle type (excl. zeros)

	All	Man	Meh	Sha
Bulls	2.3	2.3	2.2	2.3
Cows	1.6	1.7	1.5	1.7
Calves	1.4	1.5	1.2	1.5
Oxen	2.3	2.3		

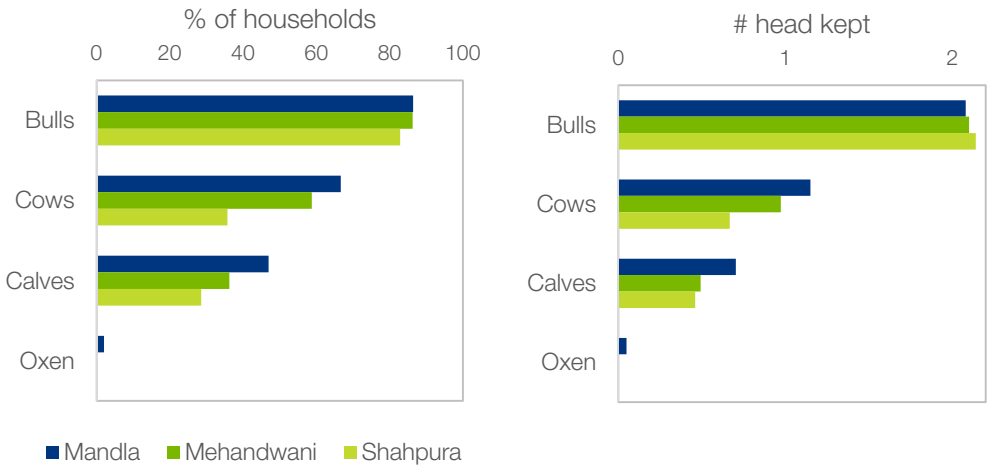


Figure 6. Percent of households maintaining cattle types and the mean head maintained (incl. zeros)

In general, households kept around three or four head of cattle and two to three chickens and goats (Table 13). Just one or two head were kept for pigs, mules, and rabbits. Considering cattle types, a slightly larger number head were maintained for bulls and oxen (mean 2.3) than for cows and calves (mean 1.6 and 1.4, respectively). Households in Mandla maintained slightly higher head counts of cows and calves than in the other blocks (Table 14, Figure 6).

Crops

A total of 33 crop species were cultivated by the surveyed communities, including ten cereals, eight legumes, 13 species of vegetables, and one species of oilseed (Table 16). Two of the vegetable species documented in Mandla block could not be identified to scientific name from the common names: *chech baji* (likely *Corchorus sp.;* Shukla et al 2010; Chauhan et al 2014*)* and *ghar.* Six households were noted to grow vegetables but it was not specified which species. Overall, households maintained a mean of 4.0 crop species, including 3.0 cereal crops, 0.4 legume species, 0.4 vegetables, and 0.1 oilseed (Table 15).

Table 15. Mean number of species of different crop types kept at the household level (incl. zeros)

	All	Man	Meh	Sha
Cereals	3.0	2.6	3.4	3.4
Legumes	0.4	0.5	0.4	0.4
Vegetables	0.4	0.7	0.2	0.2
Oilseed	0.1	<0.1	0.1	0.3

Table 16. Number of households growing crop species and crop species richness

	All	Man	Meh	Sha
Cereals	**296**	**147**	**80**	**69**
Oryza sativa	277	139	80	58
Zea mays	210	83	71	56
Panicum sumatrense	167	71	44	52
Paspalum scorbiculatum	154	51	45	58
Triticum aestivum	83	44	29	10
Hordeum vulgare	2		2	
Pennisetum glaucum	2	1	1	
Eleusine coracana	1			1
Echinochloa frumentacea	1	1		
Setaria italica	1			1
Legumes	**102**	**54**	**24**	**24**
Cajanus cajan	32	17	7	8
Cicer arietinum	30	22	5	3
Lens culinaris	25	12	12	1
Vigna mungo	22	5	2	15
Lablab purpureus	9	8		1
Pisum sativum	6	5	1	
Vigna unguiculata	2	1	1	
Glycine max	1	1		
Vegetables	**104**	**81**	**15**	**8**
Momordica charantia	78	66	11	1
Abelmoschus esculentus	14	13		1
Solanum melongena	7	5		2
Brassica rapa subsp. Oleifera	6	1	2	3
Solanum lycopersicum	3	1	1	1
Coccinia grandis	3	3		
Coriandrum sativum	1		1	
Allium cepa	1		1	
Capiscum sp.	1	1		
Brassica oleracea var Botrytis	1			1
Solanum tuberosum	1			1
Chech baji	5	5		
Ghar	2	2		
Unspecified	6	4	1	1
Oilseed	**27**	**1**	**7**	**19**
Guizotia abyssinica	27	1	7	19
Total # species	**33**	**26**	**20**	**21**
Household species richness	**4.0**	**3.8**	**4.0**	**4.2**

The most popularly cultivated crops overall were rice (93%), maize (71%), kutki millet (*Panicum sumatrense*; 56%), and kodo millet (*Paspalum scrobiculatum*; 52%) (Table 16). Maize, kutki, and kodo were slightly less common in Mandla district than in Dindori district (Figure 6). Less common cereals were wheat (28%), barley (*Hordeum vulgare*; 0.6%), pearl millet (*Pennisetum glaucum*; 0.6%), finger millet (*Eleusine coracana*; 0.3%) and foxtail millet (*Setaria italica*; 0.3%). Four legume species were popularly grown: pigeon pea (11%), chickpea (*Cicer arietinum*; 10%), lentil (*Lens culinaris*; 8%), and black gram (*Vigna mungo*; 8%). Less common legumes were hyacinth bean (*Lablab purpureus*; 3%), pea (*Pisum sativum*; 2%), cowpea (*Vigna unguiculata*; 0.6%) and soybean (*Glycine max*; 0.3%). Among the vegetables cultivated, bitter gourd was by

far the most common (25%). Less common vegetables were okra (*Abelmoschus esculentus*; 5%), eggplant (2%), mustard (*Brassica rapa* subsp. Oleifera; 2%), tomato (*Solanum lycopersicum*; 1%), ivy gourd (*Coccinia grandis*; 1%), coriander (*Coriandrum sativum*; 0.3%), onion (*Allium cepa*; 0.3%), chili (*Capsicum sp.*; 0.3%), cauliflower (*Brassica oleracea var Botrytis;* 0.3%), and potato (*Solanum tuberosum;* 0.3%). These vegetables were more commonly grown in Mandla than in Dindori district (Figure 6). Niger seed (*Guizotia abyssinica*) was grown by a considerable number of households (9%), particularly in Shahpura block (Figure 7).

Table 17. Mean area (hectares) allocated to crop by growers (excl. zeros)

	All	Man	Meh	Sha
Cereals	**1.3**	**1.2**	**1.4**	**1.5**
Pennisetum glaucum	1.1	0.2	2.0	
Setaria italica	0.8			0.8
Oryza sativa	0.6	0.6	0.6	0.6
Triticum aestivum	0.6	0.6	0.7	0.4
Eleusine coracana	0.4			0.4
Panicum sumatrense	0.4	0.4	0.3	0.4
Paspalum scorbiculatum	0.4	0.3	0.3	0.5
Hordeum vulgare	0.3		0.3	
Zea mays	0.3	0.3	0.2	0.3
Legumes	**0.4**	**0.4**	**0.3**	**0.5**
Glycine max	0.8	0.8		
Pisum sativum	0.3	0.4	0.2	
Cicer arietinum	0.3	0.3	0.3	0.5
Vigna unguiculata	0.3	0.4	0.2	
Lens culinaris	0.3	0.2	0.3	0.8
Cajanus cajan	0.3	0.3	0.2	0.4
Lablab purpureus	0.3	0.2		0.8
Vigna mungo	0.3	0.2	0.1	0.3
Vegetables	**0.5**	**0.5**	**0.6**	**0.2**
Coriandrum sativum	2.0		2.0	
Solanum lycopersicum	0.8	0.2	2.0	<0.1
Momordica charantia	0.4	0.5	0.4	0.1
Brassica rapa subsp. Oleifera	0.3	0.8	0.2	0.2
Abelmoschus esculentus	0.3	0.3		<0.1
Ghar	0.2	0.2		
Solanum melongena	0.1	0.1		0.2
Capiscum sp.	0.1	0.1		
Coccinia grandis	0.1	0.1		
Chech baji	0.1	0.1		
Unspecified	0.1	0.1	0.2	0.1
Solanum tuberosum	<0.1			<0.1
Allium cepa	<0.1		<0.1	
Brassica oleracea var Botrytis	<0.1			<0.1
Oilseed	**0.4**	**0.4**	**0.3**	**0.4**
Guizotia abyssinica	0.4	0.4	0.3	0.4

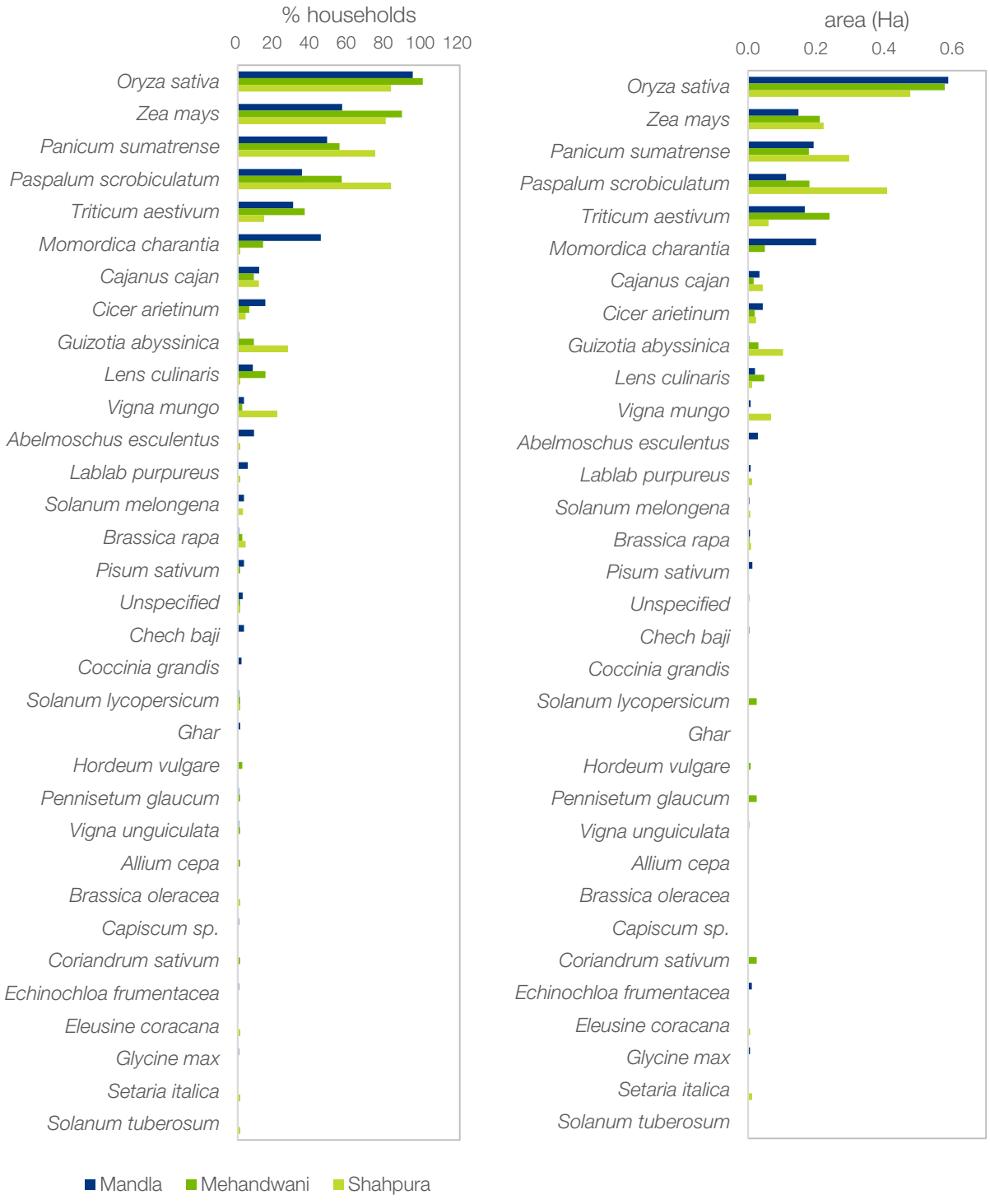


Figure 7. Percent of households cultivating different crops and the mean area cultivated (incl. zeros)

Household's assigned large areas to cereals (mean 1.3 Ha). Rice and wheat were assigned a mean 0.6 Ha by their growers, while the millets were grown in slightly smaller areas (mean 0.4 Ha). Barley and maize were grown in the smallest areas of all the cereals (mean 0.3 Ha). The few households cultivating pearl millet and foxtail millet grew them in large areas (mean 1.1 Ha and 0.8 Ha, respectively) (Table 17). Soybean was similarly grown in a large area by the one household that reported growing it (0.8 Ha). By contrast, the more popular pulses were grown in smaller areas on average (mean 0.3 Ha). When grown, vegetables were assigned a mean area of 0.5 Ha. Most vegetable species occupied small areas (<0.1 to 0.2 Ha), but bitter gourd, okra, and mustard were grown in slightly larger areas (0.5 Ha and 0.3 Ha). Tomato and coriander were grown by few households but in large areas (0.8 and 2 Ha, respectively). Despite the larger landholdings in Shahpura, farmers assigned similar area of land to different crop types as in the other blocks (Figure 8).

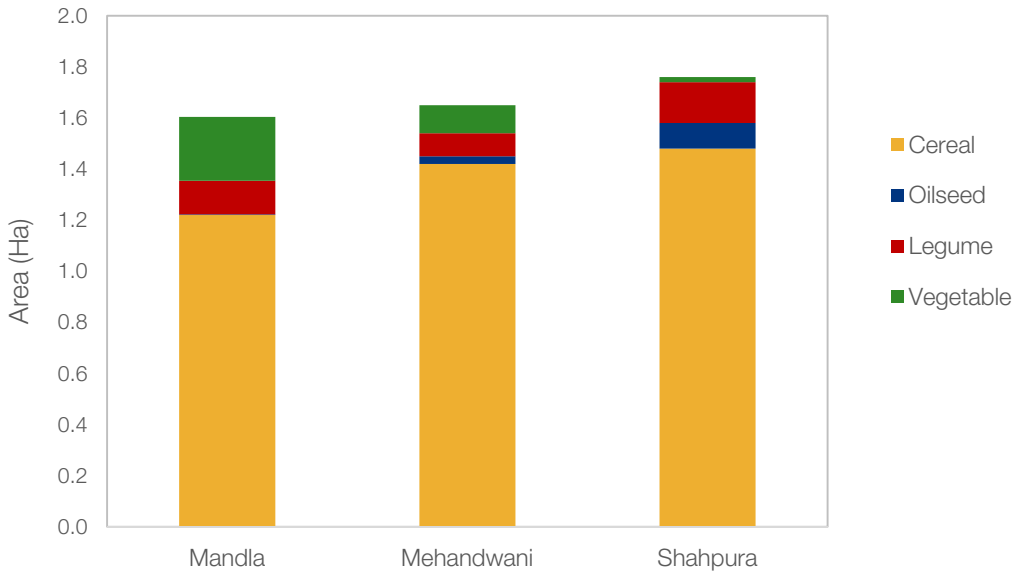


Figure 8. Mean area grown of different crop types (incl. zeros)

Household Income

The survey assessed the diversity of sources from which households drew their income. The livelihood sources included crops, crop products, livestock, livestock products, other natural resources (e.g. collection of wild plants and wood), labor and skilled job positions, credit and remittances, among others. These different sources of income are described in detail below and summarized for which were the most common and which were considered to be the most important to the household income (top 3-5 sources).

Crops for income

Many of the crops cultivated by the focal communities were providing a source of income for at least some households (Table 18). Little millet, rice, and kodo millet were the most common cash crops (for 16%, 11% and 10% of households overall, respectively). Bitter melon and wheat were fairly common income sources for households in Mandla (10% and 9% of households in the block, respectively), while Niger seed was a fairly common income source in Shahpura (16% of households in the block) (Figure 9).

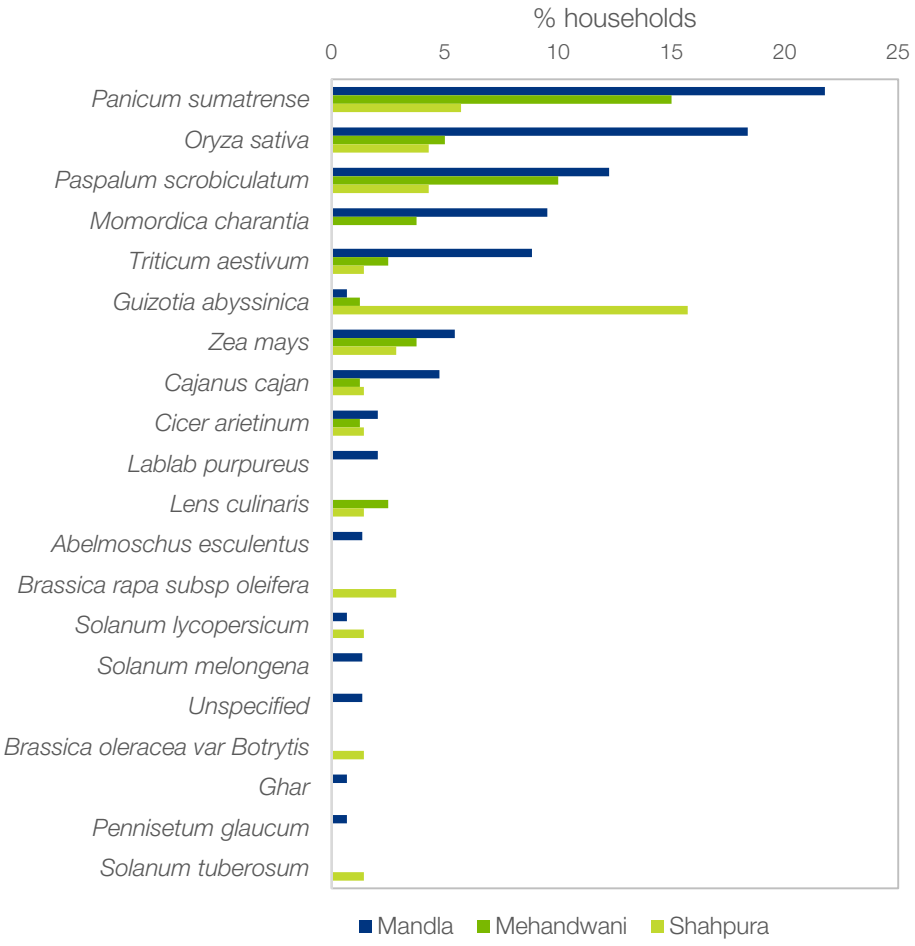


Figure 9. Percent of households reporting crops as a source of income

Table 18. Number of households earning income from different crop species

	All	Man	Meh	Sha
Cereals	**84**	**54**	**20**	**10**
Panicum sumatrense	48	32	12	4
Oryza sativa	34	27	4	3
Paspalum scorbiculatum	29	18	8	3
Triticum aestivum	16	13	2	1
Zea mays	13	8	3	2
Pennisetum glaucum	1	1		
Legumes	**20**	**13**	**4**	**3**
Cajanus cajan	9	7	1	1
Cicer arietinum	5	3	1	1
Lens culinaris	3		2	1
Lablab purpureus	3	3		
Vegetables	**26**	**20**	**3**	**3**
Momordica charantia	17	14	3	
Abelmoschus esculentus	2	2		
Solanum melongena	2	2		
Brassica rapa subsp. Oleifera	2			2
Solanum lycopersicum	2	1		1
Unspecified	2	2		
Brassica oleracea var Botrytis	1			1
Solanum tuberosum	1			1
Ghar	1	1		
Oilseed	**13**	**1**	**1**	**11**
Guizotia abyssinica	13	1	1	11
Total number citing crops as a livelihood source	**104**	**62**	**21**	**21**
Total number citing agriculture as a top livelihood source	**293**	**145**	**79**	**69**

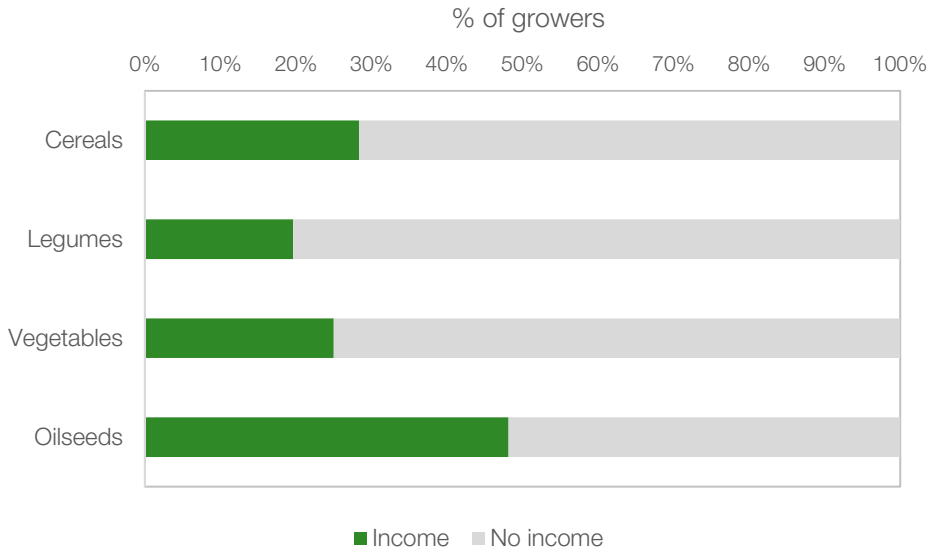


Figure 10. The proportion of growers of different crop types that were earning income

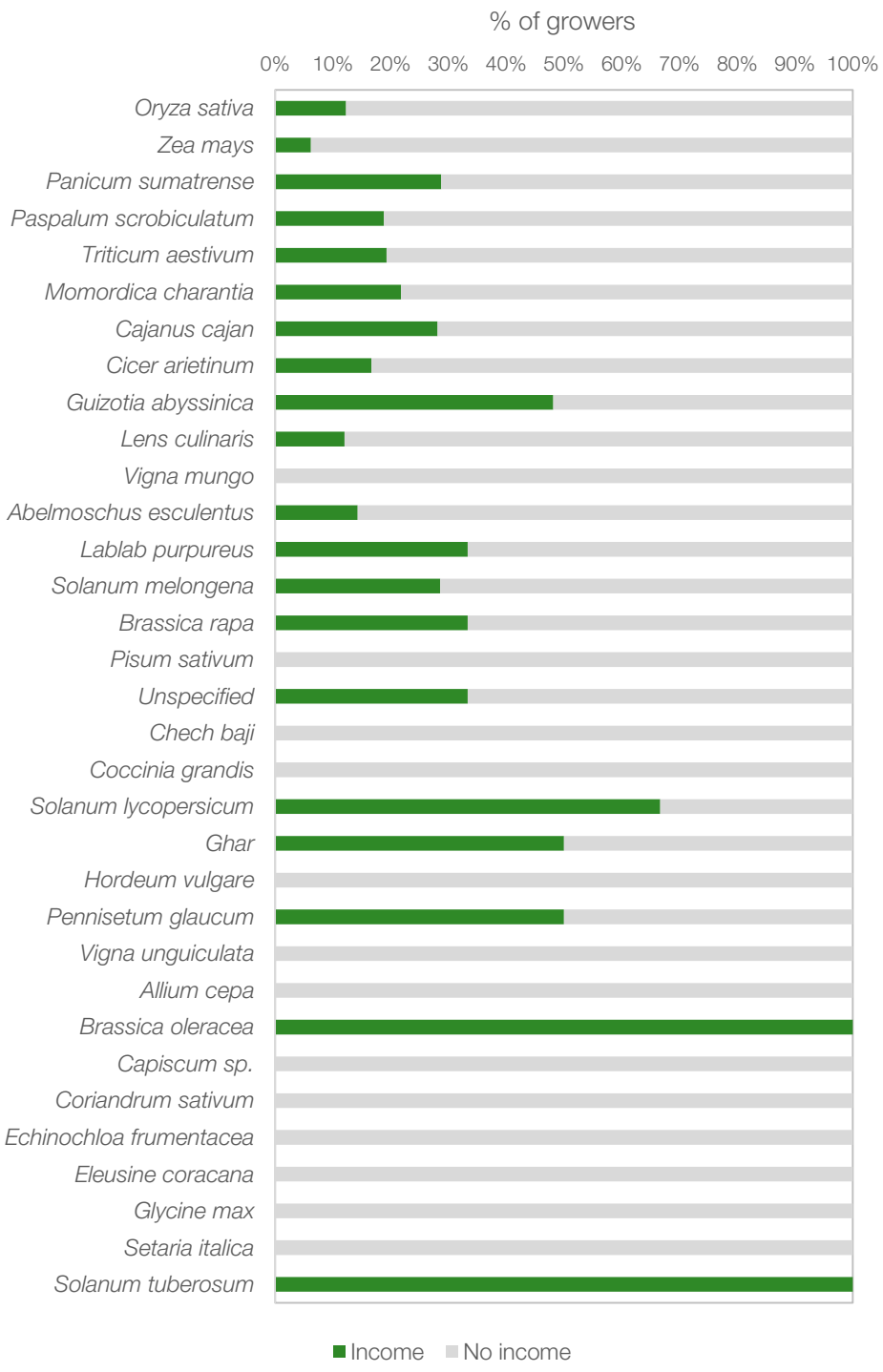


Figure 11. Percent of growers reporting crops as a source of income and among the top income sources for the household

Although some households reporting making income from some crops, production was by and large for household consumption (Figure 10). The majority ((65%) of growers did not report making income from their production and 13 of the 33 crops were not sold by any of their producers (Figure 11). It is possible that the survey did not fully capture the scale of cash crop production, as in fact 99% of respondents cited agriculture as a top income source for their household. However, a likely explanation for this discrepancy is that respondents considered sources of staple food for household subsistence as an income source.

Livestock for income

Although cattle were the most common livestock maintained they were rarely providing a source of income (Figure 13). Instead, chickens and goats were more common income sources, particularly in Mandla block (Table 19). In Mehandwani, livestock were very rarely providing a source of income (Figure 12). In additon to selling the livestock itself, 11% of households reported selling animal products (Table 20). Chicken meat was the most common animal product sold, while other types of meat, dairy and eggs were more rarely sold. As seen for sales of livestock, sales of animal products were more common in Mandla than in the sites in Dindori.

Table 19. Number of households for which specific livestock species provide a source of income

	All	Man	Meh	Sha
Chicken	28	23	2	3
Goat	13	11		2
Cattle	4	3		1
Pig	2	2		
Mule	1	1		
Rabbit	1	1		
Total number citing livestock as a livelihood source	**38**	**30**	**2**	**6**
Total number citing livestock as a top livelihood source	**3**	**1**	**2**	**0**

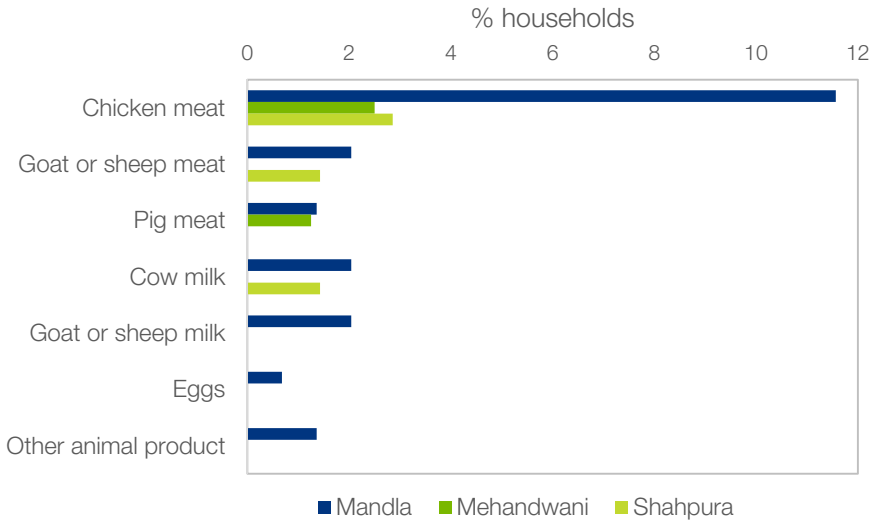


Figure 12. Percent of households reporting livestock products as income sources

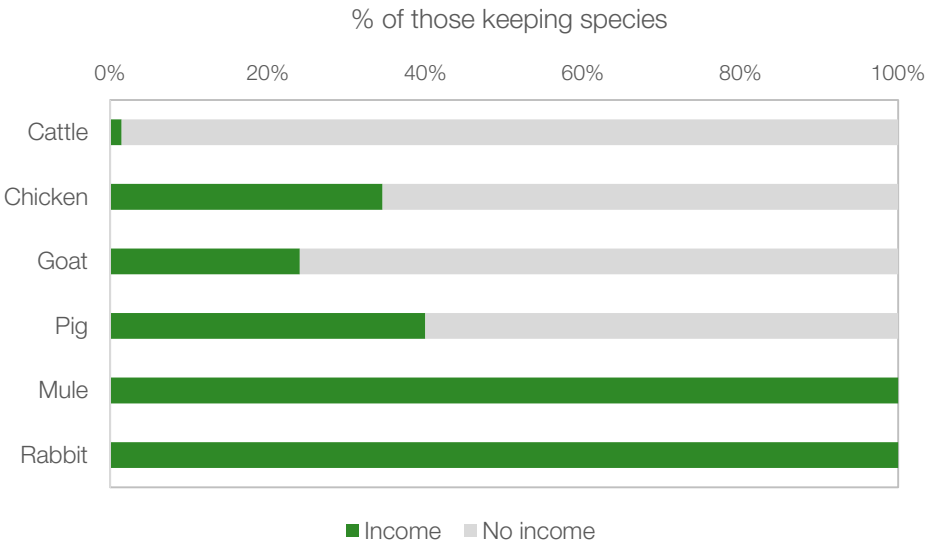


Figure 13. The percent of households keeping livestock that were earning income

Table 20. Number of households for which animal products provide a source of income

	All	Man	Meh	Sha
Meat	*26*	*20*	*3*	*3*
Chicken meat	21	17	2	2
Goat or sheep meat	4	3		1
Pig meat	3	2	1	
Dairy	*7*	*6*		*1*
Cow milk	4	3		1
Goat or sheep milk	3	3		
Eggs	1	1		
Other animal product	2	2		
Total number citing animal products as livelihood source	**32**	**25**	**3**	**4**
Total number citing animal products as top livelihood source	**0**	**0**	**0**	**0**

Other natural resource-based income sources

Aside from crops and livestock, other natural resources were also being exploited by the households as a source of income (Table 21). In particular, wild plant gathering was an income source for 74% of households. Tendupatha (leaves of *Diospyros melonoxylon*) was the main product gathered, which is used for the production of beedi cigarettes. Mahua (*Madhuca longifolia*) was also commonly gathered. The flower is used as food and to produce alcohol. Wood was gathered by many households and sold for timber (8%), fuel (4%), or charcoal (2%). Sales of manure or compost were also reported by some households (4%). Wild plant gathering and forestry were more common in Mandla and less common in Mehandwani block (Figure 14).

Table 21. Number of households reporting livelihood sources

	All	Man	Meh	Sha
Wild plant gathering	*221*	*124*	*45*	*52*
Tendupatha gathering	217	122	44	51
Mahua gathering	20	16	0	4
Forestry	*33*	*27*	*1*	*5*
Timber	24	20	0	4
Fuel wood	13	11	1	1
Charcoal	5	4	0	1
Compost/manure	12	9	0	3
# households with income from other natural resources	**229**	**130**	**46**	**53**
# households with other natural resources as a top income source	**28**	**20**	**2**	**6**

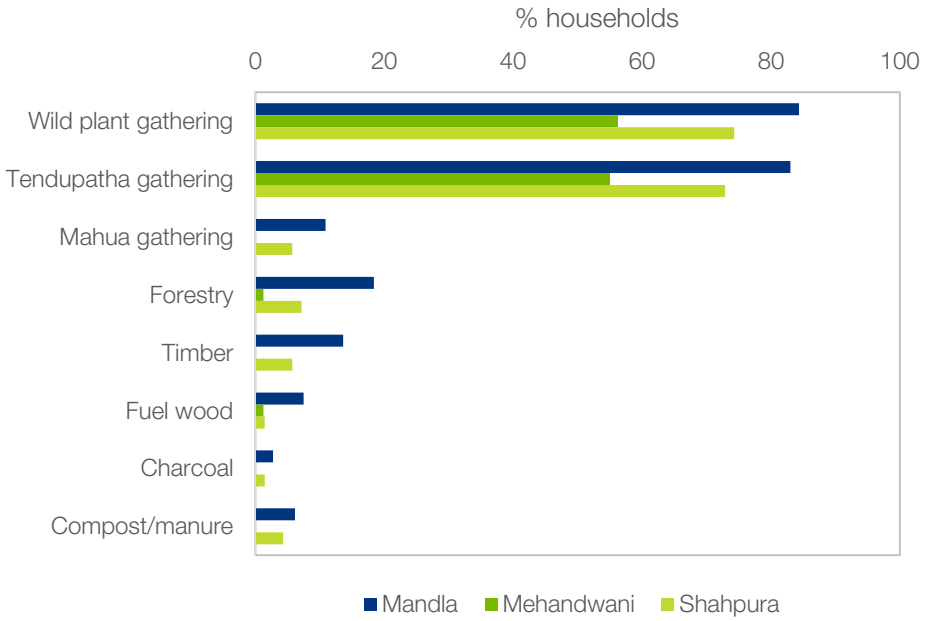


Figure 14. Percent of households reporting livelihood sources

Labor, service and other income sources

Employment of household members on other farms provided an income source for 73% of households overall (Table 22). Some households (12%) also had some members engaging in other types of labor or service work for remuneration. Additional sources of income for the surveyed households were credit (23%) and payment by government/projects (23%). Some households were also making an income from remittances (3%), renting equipment or farm animals (2%), and renting land (0.7%). Payment by government/projects was less common in Mehandwani than in the other blocks, but otherwise the frequency of the income sources was similar across the focal blocks (Figure 15).

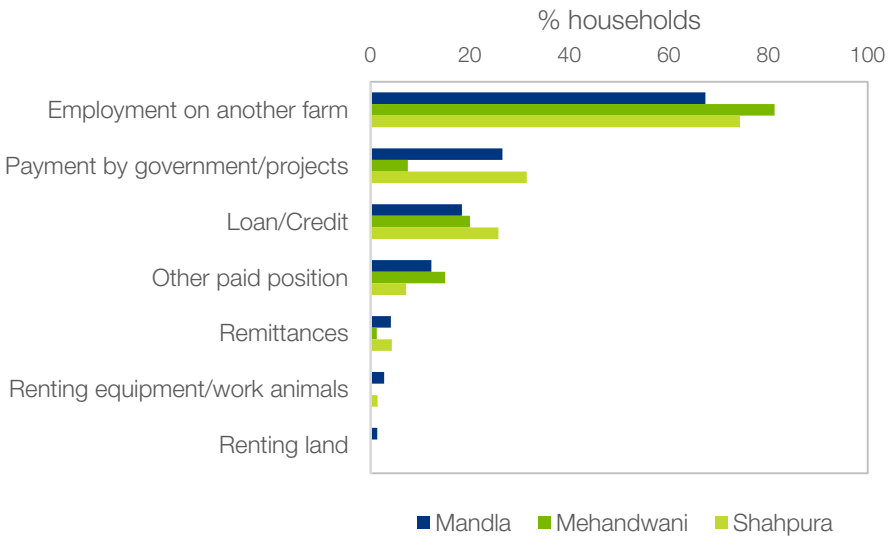


Figure 15. Percent of households reporting livelihood sources as income sources

Table 22. Number of households reporting off-farm income sources

	All	Man	Meh	Sha
Employment on another farm	216	99	65	52
Payment by government/projects	67	39	6	22
Loan/Credit	67	27	16	18
Other paid position	35	18	12	5
Remittances	10	6	1	3
Renting equipment/work animals	5	4	0	1
Renting land	2	2	0	0
# households with income from other sources	**264**	**126**	**77**	**61**
# households with other sources as top income sources	**286**	**140**	**78**	**68**

Types and numbers of income sources

The households surveyed had a total of 45 unique sources of income, considering all the specific crops, livestock, crop and animal products, other natural resources, farm labor, employment, and other sources. Overall, individual households had a mean of 3.3 income sources (Table 23). Households in Mandla had more sources of income on average than households in Dindori.

Ninety-nine percent of households were gaining an income from agriculture and 13% were gaining income from livestock (Figure 16). Ninety-six percent were gaining income from labor, services or other sources not based in natural resources. Exploitation of natural resources aside from crops and livestock (e.g. forestry, wild plant gathering) was an income source for 77% of households. Animal products (11%) were a more rare source of income. Livestock and animal products were more common sources of income in Mandla than in Dindori, while natural resources other than crops and livestock were a less common source of income in Mehandwani (Figure 17). Households had a mean of 0.7 cash crops and 0.2 animal species that generated income (Table 24). In addition, households had a mean 1.3 sources of income from labor, service

or other non-natural resource based sources and 0.9 income sources from other natural resources. Households on average had 0.1 sources of income from animal products.

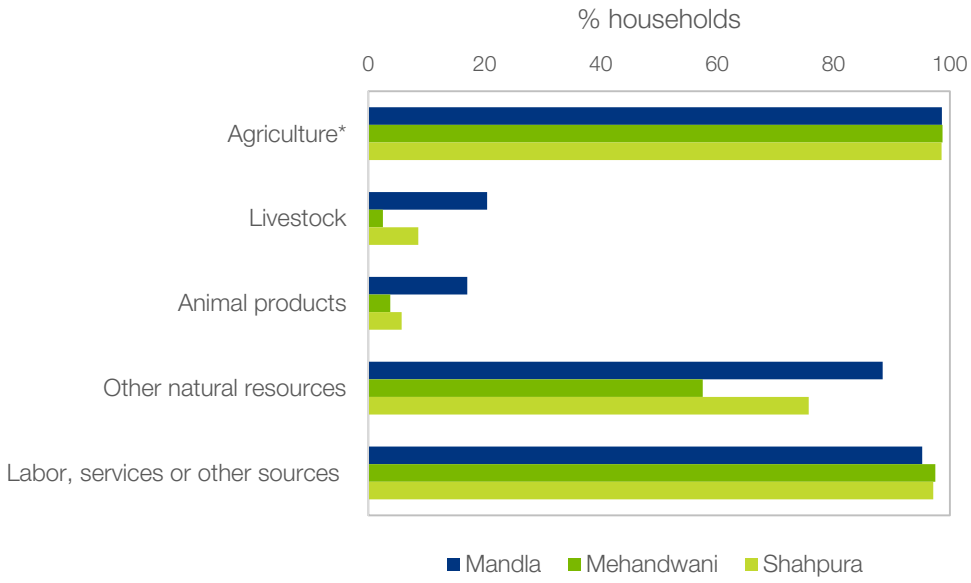


Figure 16. Number of households gaining an income from different types of livelihood sources

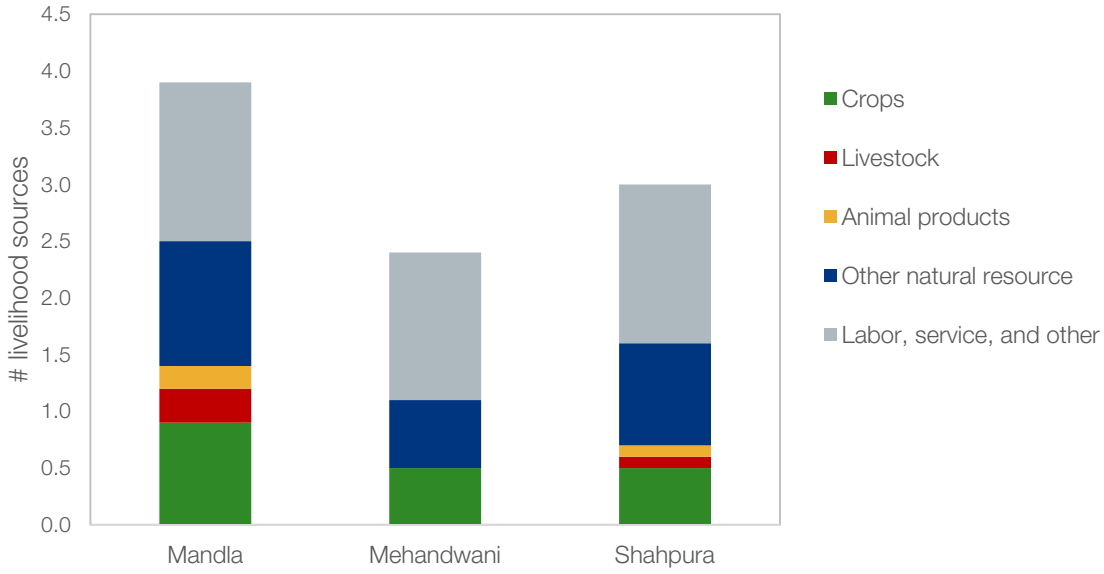


Figure 17. Mean number of livelihood sources of different types at household level (incl. zero)

Table 23. Richness of livelihood sources

	All	Man	Meh	Sha
Total # livelihood sources in region	45	41	20	30
Mean # livelihood sources at household level	3.3	3.9	2.4	2.9

Table 24. Mean number of income sources within different types of livelihood sources (incl. zero)

	All	Man	Meh	Sha
Crops	0.7	0.9	0.5	0.5
Livestock	0.2	0.3	<0.1	0.1
Animal products	0.1	0.2	<0.1	0.1
Other natural resource	0.9	1.1	0.6	0.9
Labor, service, and other	1.3	1.4	1.3	1.4

Most common and top income sources

Overall, the most common livelihood sources were wild plant gathering (74%) and farm labor (73%) (Table 25). The wild plants gathered were often tendupata (73%) or mahua (7%). Although popular, wild plant gathering was rarely cited among households' top income sources (Table 26). Instead, labor was a top income source for 96% of households. Agriculture was a top income source for effectively all the households (99%). However, there was not any particularly strong cash crop in the region. Among the crops, kutki millet was the most often mentioned as an income source (16%), followed by rice (12%), kodo millet (10%), bitter melon (6%), wheat (5%), and Niger seed (4%). It is noted that payment by government/projects (23%) and credit/loans (23%) were more common sources of income than any of these crops. Wood (11%), chickens (9%), chicken meat (7%), and goats (4%) were also among the most common sources of income in the surveyed communities.

The most common income sources were slightly different in the three blocks (Table 25). Farm labor was a more prominent income source for households in Dindori, while wild plant gathering was a more prominent income source for households in Mandla. Rice was a much more common source of income for households in Mandla (18%) compared to Mehandwani and Shahpura (5% and 4%, respectively). The millets were more important income sources in Mandla and Mehandwani than in Shahpura, instead, Niger seed was the most common cash crop in Shahpura, which was not at all common in the other blocks. Credit/loans were a common income source in Mandla (27%) and Shahpura (31%) but much less common in Mehandwani (8%).

Table 25. Most popular livelihood source ranked by number of households citing income sources

Rank	Overall	Mandla	Mehandwani	Shahpura
1	Wild plant gathering (74.4%)	Wild plant gathering (84.4%)	Farm labor (81.2%)	Farm labor (74.3%)
2	Farm labor (72.7%)	Farm labor (67.4%)	Wild plant gathering (56.2%)	Wild plant gathering (74.3%)
3	Payment by projects (22.6%)	Credit/loan (26.5%)	Payment by projects (23.8%)	Credit/loan (31.4%)
4	Credit/loan (22.6%)	*Panicum sumatrense* (21.8%)	*Panicum sumatrense* (15%)	Payment by projects (25.7%)
5	*Panicum sumatrense* (16.2%)	Payment by projects (20.4%)	Other paid position (15%)	*Guizotia abyssinica* (15.7%)
6	Other paid position (11.8%)	*Oryza sativa* (18.4%)	*Paspalum scrobiculatum* (10%)	Other paid position (7.1%)
7	*Oryza sativa* (11.5%)	Wood (18.4%)	Credit/loan (7.5%)	Wood (7.1%)
8	Wood (11.1%)	Chicken (15.7%)	*Oryza sativa* (5%)	*Panicum sumatrense* (5.7%)
9	*Paspalum scrobiculatum* (9.8%)	Other paid position (12.2%)	*Momordica charantia* (3.8%)	*Paspalum scrobiculatum* (4.3%)
10	Chicken (9.4%)	*Paspalum scrobiculatum* (12.2%)	*Zea mays* (3.8%)	*Oryza sativa* (4.3%)
11	Chicken meat (7.1%)	Chicken meat (11.6%)	Chicken (2.5%)	Chicken (4.3%)
12	*Momordica charantia* (5.7%)	*Momordica charantia* (9.5%)	Chicken meat (2.5%)	Remittance (4.3%)
13	*Triticum aestivum* (5.4%)	*Triticum aestivum* (8.8%)	*Triticum aestivum* (2.5%)	Manure/compost (4.3%)
14	Goat (4.4%)	Goat (7.5%)	*Lens culinaris* (2.5%)	*Zea mays* (2.9%)
15	*Guizotia abyssinica* (4.4%)	Manure/compost (6.1%)	Wood (1.2%)	Chicken meat (2.9%)

Table 26. Most common top income sources ranked by number of households listing them in top 3-5 income sources for the household

Rank	Overall	Mandla	Mehandwani	Shahpura
1	Agriculture (99%)	Agriculture (99%)	Agriculture (99%)	Agriculture (99%)
2	Labour (96%)	Labour (95%)	Labour (98%)	Labour (97%)
3	Other livelihood source (23%)	Other livelihood source (31%)	Other livelihood source (8.8%)	Other livelihood source (21%)
4	Timber (4%)	Timber (5.4%)	Livestock (2.5%)	Timber (5.7%)
5	Wild plant gathering (3.4%)	Wild plant gathering (5.4%)	Fuel (1.2%)	Payment by projects (1.4%)
6	Fuel wood (1.7%)	Fuel wood (2.7%)	Wild plant gathering (1.2%)	Manure (1.4%)
7	Livestock (1%)	Migration (2%)		Wild plant gathering (1.4%)
8	Migration (1%)	Manure (0.7%)		
9	Manure (0.7%)	Livestock (0.7%)		
10	Payment by projects (0.3%)			

Cultivation and sale of the target crops

The project is focused on research and development of the value chains of kodo and kutki millet and is exploring the diversity of local vegetables to identify species with potential to address nutrition gaps. A more detailed assessment was made of the current levels of cultivation and commercialization of these crops, considering the diversity of varieties, as well as the management practices and associated gender roles.

Minor millets

The most important minor millets in the project area are kodo millet (*Paspalum scrobiculatum*) and little millet (*Panicum sumatrense*), known locally as kutki. Overall, 65% of households surveyed were cultivating either kutki or kodo millet (Table 27). These cereals were most commonly grown by households in Shahpura block (86%) and least commonly in Mandla block (56%). In Dindori district, most households grew both kodo and kutki millets and few households grew either crop on its own. A considerable number of households were growing only kutki in Mandla block. On average growers devoted 0.6 Ha of land to kodo and kuki production. In Shahpura the area allocated to these millets was higher at 0.8 Ha. Kodo and kutki were providing an income source for 19% of the surveyed households (Table 28).

Millets other than kodo and kutki were rarely grown by producers in the study area. Finger millet (*Eleusine coracana*; ragi) was grown by one producer in Shahpura, barnyard millet (*Echinochloa* sp.; sawan) was grown by one producer in Mandla, foxtail millet (*Setaria italica*, kangni) was grown by one producer in Shahpura, and pearl millet (*Pennisetum glaucum*) was grown by two producers (one in Mandla and one in Mehandwani). In the following sections, further detail on the production and sale of the focal millets, kodo and kutki is provided.

Table 27. Number of households cultivating kodo and kutki millet and area allocated

	All	Man	Meh	Sha
# households growing kodo or kutki millet	192	82	50	60
% of households growing kodo or kutki millet	64.6	55.8	62.5	85.7
# households growing both kodo and kutki millets	129	40	39	50
# households growing kodo millet only	25	11	6	8
# households growing kutki millet only	38	31	5	2
Mean area devoted to kodo and kutki millet by growers (Ha)	0.6	0.6	0.6	0.8
Mean % of farmland devoted to kodo and kutki millet by growers	51.4	53.3	44.2	54.7

Table 28. Number of households selling kodo and kutki millet

	All	Man	Meh	Sha
# households selling kodo or kutki millet	55	35	13	7
# households selling both kodo and kutki	22	15	7	0
# households selling only kutki millet	26	17	5	4
# households selling only kodo millet	7	3	1	3

Kodo millet

Cultivation of kodo millet

The level of cultivation of kodo millet in the surveyed blocks is shown in Table 29. Overall more than half the surveyed households were growing kodo millet. A higher proportion of households was growing kodo millet in Shahpura block 83%, while a lower proportion of households was growing kodo in Mandla block (52%). Overall, the farmers allotted a mean 0.4 Ha to kodo millet, representing about 30% of their total farmland. The area of kodo cultivation was slightly larger in Shahpura (0.5 Ha) compared to the other two blocks (0.3 Ha).

Table 29. Number of households cultivating kodo and area devoted to the crop

	All	Man	Meh	Sha
# of households growing kodo millet	154	51	45	58
% of households growing kodo millet	51.9	34.7	56.3	82.9
Mean area devoted to kodo millet by growers (Ha)	0.4	0.3	0.3	0.5
Mean % of farmland devoted to kodo millet by growers	29.6	31.7	24.6	31.7

Table 30. Number of households growing kodo varieties and variety richness

Variety	All	Man	Meh	Sha
Ashadi Rarvi	15	13	2	
Badi kodon	3	2		1
Chhoti	56	21	21	14
Chhoti Badi	1			1
Dong	1			1
Gurmatiya	2			2
Indra	9	2		7
Kali	10	1	4	5
Kodli	3	2		1
Kori chhota Dehati	1	1		
Lal	28	1	11	16
Desi*	21	6	6	9
Unspecified*	4	2	1	1
Total # varieties in region	**11**	**7**	**4**	**10**
Mean # varieties at household level	**1.0**	**1.0**	**1.0**	**1.0**

**Not counted in regional variety richness*

A total of 11 specific varieties of kodo were grown across the villages (Table 30). 10 of these varieties were found in Shahpura district, while lower variety diversity was seen in the other blocks. Mandla had an intermediate variety richness, with 7 varieties, while Mehandwani had the lowest richness of kodo with only 4 varieties. The most common kodo variety was *chhoti*, followed by *lal, ashadi rarvi* and *indra*. *Chhoti* was popular across the three blocks. *Ashadi rarvi* was more common in Mandla and was grown in fairly large areas, especially compared to the lal variety, which was grown by more farmers but covered much less total area (Figure 18). The *lal* variety was more common in Dindori district. Another variety that was popular in this district was *kali*. Across the villages households typically only cultivated one variety of kodo millet. Only in one case did a household in Shahpura report growing two varieties of kodo.

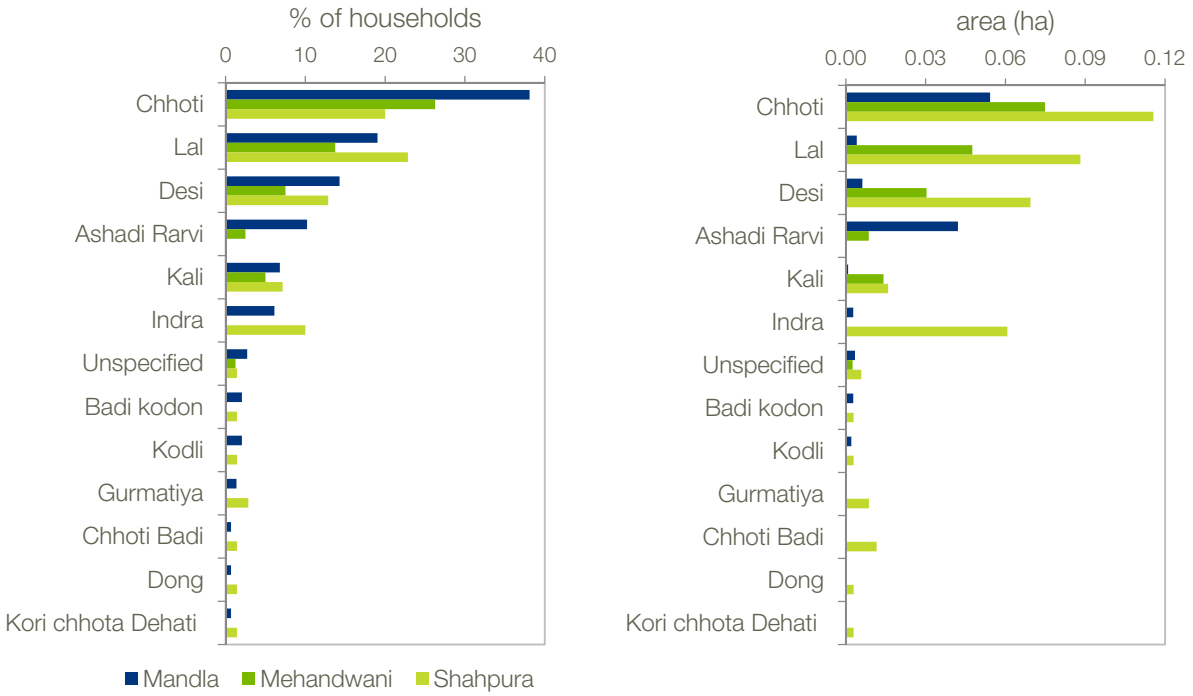


Figure 18. Percent of households growing varieties of kodo millet and the total area in the sample

Management of kodo millet

The work carried out for managing kodo millet included preparing the soil, sowing the seed, weeding, past management, and harvesting (Table 31). In the survey, respondents noted the household members who were engaged in each activity. The household members listed were more commonly men than women except for weeding, which was a female-dominated activity (Figure 19). It is noted that only one family member was listed for each activity, whereas the survey design anticipated multiple family members to be listed. The results could be biased towards men for this reason. In any case the results seem to reflect the primary person and gender responsible for the work.

Table 31. Number of households carrying out different stages of kodo millet management and the proportion of workers who were female

Role	All	Man	Meh	Sha
Preparing soil	149	48	44	57
	(1.3)	0.0	0.0	(3.5)
Sowing seed	148	47	44	57
	(2.0)	(2.1)	0.0	(3.5)
Weeding	143	43	44	56
	(61.5)	(51.2)	(79.5)	(55.4)
Pest management	139	40	43	56
	(3.6)	0.0	(2.3)	(7.1)
Harvesting	145	44	44	57
	(2.8)	(2.3)	0.0	(5.3)

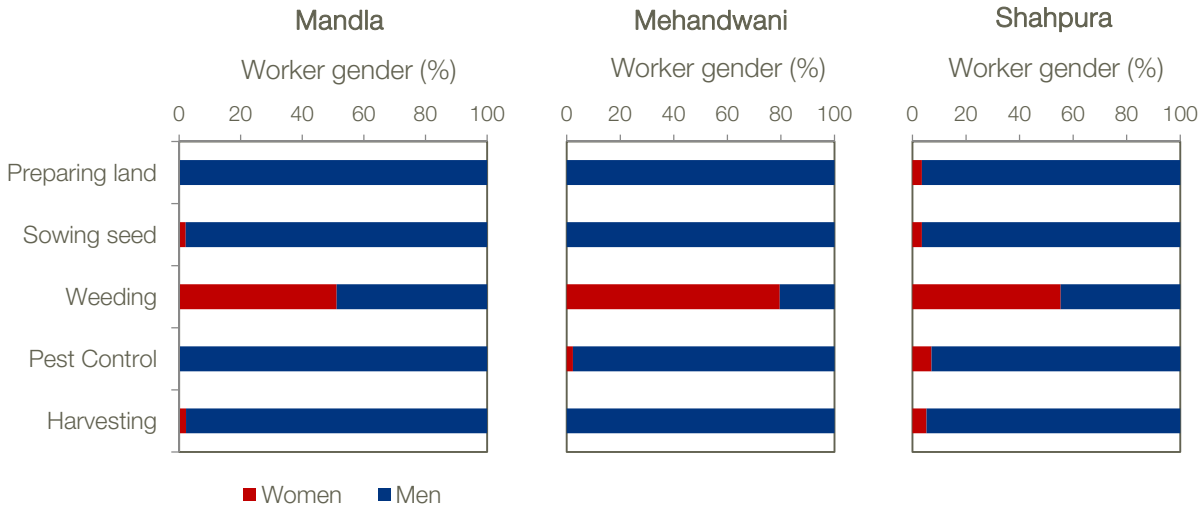


Figure 19. Gender ratio of workers involved in different stage of kodo millet management

The sources of kodo millet seed were reported in the survey. Effectively all respondents sourced their seed from their own production. One farmer in Mandla reported sourcing seed from another farmer. In general kodo was produced without the use of inputs. Just four farmers reported using fertilizer in the cultivation of kodo (two in Mandla and one in both Shahpura and Mehandwani).

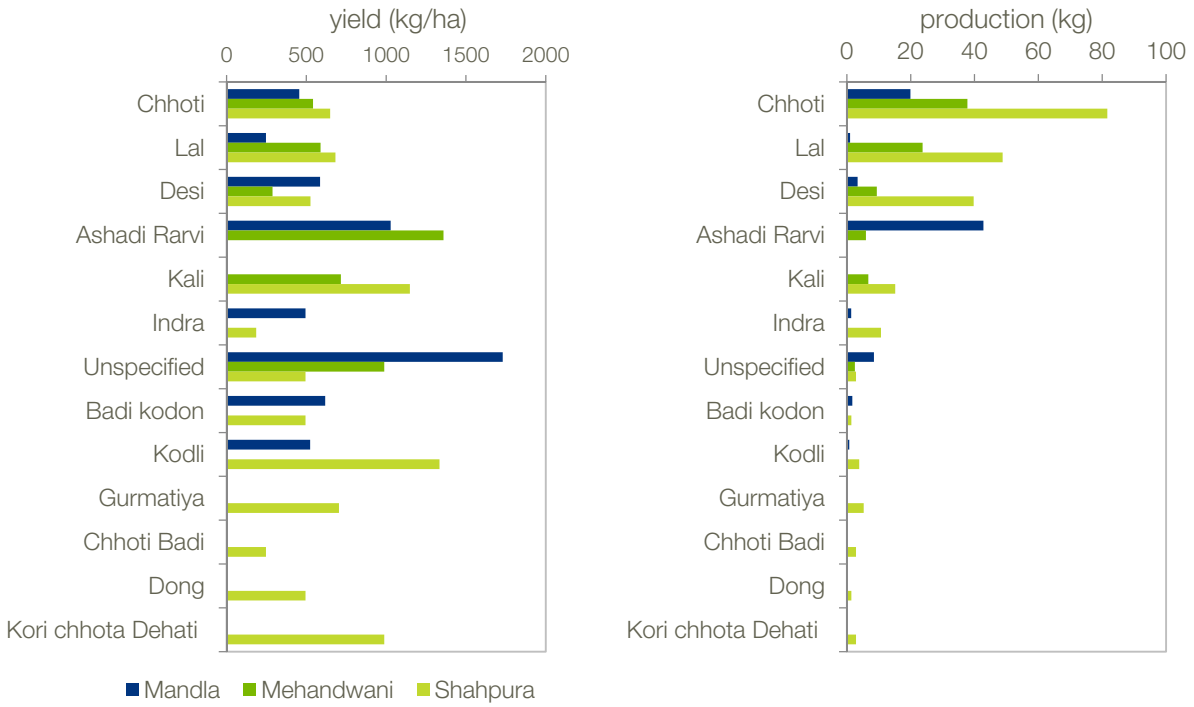


Figure 20. Mean yield and total production of different kodo varieties

Table 32. Mean yield and production of kodo millet among growers

	All	Man	Meh	Sha
Yield (Kg/Ha)	623.0	668.3	581.3	616.3
Production (Kg)	220.4	233.4	153.1	261.3

Overall, the mean yield achieved for kodo was 623 kg/ha. Yields were highest in Mandla and lowest in Mehandwani (Table 32). The yields of the different varieties were quite variable (Figure 20). The *ashad rarvi*, *kodli*, *kali* and *kori chhota dehati* varieties stood out as having fairly high yields, while the *chhoti badi* and *indra* varieties had lower yields. It is noted that the precision of the yield data was limited by the recall capacity of the farmers and some of the varieties had very few records, which limits the quality of these observations. The yields of the kodo varieties did not correspond well to their popularity.

Sale of kodo millet

Overall, 19% of kodo producers were selling part of their harvest (Table 33). Whereas the grand majority of households were growing millet in Shahpura, only 5% of producers in this block reported selling the crop. By contrast, sales of kodo millet were most common in Mandla, where cultivating the crop was much less common. Across the blocks, those who marketed kodo sold on average half of their production. All sales were made in a raw, unprocessed, form.

Table 33. Number of households selling kodo millet and the relative percentage of growers that were producing commercially

	All	Man	Meh	Sha
# of households selling kodo millet	29	18	8	3
% of kodo millet growers selling production	18.8	35.3	17.8	5.2
Mean % of kodo production sold by commercial producers	50.6	49.9	51.3	53.6
Mean volume sold by commercial producers (kg)	59.4	65.4	69.6	17.9
Total income from fonio among commercial producers (INR)	2,166	2,301	2,253	1,300
INR/Ha among commercial producers	4,975	5,634	3,925	3,212

Table 34. Locations of sale for kodo millet and average price obtained (INR)

	All	Man	Meh	Sha
Local market	21	15	5	1
	(13)	(12)	(16)	(10)
Mandi	2	1	1	0
	(15)	(15)	(15)	

The price and buyers of kodo millet are shown in Table 34. Kodo producers generally sold their grain to the local market. Two households reported selling kodo to the *mandi,* which is a bigger regulated market. Details on the prices achieved in the different village markets are detailed in Table 35. The highest price was achieved in the market in Khari where on average producers received 19 INR/kg (approximately 0.28 USD/kg). The lowest prices were reported for the local markets in Salaiya Mal and Tikraberpani, where producers obtained only 10 INR/kg (0.15 USD/kg). The mandi price was higher than the local market price

overall, noting that there were only two records of sales in the mandi. The mean price achieved for kodo in the local market in Mehandwani was notably higher than local market prices in the other blocks.

Table 35. Number of transactions and prices obtained in village markets

Block	Village market	# households	Average price (INR/kg)
Mandla	Khari	2	19
	Salaiya	3	14
	Khuksar	2	12
	Singarpur	1	12
	Tikraberpani	7	10
Mehandwani	Barrai	2	18
	Khamhariya	2	15
Shahpura	Salaiya Mal	1	10

The mean gross income earned by commercial kodo producers was 2,166 INR, corresponding to 4975 INR/Ha. Commercial kodo producers in Mandla district achieved higher total and per-hectare incomes for kodo compared to those in Dindori district. The few commercial kodo producers in Shahpura district earned a lower total income than commercial producers in the other blocks. This was due to the lower volumes of the transactions but also lower price achieved.

Given that relatively few households reported selling kodo millet across the blocks, it was surprising that the majority of respondents considered kodo millet to have an important contribution to their income (Table 36). Almost all households in Shahpura and Mehandwani blocks considered kodo millet to have a major importance in their income (Figure 21). In Mandla, the majority of respondents considered kodo to have a medium to major importance in their income. This result may reflect the value of the crop for subsistence. The kodo varieties involved in commercial transactions are shown in Table 37. Some varieties were sold proportionally more than others. The *ashadi rarvi* variety and unspecified varieties were sold most often (Figure 22). Varieties that were not reportedly sold were *badi kodon*, *chhoti badi*, *dong*, *gurmatiya*, *indra*, *kodli*, and *kori chhota dehati*.

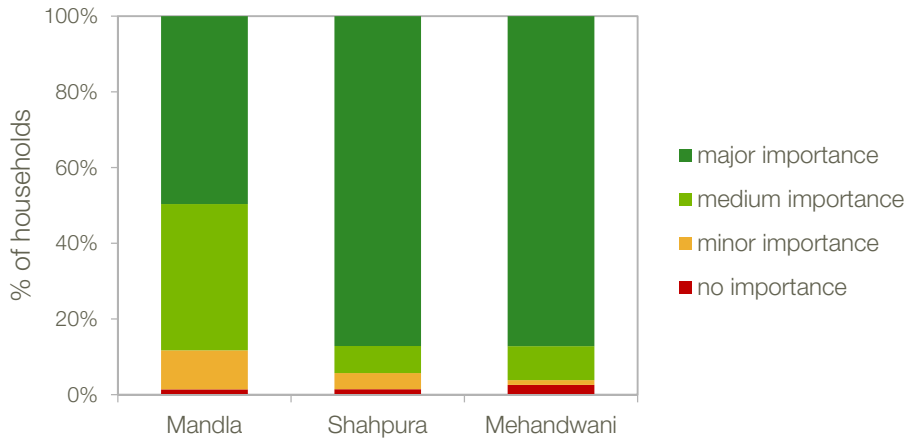


Figure 21. Importance of kodo millet to household income

Table 36. Number of households reporting importance of kodo millet to household income

Importance to income	All	Man	Meh	Sha
Major	201	72	68	61
Medium	68	56	7	5
Minor	19	15	1	3
None	5	2	2	1

Table 37. Number of households reporting selling specific varieties of kodo

Variety	All	Man	Meh	Sha
Ashadi Rarvi	8	7	1	0
Chhoti	9	5	4	0
Desi	4	3	0	1
Kali	1	0	0	1
Lal	5	1	3	1
Unspecified	2	2	0	0

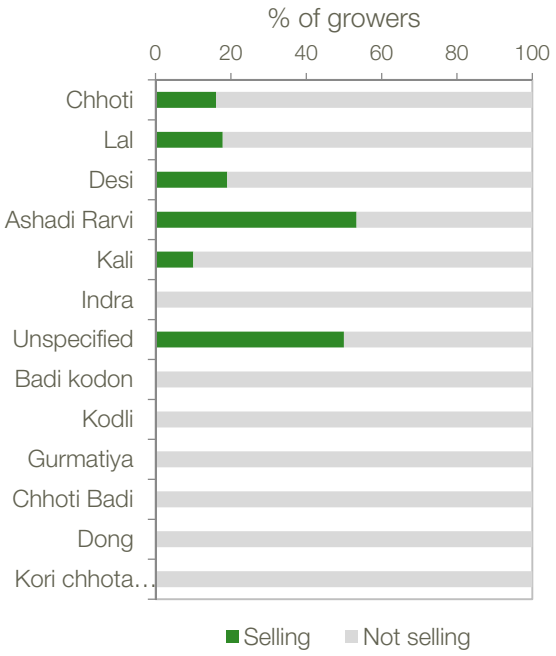


Figure 22. Percentage of growers reporting selling specific varieties of kodo millet

Kutki millet

Cultivation of kutki millet

The level of cultivation of kutki millet was slightly higher than kodo millet, cultivated by 57% of households surveyed (Table 38). It was most often cultivated by households in Shahpura (74%) and least commonly by households in Mandla (48%). It was notably more popular in Mandla as compared to kodo millet. On average the amount of land dedicated to kutki was similar as for kodo millet (0.4 Ha to representing about 31% of producers farmland). However, in Mandla, larger areas were devoted to kutki millet (38% of farm land) than was seen for kodo. A total of nine specific varieties were noted across the sites with four to five varieties named in each block (Table 39). The most common variety was *desi kali*. This variety had by far the largest area planted, especially in Mandla district (Figure 23). Similar to the results for kodo millet, households across the villages tended to plant just one variety. There were no cases of farmers planting more than one kutki variety.

Table 38. Details on cultivation of kutki millet in full sample and by region

	All	Man	Meh	Sha
# of households growing kutki millet	167	71	44	52
% of households growing kutki millet	56.6	48.3	55	74.3
Mean area devoted to kutki millet by growers (Ha)	0.4	0.4	0.3	0.4
Mean %of rainfed land devoted to kutki millet by growers	31.3	38.1	25.1	27.3

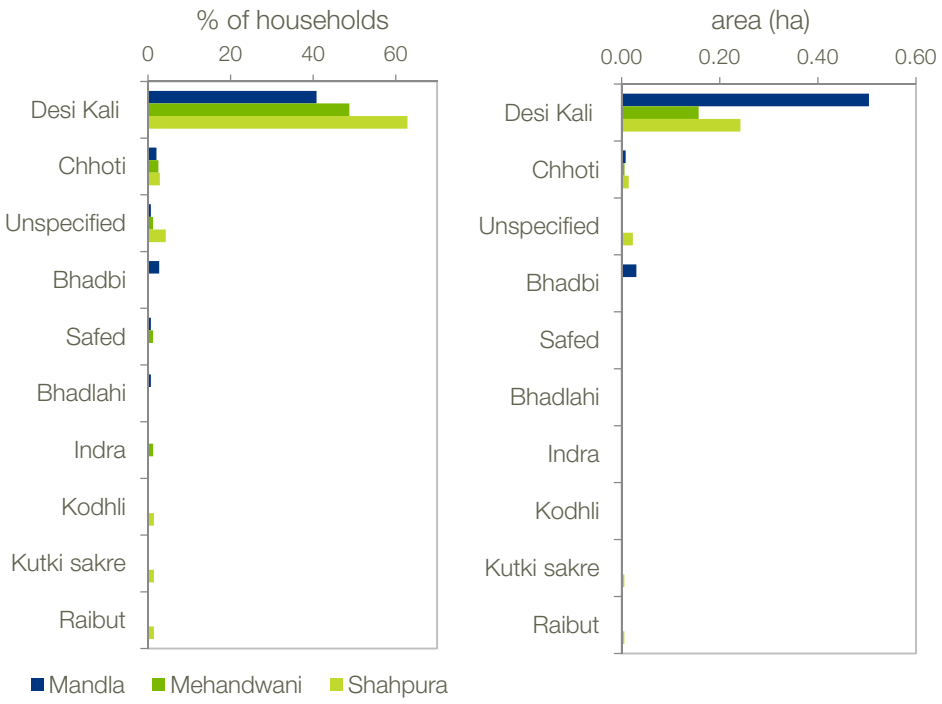


Figure 23. Number of households cultivating varieties and their yield (as remembered by farmers)

Table 39. Number of households growing kodo millet varieties and variety richness at household and regional levels

Variety	All	Man	Meh	Sha
Bhadbi	4	4		
Bhadlahi	1	1		
Chhoti	7	3	2	2
Desi Kali	143	60	39	44
Indra	1		1	
Kodhli	1			1
Kutki sakre	1			1
Raibut	1			1
Safed	2	1	1	
Unspecified*	5	1	1	3
Total # varieties in region	**9**	**5**	**4**	**5**
Mean # varieties at household level	**1.00**	**1.00**	**1.00**	**1.00**

Management of kutki millet

The work carried out for managing kutki millet included preparing the soil, sowing the seed, weeding, past management, and harvesting (Table 40). As seen for kodo, men were more involved in these activities than women with the exception of weeding, which was a female-dominated activity (Figure 24). It is noted that only one family member was listed for each activity, whereas the survey design anticipated multiple family members to be listed. The results could be biased towards men for this reason.

The sources of kutki seed were reported in the survey. Effectively all kutki producers had sourced their seed from their own production. Two farmers in Mandla reported sourcing seed from the local farmer producer company and another farmer in the block reported obtaining seed from another farmer. In general kutki millet was produced without the use of inputs. Just four farmers reported using fertilizer in the cultivation of kutki (two in Mandla and two in Mehandwani).

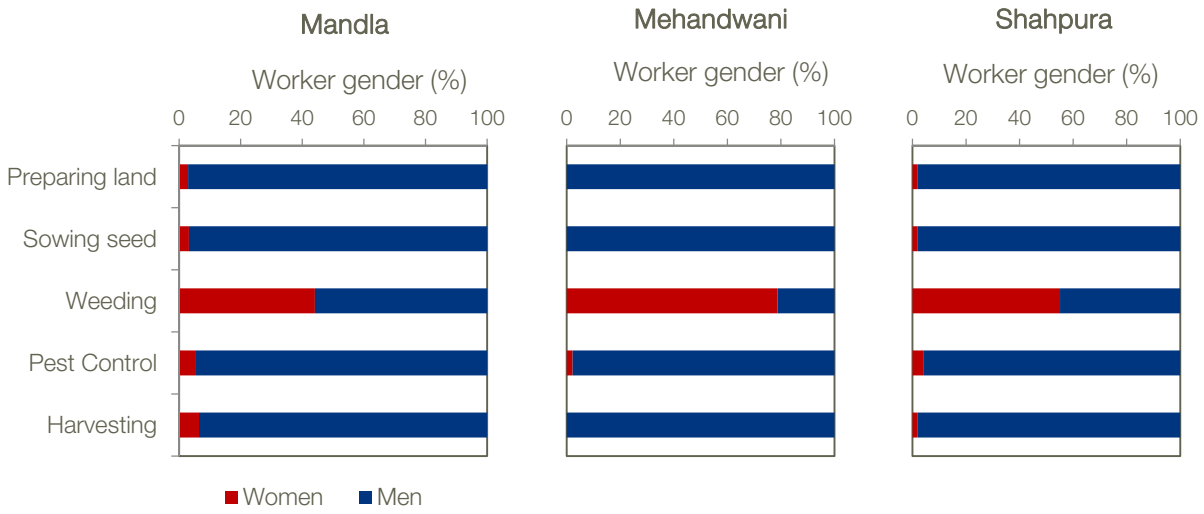


Figure 24. Gender ratio in stages of kutki management

Table 40. Number of households carrying out different stages of kutki management and the proportion of female members involved in the work

Role	All	Man	Meh	Sha
Preparing land	165 (1.8)	68 (2.9)	47 (0.0)	50 (2.0)
Sowing seed	160 (1.9)	63 (3.2)	47 (0.0)	50 (2.0)
Weeding	155 (48.8)	59 (52.0)	47 (44.0)	49 (45.0)
Pest Control	147 (4.1)	55 (5.5)	45 (2.2)	47 (4.3)
Harvesting	159 (3.1)	62 (6.5)	47 (0.0)	50 (2)

Overall, the mean yield achieved for kutki was 571.6 kg/ha, which was slightly lower than the mean yield for kodo. Yields were highest in Mehandwani and lowest in Shahpura (Table 41). The yields of the different varieties were quite variable (Figure 25). The *bhadbi*, *safed, ghadlahi* and *raibut* varieties were seen to have higher yields. It is noted that the precision of the yield data was limited by the recall capacity of the farmers and some of the varieties had very few records, which limits the quality of these observations. The yields of the kutki varieties did not correspond well to their popularity.

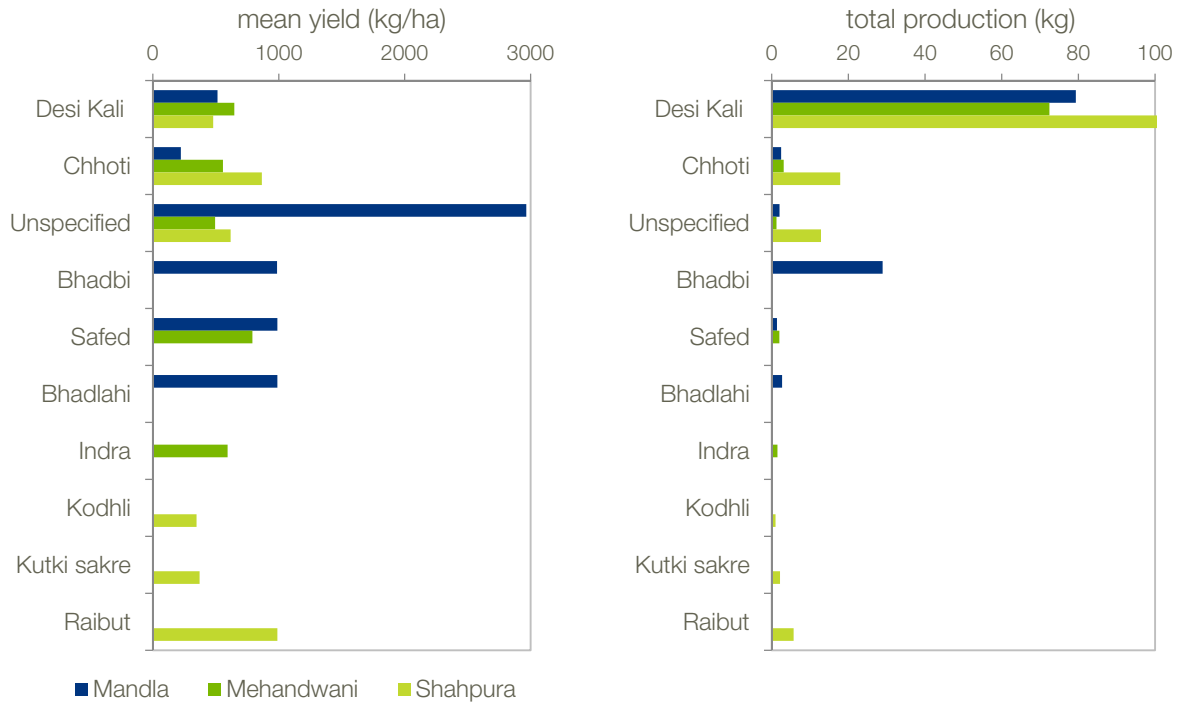


Figure 25. Mean yield and total production of kutki varieties

Table 41. Mean yield and production of kutki millet

	All	Man	Meh	Sha
Mean yield (kg/ha)	571.6	576.7	640.5	506.5
Mean production (kg)	203.8	245.3	146	196.7

Sale of kutki millet

Sixteen percent of households surveyed reported selling kutki millet, which was 29% of those who were growing kutki millet (Table 42). The sale of kutki was notably more common than sale of kodo, especially in Mandla district. Sales of kutki were most common in Mandla and least common in Shahpura district, even though it was produced more common in the latter district. Across the blocks, those who marketed kutki sold on average 41% of their production. The mean volume sold was 59 kg, with similar volumes traded in Mehandwani and Mandla and lowest volumes traded in Shahpura. All sales were made in raw, unprocessed, form.

The price and buyers of kutki millet are shown in Table 43. The producers generally sold their kutki millet to the local market. Seven households—more than for kodo—reported selling kutki to the mandi. Details on the prices achieved in the different village markets are detailed in Table 44. The highest price was achieved in the market in Tikraberpani in Mandla and Chirpoti Mal in Mehandwani, where on average producers received 28 INR/kg (approximately 0.42 USD/kg). The lowest prices for kutki were reported for the local market in Dhirwan Khurd in Shahpura, where producers obtained only 15 INR/kg (0.22 USD/kg). The prices achieved for kutki were notably higher than those achieved for kodo millet. While there were few records of selling in the mandi, the price obtained in the mandi was lower on average than the price achieved in the local markets.

Table 42. Number of households selling kodo millet and the relative percentage of growers that were producing commercially

	All	Man	Meh	Sha
# of households selling kutki millet	48	32	12	4
% of kutki millet growers selling production	28.7	45.1	27.2	7.7
Mean % of kutki production sold by commercial producers	40.6	46.4	29.8	27.5
Mean volume sold by commercial producers (kg)	59.4	65.4	69.6	17.9
Total income from kutki among commercial producers (INR)	4,390	4,880	3,011	3,750
INR/ha from kutki among commercial producers	8,730	9,294	6,853	9,267

Table 43. Locations of sale and average price obtained for kutki millet (INR/kg)

	All	Man	Meh	Sha
Local market	32	25	6	1
	(24)	(24)	(25)	(15)
Mandi	7	3	3	1
	(21)	(20)	(20)	(25)

Table 44. Number of transactions and prices obtained in local markets for kutki millet

Block	Village market	# households	Mean price (INR/kg)
Mandla	Piparpani	3	25
	Singarpur	2	26
	Jahpani	1	26
	Salaiya	4	23
	Silpuri	4	23
	Tikraberpani	7	28
Mehandwani	Barrai	3	24
	Chirpoti Mal	1	28
	Khamhariya	2	24
Shahpura	Dhirwan Khurd	1	15

The mean total income earned from kutki was 4,390 INR corresponding to 8,730 INR/Ha. Incomes from kutki were highest in Mandla and lowest in Mehandwani (Table 42). The income gained per hectare of production was similar between Mandla and Shahpura and lowest in Mehandwani. It seems that a low price in Mehandwani was the factor behind lower incomes, while in Shahpura, the lower level of production and volumes traded were the reasons for lower income.

Although relatively few households reported selling kutki millet across the blocks, surprisingly the majority of respondents considered kutki millet to have an important contribution to their income (Table 45). This was a similar result as seen for kodo millet. Almost all households in Shahpura and Mehandwani blocks considered kodo millet to have major importance in their income (Figure 26). In Mandla, the majority considered kodo to have a medium to major importance in their income. These results may reflect the livelihood value of these millets in terms of subsistence.

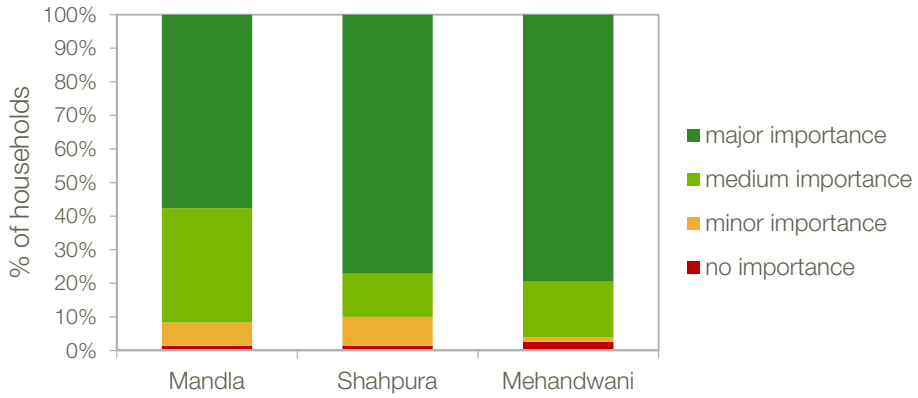


Figure 26. Importance of kutki millet to household income

Table 45. Number of households reporting importance of kutki to household income

Importance to income	All	Man	Meh	Sha
Major	199	83	62	54
Medium	71	49	13	9
Minor	17	10	1	6
None	5	2	2	1

The kutki varieties involved in commercial transactions are shown in Table 46. Some varieties were sold proportionally more than others (Figure 27). The *bhadlahi* and *bhadbi* varieites for instance were sold by most or all of their growers while the *india, kodhli, kutki sakre*, and *raibut* varieties were not reported to be sold.

Table 46. Number of households reporting selling specific varieties of kutki

Variety	All	Man	Meh	Sha
Bhadbi	3	3		
Bhadlahi	1	1		
Chhoti	3	2	0	1
Desi Kali	38	25	11	2
Indra	0		0	
Kodhli	0			0
Kutki sakre	0			0
Raibut	0			0
Safed	1	0	1	
Unspecified	2	1	0	1

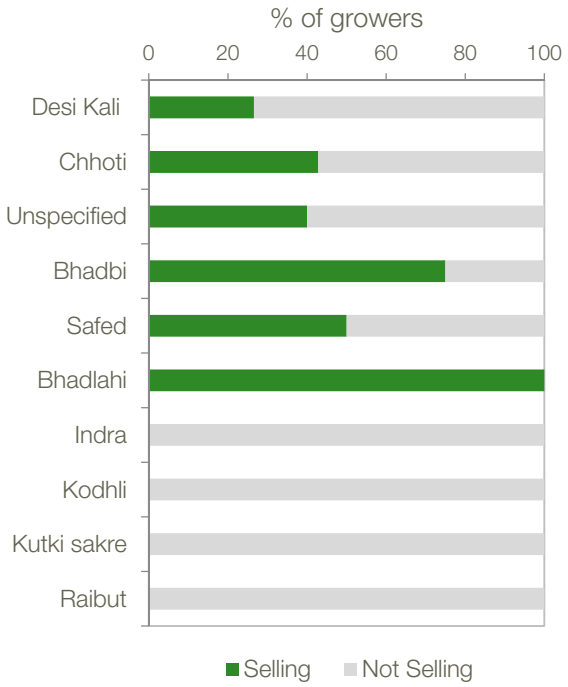


Figure 27. Number of households reporting selling specific varieties of kodo millet in the overall sample

Vegetables

Cultivation of vegetables

Half of the households surveyed reported cultivating some vegetable species. Vegetables were more commonly cultivated in Mandla block than in Dindori block (Table 47). Similar areas were assigned to vegetable cultivation as compared to minor millets overall but in Shahpura block, a notably smaller mean area was assigned to vegetable production.

Table 47. Details on cultivation of vegetables in full sample and by region

	All	Man	Meh	Sha
# households growing vegetables	104	81	15	8
% of households growing vegetables	35	55.1	18.8	11.4
Mean area devoted to vegetables by growers (Ha)	0.5	0.5	0.6	0.2

Table 48. Species names, common names and geographic origins of vegetables grown by the surveyed communities (Source: Khoury et al 2016 unless otherwise specified)

Scientific name	Common names	Origin
Abelmoschus escuelentus	Okra, lady finger, bhindi	E & W Africa; S Asia[A]
Allium cepa	Onion, piyaj	W & C Asia
Brassica oleracea var Botrytis	Cauliflower, Gobhi	SW, SE & N Europe, S & E Mediterranean, W, C, & E Asia
Brassica rapa subsp Oleifera	Mustard	Europe, N Africa, W, E, C, S, & SE Asia[B]
Capiscum sp.	Pepper, mirchi	Tropical S America; C America & Mexico; Carribean
Corchorus sp.[C]	Chech baji, Jew's mallow	Africa, South Asia[D]
Coccinia grandis	Ash gourd, kundru	E Africa[E]
Coriandrum sativum	Coriander, dhaniya	W Asia, N Africa[F]
Momordica charantia	Bitter gourd , kareli, bhata	Africa
Solanum lycopersicium	Tomato, tamatar	Andean S America
Solanum melongena	Eggplant, brinjal, began	S, SE, & E Asia
Solanum tuberosum	Potato, alu	Andean S America
Unknown	Ghar	

[A] Kumar et al 2010
[B] Guo et al 2014
[C] Likely identification based on Shukla et al 2010 and Chauhan et al 2014
[D] Benor et al 2012, Kundu et al 2013
[E] Shaefer et al 2009, Muniappan et al. 2009
[D] Diederichsen 1996

A total of 14 vegetable species were cultivated across the study communities (Table 16). Households that were growing vegetables had a mean of 1.2 species. Most of the vegetable species were more commonly cultivated by households in Mandla than in Dindori district (Figure 6). The most common vegetable species was bitter gourd. Less common vegetables were okra, eggplant, mustard, tomato, ivy gourd, coriander, onion, chili, cauliflower, and potato. Most vegetable species occupied small areas (<0.1 to 0.2 Ha), but bitter gourd, okra, and mustard were grown in slightly larger areas (0.5 Ha and 0.3 Ha) and tomato and coriander were grown by few households but in large areas (0.8 and 2 Ha, respectively). Of the 14 vegetable species recorded, only four were from South Asian origins: okra, eggplant, mustard, and chech baji (Table 48). Bitter gourd and ash gourd originally diversified in Africa but also have a centre of diversity in South

Asia due to their long history in the region (Schaefer et al 2009). The two unidentified species in Mandla (chech baji and ghar) could also likely be native to the region. Even for the species that have South Asian origins, the actual varieties used may not necessarily have originated in the region.

Management of vegetables

The work carried out for managing vegetables included preparing the soil, sowing the seed, weeding, past management, and harvesting (Table 49). Compared to the millets there was a notably higher involvement of women in the cultivation activities for vegetable. Nonetheless, men were more involved in these activities than women with the exception of weeding, which was a female dominated activity (Figure 28). It is noted that only one family member was listed for each activity, whereas the survey design anticipated multiple family members to be listed. The results could be biased towards men for this reason.

Table 49. Number of households carrying out different stages of kutki management and the proportion of female members involved in the work

	All	Man	Meh	Sha
Preparing soil	36	26	2	8
	(13.9)	(15.4)	(0)	(12.5)
Sowing seed	30	20	2	8
	(20.0)	(25.0)	(0)	(12.5)
Weeding	29	19	2	8
	(48.3)	(36.8)	(100)	(62.5)
Pest management	29	19	2	8
	(34.5)	(26.3)	(50.0)	(50)
Harvesting	30	20	2	8
	(13.3)	(15.0)	(0)	(12.5)

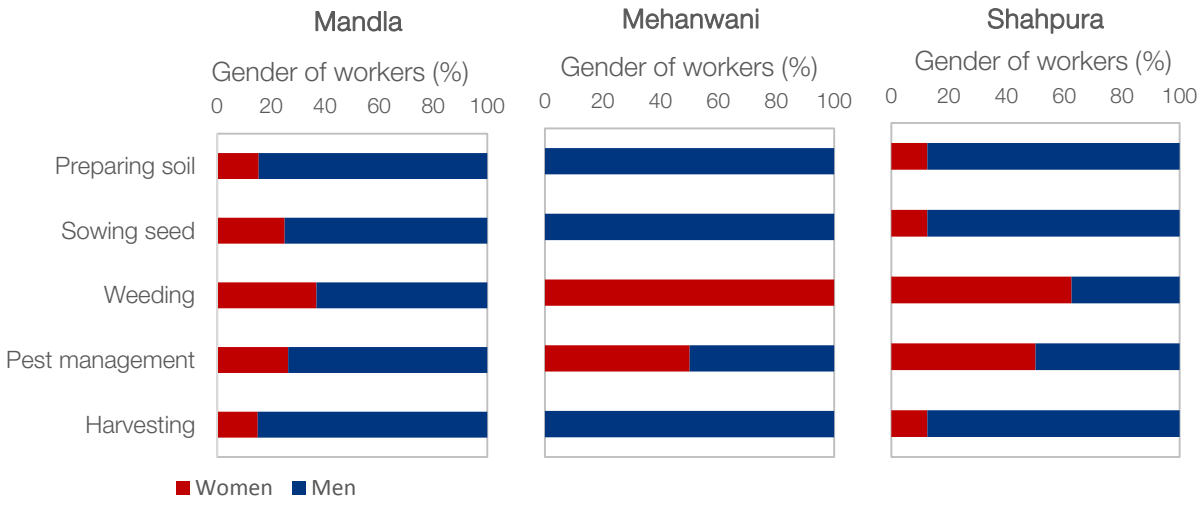


Figure 28. Gender ratio in stages of vegetable management

Only one household in Mandla block noted growing their vegetables under irrigation. Just 2% of households (N=7) noted using fertilizer in vegetable production. Almost all the vegetable producers sourced their seed from their own production. One household obtained their seed of *bhata mirchi* from the local farmer producer company (in Mandla) and one household obtained their seeds for cauliflower, tomato and potato from a seed dealer.

Sale of vegetables

A quarter of vegetable producers (25%) were selling part of their harvest. Sales were by far most common for vegetables in Mandla district and were very rare in Dindori district (Table 50). Few details were provided on these sales. Producers of cauliflower, tomato, potato, okra, and eggplant reported receiving 10-15 INR per kg from the local markets in Mandla district. Producers of green beans in Mandla reported receiving prices of 15 to 50 INR per kg from the mandi. Many households reported vegetables as having minor to major importance in their income (Table 51, Figure 29), however, they were an important source of income for fewer households compared to the millets.

Table 50. Number of households selling kodo millet and the relative percentage of growers that were producing commercially

	All	Man	Meh	Sha
# of households selling vegetables	26	20	3	3
% of vegetable growers selling production	25	24.7	20	37.5

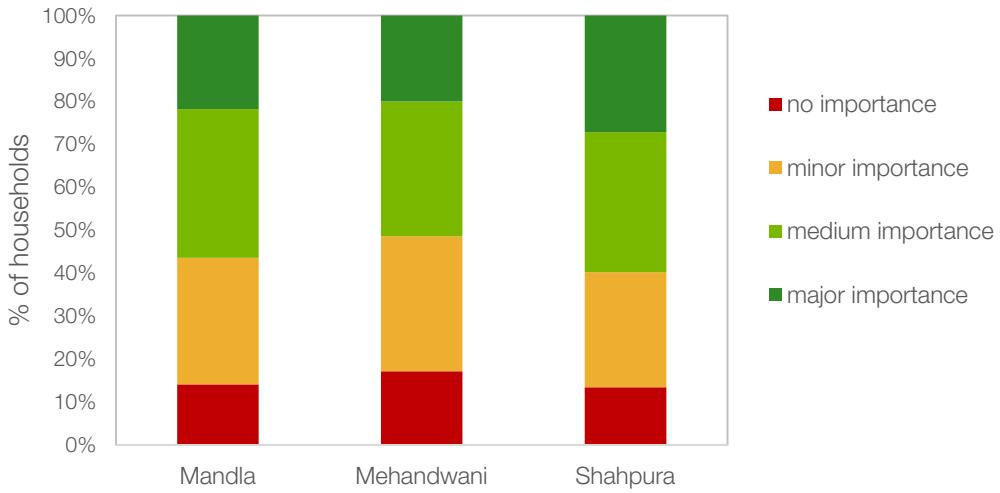


Figure 29. Importance of vegetables to household income

Table 51. Number of households reporting importance of vegetables to household income

Importance to income	All	Man	Meh	Sha
Major	48	17	14	79
Medium	46	27	22	95
Minor	33	23	22	78
None	16	11	12	39

Food security and diet diversity

The food security and diet diversity of the households surveyed was assessed using a variety of indicators with the questions directed to the woman respondent. In order to better understand patterns of food insecurity in the eight villages, the months of adequate household food provisioning indicator (Bilinsky & Swindale, 2010) and the coping strategy index (rCSI; Maxwell and Caldwell 2008) were applied. The food consumption score (FCS) was applied to assess diet quality (WFP 2008). The description of these indicators and results are presented below.

Food security (access dimension)

Months of adequate household food provisioning

Months of adequate household food provisioning (Bilinski and Swindale, 2010) is a tool used to help understand patterns of food insecurity throughout the year. Respondents were asked to indicate which months last year they did not have enough food to eat. Only 25 households reported experiencing insufficient food provisioning at any point in the past 12 months. The months with highest occurrence of food insufficiency were September and October (Table 52). Mandla and Shahpura appeared to be the most affected blocks (Figure 30). The mean number of months households experienced insufficient food provisioning in the last year was quite low overall (0.25 months). Households in Mandla and Shahpura experienced longer periods of food insufficiency during the year as compared with Mehandwani: mean 0.34 months in Mandla and 0.33 months in Shahpura versus 0.04 months in Mehandwani. No household experienced food insecurity for more than six months in the past twelve (Table 53).

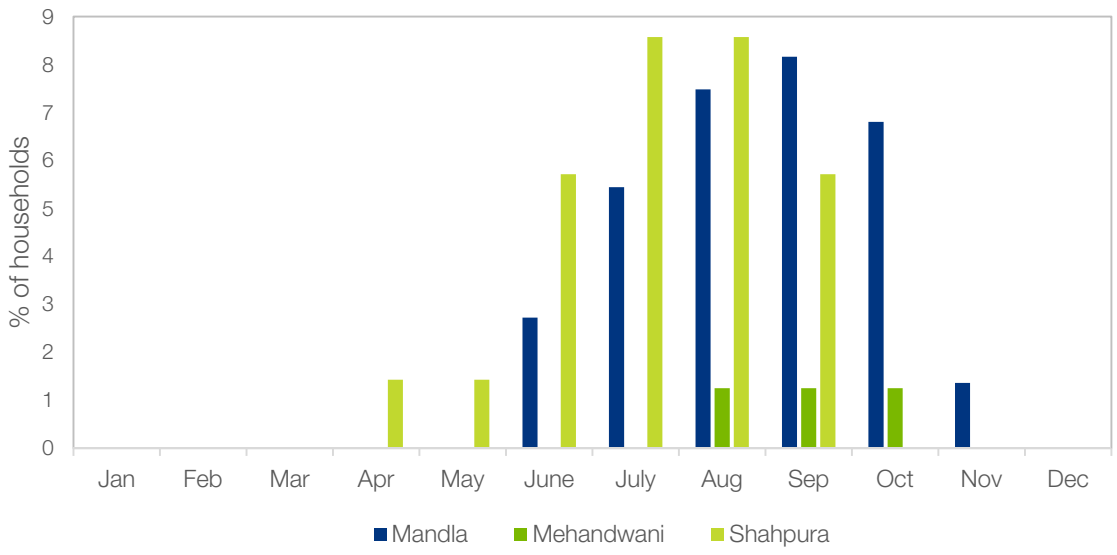


Figure 30. Percentage of households that reported insufficient food consumption by month

Table 52. Number of households reporting insufficient food provisioning by each month of the previous year

	All	Man	Meh	Shah
January				
February				
March				
April	1			1
May	1			1
June	8	4		4
July	14	8		6
August	18	11	1	6
September	17	12	1	4
October	11	10	1	
November	2	2		
December				

Table 53. Number of households experiencing periods of food shortages for specified number of months in last year

# months of food insufficiency	All	Man	Meh	Shah
None	258	119	79	60
One to two	9	9		
Three to four	15	9	1	5
Five to six	1			1

Coping Strategy Index (rCSI)

The coping strategy index (CSI) is an indicator of household food insecurity that measures the behavior of households in coping with the absence of food or money to buy food (WFP 2008). The original version is context-specific, with the behaviors to be evaluated identified through focus group discussions and community consultations. The reduced CSI (rCSI) was developed to compare food security across different contexts and is calculated using a set of behaviors that are commonly adopted in response to food shortage (WFP 2008). The rCSI does not include some extreme behaviors associated with food insecurity, so it is less powerful than the context-specific CSI for identifying the most vulnerable households in a locality (WFP 2008). However, it was selected to use the rCSI to reduce the time burden of the survey for the participating farmers. Testing and comparisons have shown that rCSI is an accurate indicator of acute food insecurity (Coates et al. 2007, Bickel et al. 2000, Maxwell et al. 1999).

The five standard coping strategies assessed in the rCSI (and their severity weightings) are: i) eating less preferred foods (1.0), ii) borrowing food/money from friends and relatives (2.0), iii) limiting portions at mealtime (1.0), iv) limiting adult intake (3.0), and v) reducing the number of meals per day (1.0). The rCSI is based on a recall period of seven days. The respondent is asked on how many days each behavior was adopted in the past week. The frequency (ranging from 0 to 7) is multiplied by the weight for each behavior and the values are summed to calculate the rCSI score, which ranges from 0 to 56. Higher scores indicate more food insecure households.

Coping strategies applied

75% of the households interviewed had adopted one or more coping strategy in the last week. The most commonly adopted coping strategies overall were eating less preferred foods, reducing the number of meals per day, and limiting portions at meal time (Table 54, Figure 31). The more severe strategies of borrowing food or money from friends and relatives and restricting adult consumption in order to feed children were less commonly adopted.

Mandla had the highest percentage of households adopting coping strategies (86%) compared to Shahpura (64%) and Mehandwani (65%). In Mandla, the percentage of households applying each coping strategy was generally higher than in the other blocks, with the exception of reducing the number of meals. Mehandwani, appeared to be the most food secure block because only two of the less severe coping strategies were adopted and in lower percentages than the other blocks.

Table 54. Number of households using coping strategies in the last week (and mean number of days on which they used the strategy, excl. zeros)

In the past 7 days, if there have been times when you did not have enough food or money to buy food, how many days your household had to:	**All**	**Man**	**Meh**	**Shah**
Rely on less preferred and less expensive foods?	219 (1.8)	127 (2.0)	49 (1.3)	43 (1.9)
Reduce number of meals eaten in a day?	67 (2.2)	27 (2.8)	17 (1.9)	23 (1.7)
Limit portion size at mealtimes?	16 (2.8)	14 (3.0)	0 (0)	2 (1.5)
Borrow food or rely on help from a friend or relative?	18 (1.1)	13 (1.3)	0 (0)	5 (1.0)
Restrict consumption by adults in order for small children to eat?	13 (3.6)	11 (3.5)	0 (0)	2 (1.5)

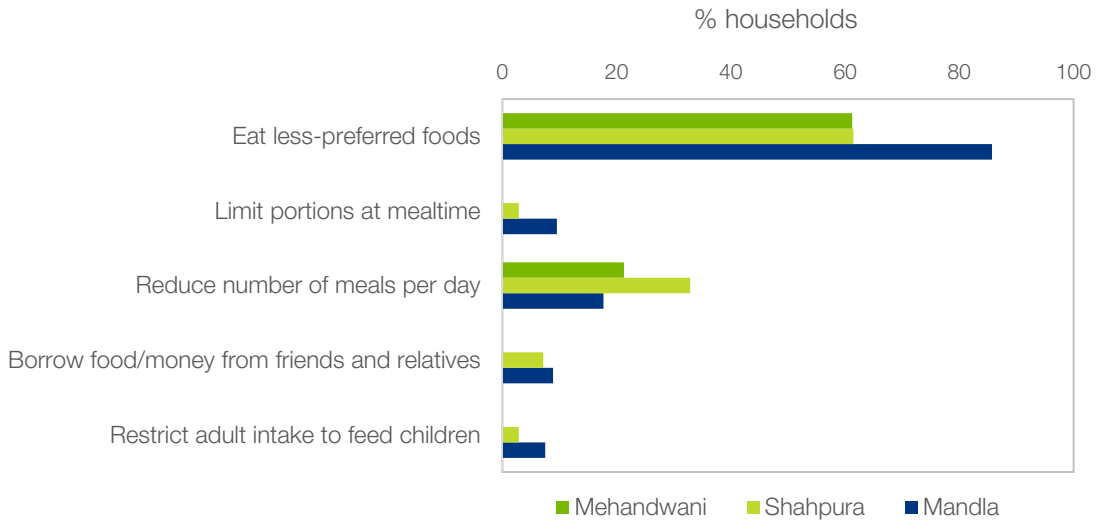


Figure 31. Percentage of households applying coping strategies

rCSI Score

The mean rCSI score overall was 2.5 (±4.4 s.d.), which was well below the maximum of 56. The mean rCSI score was highest in Mandla, indicating that households in this block were more food insecure than households in the other blocks (Table 55). In Dindori, all the scores were below 12, while in Mandla the maximum score was 31 with several households scoring more than 20. It is noted that data collection took place in the last two weeks of September, which, according to the results reported for the adequate food provisioning assessment, is the time of year when more households are food insecure (6% overall and 9% in Mandla).

Table 55. Mean rCSI Scores overall and by block

	All	Man	Meh	Sha
Mean rCSI score	2.5	3.5	1.2	2.0

Food Aid

Households were asked if they had accessed food aid during any months of the last year. Most of the households surveyed indicated that they had. 92% received food aid every month of last year, while 8% received food aid for between two and eleven months in the past year (Table 56). Proportionally more households in Mehandwani sought food aid in each month but the majority in each block was consistently accessing food aid (Figure 32). This food aid was most likely via the Public Distribution System but this must be confirmed.

Table 56. Number of households that accessed food aid in different months of the last year

	Overall	Mandla	Mehandwani	Shapura
January	281	135	80	66
February	282	136	80	66
March	278	134	79	65
April	274	133	78	63
May	274	133	78	63
June	270	130	78	62
July	265	127	78	60
August	265	127	78	60
September	267	129	78	60
October	271	131	78	62
November	277	131	80	66
December	282	136	80	66

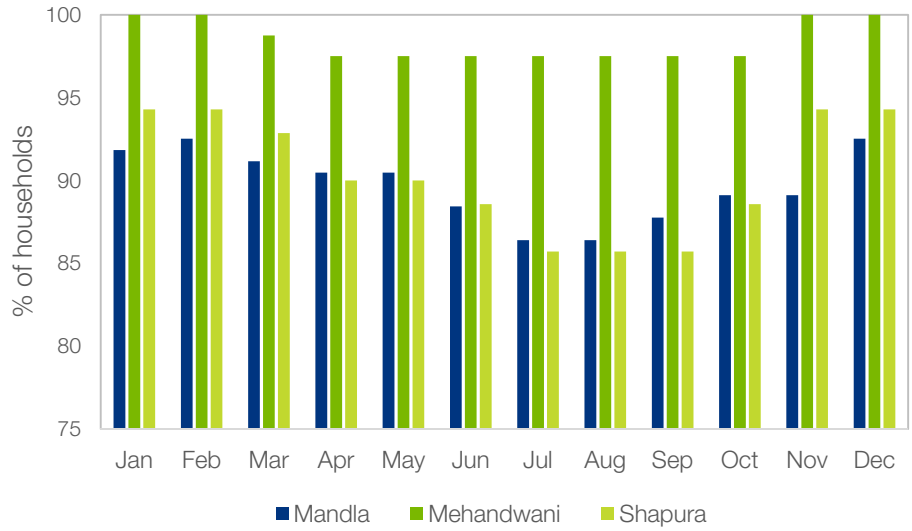


Figure 32. Percentage of households accessing food aid in different months of the year

Diet Quality

Food Consumption Score (FCS)

The Food Consumption Score (FCS) is a tool developed by WFP (2008). It is based on dietary diversity, frequency of consumption, and nutritional composition of different food groups. FCS is used as a proxy to determine the adequacy of the diet and to better understand the access dimension of food security in a given population. The FCS is validated at household level (Wiesmann et al 2009), but in this context information were collected at the individual level, with the questions directed at the female respondent. The FCS is based on a list of country-specific food items that are subsequently grouped in eight standard food groups:

1. **Main staples:** energy dense and eaten in large quantities, low protein efficiency ratio (weight 2).
2. **Pulses:** energy dense and rich in protein (lower protein efficiency ratio than meat) (weight 3).
3. **Vegetables:** low levels of energy, proteins and fats. Good levels of micronutrients (weight 1).
4. **Fruits:** low levels of energy, proteins and fats. Good levels of micronutrients (weight 1).
5. **Meat, eggs and fish:** energy dense, with great quantities of high quality proteins and fat (weight 4).
6. **Dairy:** energy dense, with great quantities of high quality proteins, fat and micro-nutrients (weight 4).
7. **Sugar and sweets:** mainly composed by empty calories, and frequently consumed in small quantities (weight 0.5).
8. **Oil and fats:** energy dense but absence of other important micro-nutrients, usually consumed in small quantities (weight 0.5).

Each respondent was asked to recall the number of days she consumed each food group in the past seven days, such that each food category was assigned a frequency of consumption ranging from 0 to 7. Each food group has a standard weight and the FCS is calculated by summing the values obtained by multiplying the weights of each food group by the frequency of consumption. The FCS scores range from 0 to 112.

Three categories of food consumption quality are defined based on thresholds in the FCS score. A household is considered to have *poor consumption* if has an FCS score from 0 to 21, a *borderline consumption* if its score is between 21.5 and 35 and an *acceptable food consumption* if the score is higher than 35. If the consumption of fats and sugars happens on a regular basis, the thresholds are 7 points higher. As fats and sugars were frequently consumed in Madhya Pradesh, it was decided to apply the higher thresholds.

Overall, 52% of households interviewed had an acceptable FCS, 29% had a borderline score and 20% had a poor score (Table 57). Mandla block had a slightly higher percentage of households with poor consumption (23%) than Shahpura (18%) and Mehandwani (15%) (Figure 33). In Mehandwani, households were more likely to have had an acceptable consumption. The mean FCS scores reflected these distributions. The overall mean FCS score just fell in the acceptable range (Table 57). The mean FCS score was highest for Mehandwani block, which fell in the acceptable category. The mean score in Shahpura was also in the acceptable range, while Mandla had the lowest mean FCS score that corresponded to a borderline diet.

Table 57. Mean FCS score and number of households within FCS threshold categories

FCS Category	All	Man	Meh	Sha
Mean FCS score	42.2	40	45.9	42.9
Poor (0 to 28)	57	34	11	12
Borderline (28.5 to 42)	83	45	15	23
Acceptable (>42)	147	66	48	33

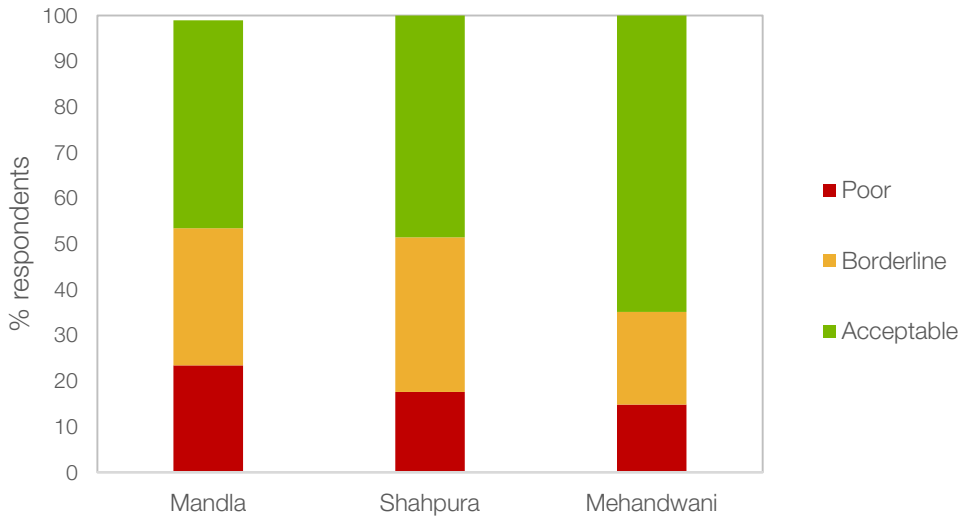


Figure 33. Percent of respondents in FCS threshold categories by block

Food groups consumed

Almost all the households across the blocks consumed cereals and vegetables in the last week (Table 58). Pulses and nuts were also commonly consumed, along with sweets (>80%). Fewer households reported consuming fruits (46%), dairy products (50%), and meat and fish (60%) in the last week. Meat and fish were more commonly consumed in Mandla (74%) and less commonly consumed in Mehandwani (39%) (Figure 34). Fruits and milk were more commonly consumed in Shahpura than the other blocks. Smaller differences were seen between blocks for the other food groups.

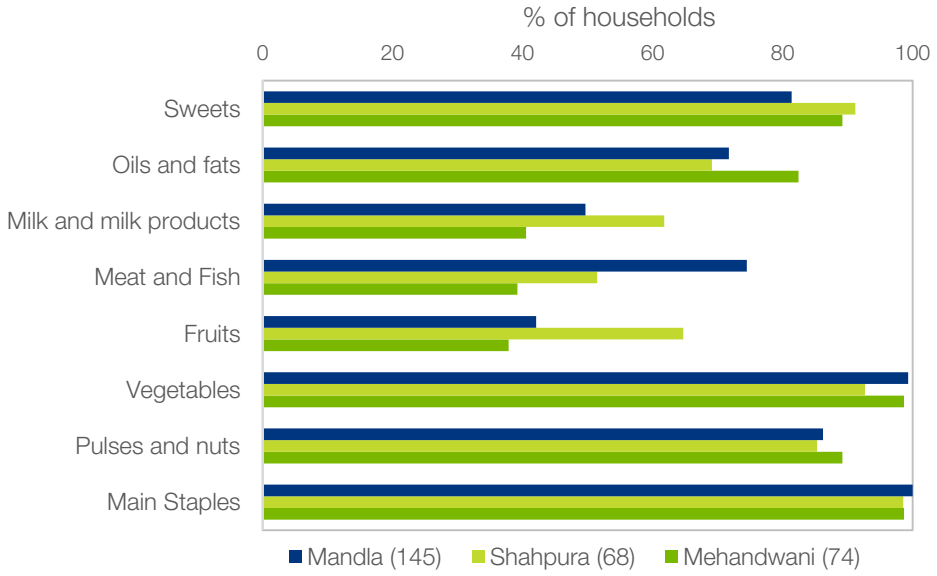


Figure 34. Percentage of households reporting consuming each food group by block

Table 58. Number of the overall sample reported consuming each food group and mean frequency of consumption (# days per week)

	All	Man	Meh	Sha
Main Staples	285 (6.8)	145 (6.8)	73 (7)	67 (6.7)
Pulses and nuts	249 (4.4)	125 (3.7)	66 (5.7)	58 (4.4)
Vegetables	280 (4.4)	144 (3.8)	73 (5.8)	63 (4.2)
Fruits	133 (1.4)	61 (1.4)	28 (1.5)	44 (1.2)
Meat and Fish	172 (1.2)	108 (1.2)	29 (1.2)	35 (1.3)
Milk and milk products	144 (2.6)	72 (2.6)	30 (2.5)	42 (2.9)
Oils and fats	212 (5.6)	104 (5.3)	61 (5.9)	47 (5.9)
Sweets	246 (4.3)	118 (4.2)	66 (4.6)	62 (4.5)
Spices , condiments	129 (4)	70 (3.5)	31 (4.6)	28 (4.4)

Table 59. Number of households in each block, for each category, reporting consuming food groups at least once in last week

	All			Mandla			Mehandwani			Shapura		
	Poor	Border	Accept	Poor	Border	Accept	Poor	Border	Accept	Poor	Border	Accept
Main Staples	56 (6.25)	82 (7)	147 (7)	34 (6.3)	44 (7)	67 (7)	10 (7)	15 (7)	48 (7)	12 (5.5)	23 (7)	32 (7)
Pulses and nuts	30 (1.6)	73 (2.5)	146 (5.9)	22 (1.6)	37 (2)	66 (5.4)	3 (1.3)	15 (3)	48 (6.8)	5 (1.6)	21 (3)	32 (5.7)
Vegetables	52 (3.2)	82 (3.5)	146 (5.3)	33 (2.4)	44 (3.5)	67 (4.6)	10 (5.4)	15 (3.6)	48 (6.5)	9 (3.3)	23 (3.4)	31 (5)
Fruits	17 (1)	25 (1.2)	91 (1.5)	9 (1.1)	8 (1)	44 (1.5)	2 (1)	6 (1.7)	20 (1.5)	6 (1)	11 (1.1)	27 (1.4)
Meat and fish	24 (1)	51 (1.2)	97 (1.3)	18 (1)	37 (1.2)	53 (1.3)	2 (1)	4 (1)	23 (1.3)	4 (1)	10 (1.1)	21 (1.5)
Dairy	6 (1.2)	32 (1.7)	106 (3)	5 (1.2)	14 (1.7)	53 (3)	0	4 (1.7)	26 (2.6)	1 (1)	14 (1.8)	27 (3.5)
Oils and fats	25 (5)	58 (5.6)	129 (5.8)	12 (4.7)	34 (5.8)	58 (5.2)	7 (5.4)	11 (5)	43 (6.3)	6 (5.3)	13 (6)	28 (6)
Sweets	32 (3.3)	74 (3.7)	140 (4.9)	18 (2.6)	36 (4.6)	64 (4.4)	8 (4.1)	15 (2.3)	43 (5.4)	6 (4.2)	23 (3.2)	33 (5.4)
Spices, condiments	18 (3)	18 (3.7)	93 (4.2)	12 (2.3)	12 (4.5)	46 (3.4)	4 (7)	1 (2)	26 (4.7)	2 (4)	5 (2)	21 (5)

The number of households reporting consumption of most food groups was lower in households with a poor diet than in households with an acceptable diet, especially for pulses, fruits, meat and fish, and dairy (Table 59, Figure 35). The frequency of consumption of most food groups was also lower for those with a poor diet, especially for pulses, vegetables and dairy products (Table 59, Figure 36).

Figure 35. Percentage of households in each block, for each category, reporting consuming food groups at least once in last week

Figure 36. Mean frequency (# days per week) that households in each block, for each diet quality category, reported consuming food groups

On average, respondents consumed food items from 6.0 food groups. The largest number of respondents had eaten six (25%) or five (23%) different food groups over the last week; 14.6% had eaten from less than five food groups and 37.6% ate seven or eight food groups. Two women (one in Mandla and one in Mehandwani) had eaten only one food group in the last week. There were only slight differences between the blocks. Women respondents in Shahpura consumed a higher mean number of food groups (6.2), while those in Mehandwani consumed a lower number of food groups on average (5.8). In Mandla, the responding women consumed on average items from 6.1 food groups.

Dark leafy greens, vitamin-A rich produce and flesh foods

For our study, data were collected using the dietary diversity score categories (Kennedy et al 2011), which have a finer level of detail than the FCS food group categories. These categories were aggregated to create the standard FCS food groups. The “vegetables” food group, for example, was the result of the aggregation of three sub-categories: vitamin A-rich vegetables, leafy dark green vegetables and other vegetables. As data were collected in greater detail, it was possible to make a more specific analysis on patterns of consumption and dietary diversity of households in the study sites. The most consumed sub-category of vegetables was leafy greens, which are an important source of iron: More than 80% of households in the three blocks consumed leafy greens at least once in the past week (Figure 37). Vitamin A-rich vegetables and fruits were consumed by 37% and 25% of the total sample, respectively in the past week. Although households in Shahpura were consuming fruits more commonly than households in the other districts, there was not a substantial difference in consumption of vitamin-A rich fruits. Consumption of fish and eggs was lower overall than consumption of flesh meat (Figure 37). In Mandla, there was higher consumption of fish than the other sites, at similar levels as flesh meat consumption, which contributed to the higher levels of meat and fish consumption seen in this block in the FCS categories. Organ meat consumption was very low across the blocks, reported by only by 3% of the overall sample.

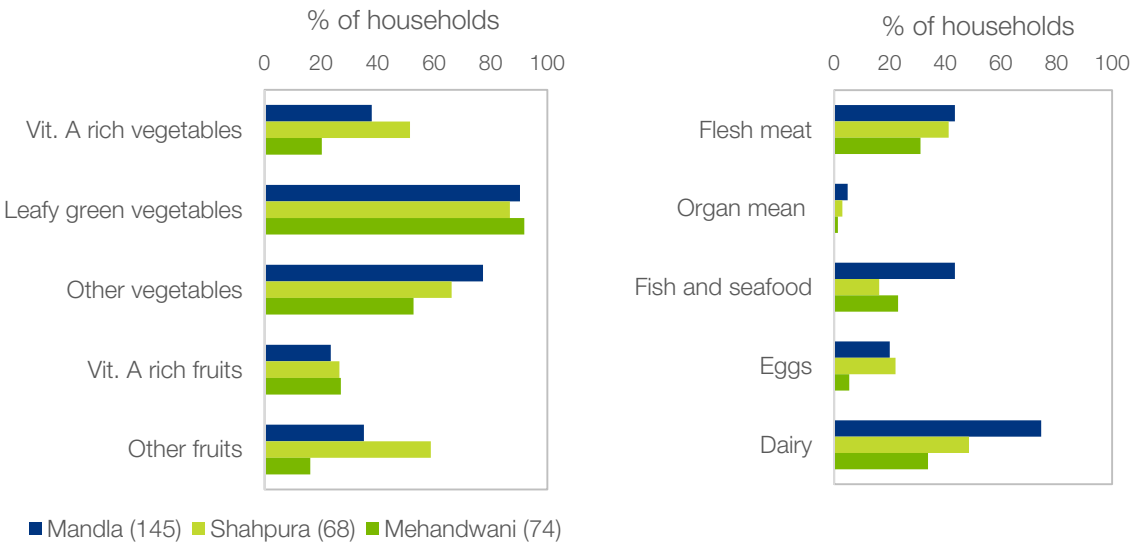


Figure 37. Detail on fruits and vegetable consumption in the last week with sub-categories from the dietary diversity score

Considering the consumption of food groups with low nutrient density, as can be seen in Figure 38, spices and other condiments was the least frequently consumed food group (approx. 45% and slightly lower in Shahpura). The consumption of oils and sugars was generally more common, with 75% and 86% of respondents, respectively, having consumed these foods in the last week.

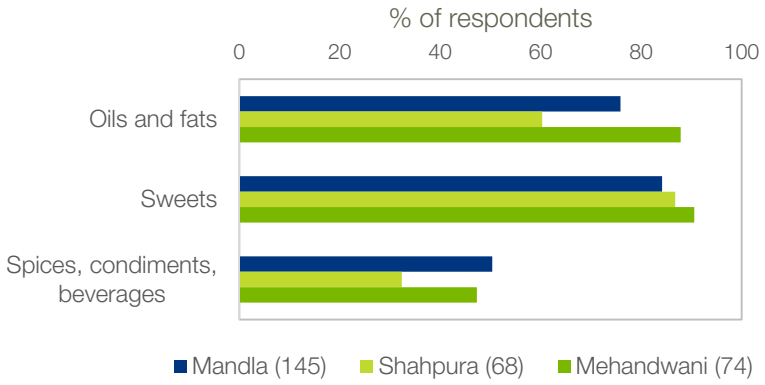


Figure 38. Low nutrient density food groups, percentage of reporting consumption

Table 60. Average frequency of consumption of FCS food groups in last seven days (# days)

	All	Man	Meh	Sha
Main Staples	6.80	6.80	6.91	6.63
Pulses and Nuts	3.82	3.21	5.12	3.72
Vegetables	4.27	3.72	5.69	3.85
Fruits	0.64	0.60	0.58	0.81
Meat and Fish	0.75	0.94	0.49	0.68
Dairy	1.33	1.30	1.01	1.76
Oils and Fats	4.16	3.80	4.91	4.07
Sugar, Sweets	3.74	3.39	4.08	4.09
Spices	1.78	1.68	1.93	1.81

Frequency food groups consumed

Table 60 shows the average frequencies of consumption for each food group over a one week period, at country level and block levels. As can be noted, the main staples category is the only food group that was consumed on a near-daily basis. Pulses and nuts were consumed on average 3.82 days/week and vegetables were eaten on average 4.27 days/week. Higher consumption of these food groups was observed in Mehandwani, where pulses and nuts were consumed on average 5.12 days/week and vegetables were consumed almost six days in the previous week. Fruits and meat and fish were consumed less than one day/week across the sites. However, in Mandla consumption of meat was more frequent and nearly once per week on average. The low nutrient density food groups—*oils and fats* and *sugar and sweets*—were consumed on average four days a week in the overall sample. Households in Mandla had the lowest mean consumption frequency for these low nutrient density foods.

Food groups in the production system

Eleven species were grown across the communities that belonged to the starch-heavy group of *grain, white roots, tubers and plantains*, including rice, maize, millets, barley, wheat, and potato (Table 61). Eight species of *pulses* were grown, namely pigeon pea, chickpea, lentil, black gram, hyacinth bean, pea, cowpea, and soybean. Cowpea and pea were also counted as vegetables: cowpea provides a dark green leafy vegetable while fresh pea was counted as an 'other' vegetable. The only other species of *dark green leafy vegetable* was field mustard. Chili was the only *other vitamin A-rich fruit or vegetable* grown in these production systems. In addition to pea, there were nine o*ther vegetables* including bitter gourd, okra, eggplant, tomato, ash gourd, coriander, onion, and cauliflower, as well as the unidentified vegetables chech baji and ghar. Niger seed was the only species grown in the *nuts and seeds* category. No fruits were documented in the production system survey.

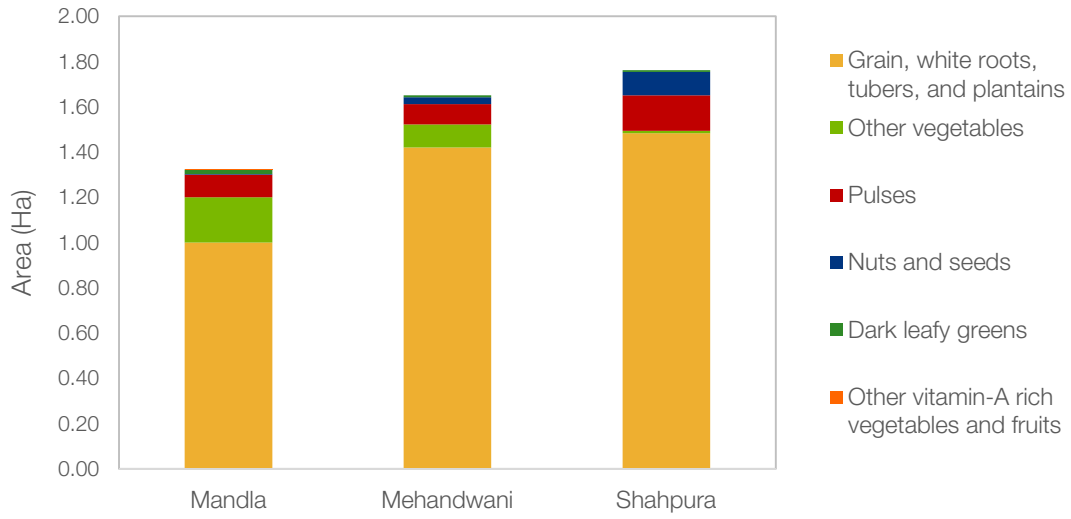


Figure 39. Mean area (Ha) of crop type grown (incl. zero)

Table 61. Total number of species of crop type grown at community/regional levels

	All	Man	Meh	Sha
Grain, white roots, tubers, and plantains	11	7	7	8
Other vegetables	10	7	4	5
Pulses*	8	8	6	5
Dark leafy greens*	2	2	2	1
Other vitamin-A rich vegetables and fruits	1	1		
Nuts and seeds	1	1	1	1
Other fruit				

* cowpea was counted as a pulse and a dark leafy green

The household farms provided better sources of some food groups than others. The largest areas of farmland (mean 3 Ha) were allocated to the starches (Table 63). Non-vitamin A-rich *'other' vegetables* and pulses were grown in 0.2 and 0.1 Ha on average, respectively. Smallest areas were assigned to nuts and

seeds, dark green leafy vegetables, and other vitamin-A rich vegetables which are three important, nutrient-dense food groups. Overall, households maintained a mean of 3.0 starch crops, 0.4 pulses, 0.4 other vegetables, 0.1 nut/seed crops, 0.03 dark leafy greens, and less than 0.01 dark green leafy vegetable (Table 62). A larger area of other vegetables was grown in Mandla and Mehandwani, while a larger area of nuts/seeds was grown in Shahpura (Figure 39).

Table 62. Mean number of species of crop type grown at household level (incl zero)

	All	Man	Meh	Sha
Grain, white roots, tubers, and plantains	3.03	2.65	3.4	3.39
Pulses	0.43	0.48	0.35	0.4
Other vegetables	0.41	0.68	0.19	0.09
Nuts and seeds	0.09	0.01	0.09	0.27
Dark leafy greens	0.03	0.01	0.04	0.04
Other vitamin-A rich vegetables and fruits	<0.01	0.01		
Other fruit				

Table 63. Mean area (Ha) of crop type grown (incl. zero)

	All	Man	Meh	Sha
Grain, white roots, tubers, and plantains	1.00	1.00	1.42	1.48
Other vegetables	0.20	0.20	0.10	0.01
Pulses	0.10	0.10	0.09	0.16
Nuts and seeds	0.03	0.00	0.03	0.10
Dark leafy greens	0.01	0.02	0.01	0.01
Other vitamin-A rich vegetables and fruits	<0.01	<0.01	<0.01	<0.01
Other fruit	0.00	0.00	0.00	0.00

Consumption of target crops

In addition to the assessment of food security and the food groups consumed in the week, a series of questions in the survey investigated the consumption behaviour for the target crops to understand at what points of the year, what frequency and which recipes they are consumed. The questions were directed to the female respondent.

Kodo millet

Kodo millet was consumed by half of the sampled households in the past year (147 of 297). It was least popularly consumed in Mandla block—by only about one third of the households interviewed. Consumption of kodo millet was more common in Dindori district, where it was eaten by 55% of households in Mehandwani and 71% of households in Shahpura. Kodo millet was consumed most commonly from July to January, with the highest number of households consuming the crop in November and August (Table 64, Figure 40). It is noted that August is one of the months of the year when these communities experience higher levels of food insecurity.

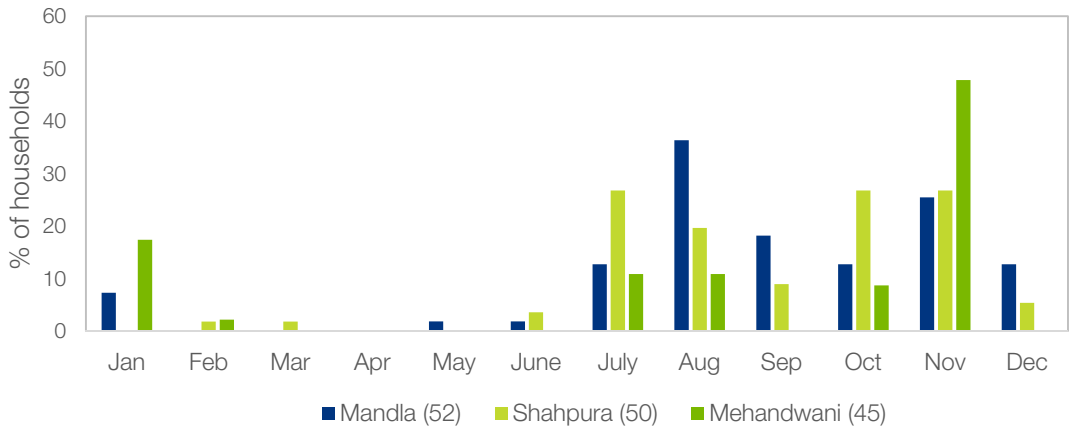


Figure 40. Percentage of households consuming kodo during the year

Table 64. Number of households consuming kodo millet by month

	All	Man	Meh	Sha
January	12	4	8	0
February	2	0	0	1
March	1	0	0	1
April	0	0	0	0
May	1	1	0	0
June	3	1	0	2
July	27	7	5	15
August	36	20	5	11
September	15	10	0	5
October	26	7	4	15
November	51	14	22	15
December	10	7	0	3

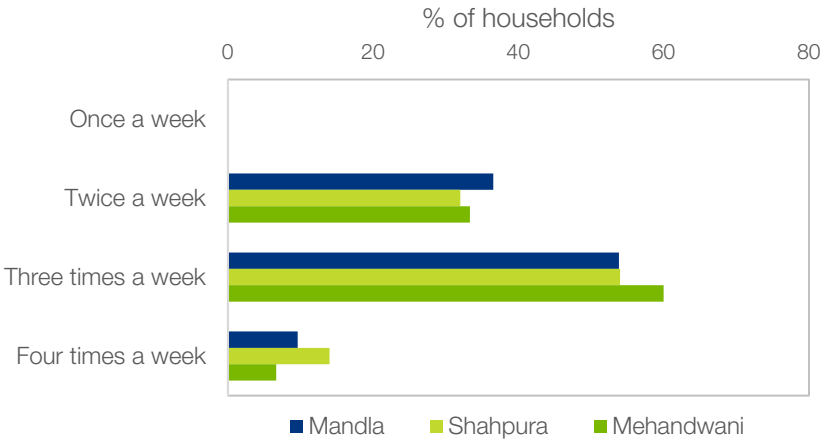


Figure 41. Percentage of the frequency of kodo consumption

Table 65. Number of household reporting frequency of consumption of kodo millet

	All	Man	Meh	Sha
Once a week	0	0	0	0
Twice a week	50	19	15	16
Three times a week	82	28	27	27
Four times a week	15	5	3	7

Kodo millet was eaten by 80% of households for just one month of the year. Fewer households consumed this crop over two or three months of the year. During the periods when it was consumed, kodo millet was consumed typically two times a week (34%) to three times a week (56%) (Table 65, Figure 41). Kodo was usually consumed like rice, or in typical Indian desserts and puddings such as *laddu* and *kheer*.

Kutki millet

Kutki millet was consumed by nearly half (48%) of the surveyed households. As seen for kodo millet, it was most commonly consumed in Shahpura block (by about 62% of households) and less commonly in in Mehandwani (51%) and Mandla (40%) blocks. The highest numbers of households consumed kutki millet between August and November—especially in Shahpura and Mehandwani blocks (Table 66, Figure 42).

Kutki millet was reportedly eaten during just one month of the year by 80.6% the households. During the period it was consumed, kutki millet was usually consumed two or three times a week (Table 67, Figure 43). Around 10% of households in all the blocks reported more frequent consumption of kutki—four times a week. Just like kodo, kutki was normally consumed like rice, or in typical Indian desserts and puddings such as *laddu* and *kheer.*

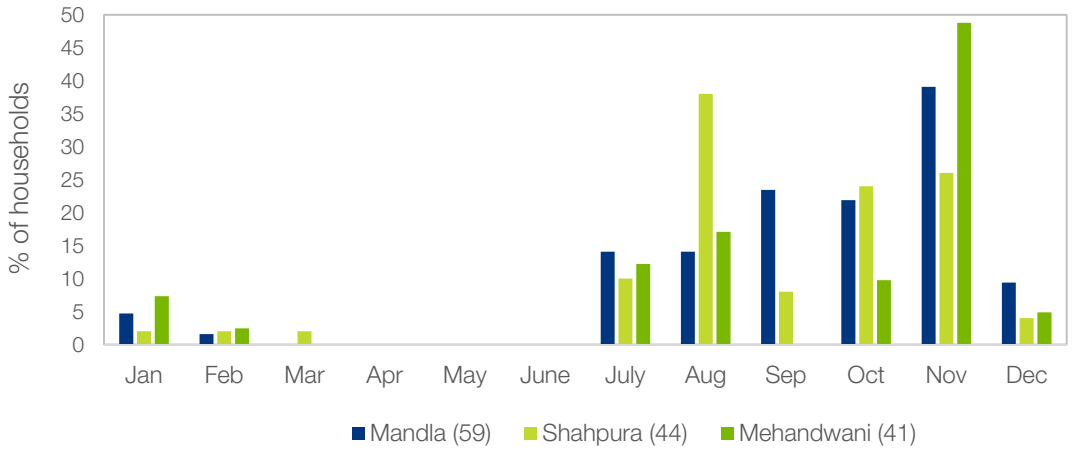


Figure 42. Percentage of households consuming kutki during the year

Table 66. Number of households consuming kutki millet by month

	All	Man	Meh	Sha
January	7	3	3	1
February	3	1	1	1
March	1	0	0	1
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	19	9	5	5
August	35	9	7	19
September	19	15	0	4
October	30	14	4	12
November	58	25	20	13
December	10	6	2	2

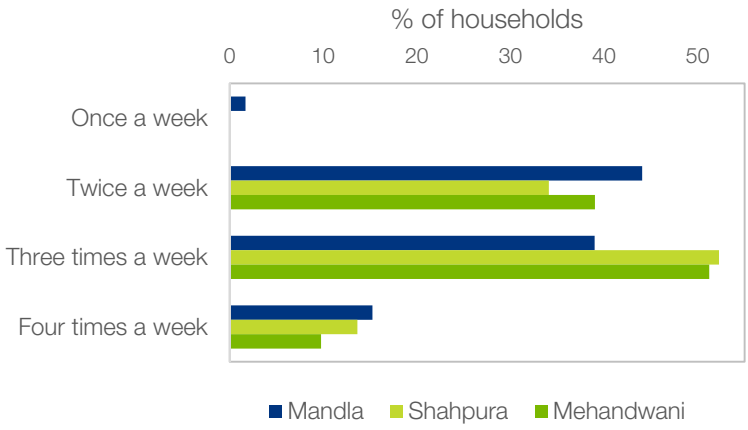


Figure 43. Percentage of the frequency of kutki consumption

Table 67. Number of households reporting frequency of consumption of kutki millet

	All	Man	Meh	Sha
Once a week	1	1	0	0
Twice a week	57	26	16	15
Three times a week	67	23	21	23
Four times a week	19	9	4	6

Vegetables

Vegetables were not said to be consumed by many households and those who said they consumed vegetables, consumed them rarely (Tables 68 and 69, Figure 44 and 45). The results for this section of the survey may be incomplete due to drop out and fatigue toward the end of the survey.

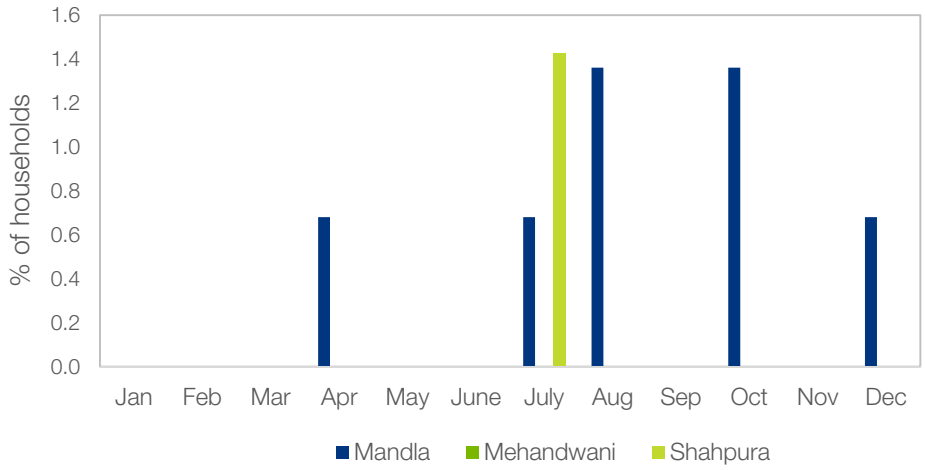


Figure 44. Percentage of households consuming vegetables during the year

Table 68. Number of households consuming vegetables by month

	All	Man	Meh	Sha
January				
February				
March				
April	1	1		
May				
June				
July	2	1		1
August	2	2		
September				
October	2	2		
November				
December	1	1		

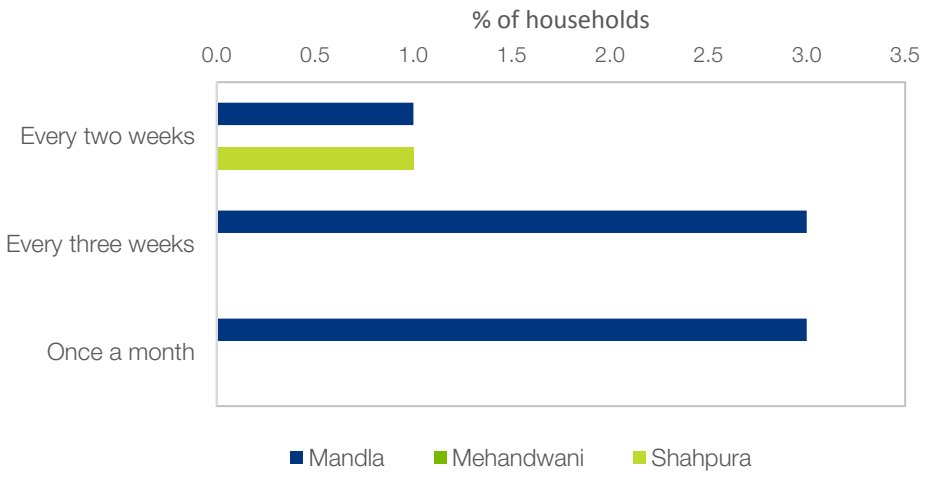


Figure 45. Percentage of the frequency of vegetable consumption

Table 69. Number of households consuming vegetables by frequency

	All	Man	Meh	Sha
Every two weeks	2	1		1
Every three weeks	3	3		
Once a month	3	3		

Climate change adaptation

Both the man and woman were asked to describe the actions they have been taking to adapt to changes in the weather and environment in the last three years. Special attention was given to agrobiodiversity-based actions, especially modifications in the crops and varieties grown. The respondents were probed specifically on whether they had made changes in the crops and varieties they grew. They were then asked more openly if they had made changes in crop management, use of inputs, management of soil and water, or livestock.

Changing crop species and varieties

Sixty seven percent of the households surveyed had introduced new varieties in the last three years as an action to adapt to climate change (Table 70). The introduced varieties were mostly higher yielding and often pre-treated/ improved, better quality, or short cycle. Farmers much more rarely introduced drought and flood tolerant varieties or longer cycle varieties, although these could have been characteristics of the higher yielding varieties. No households mentioned stopping growing varieties in the last three years. In most cases the variety was changed for rice but in several cases farmers changed the variety of maize, kodo and kutki. In more rare cases the variety was changed for other crops (wheat, pigeon pea, black gram, barley, and foxtail millet).

Table 70. Number of households modifying crop species cultivated

	All	Man	Meh	Sha
Introduced a new variety	204	105	57	42
Characteristics of introduced varieties				
Higher yielding variety	194	102	56	36
Pre-treated improved variety	41	4	26	11
Better quality variety	34	10	10	14
Short cycle variety	19	1	5	13
Drought tolerant variety	2	1	0	1
Long cycle variety	2	0	1	1
Flood tolerant variety	1	1	0	0

Table 71. Number of households modifying crop species cultivated

	All	Man	Meh	Sha
Expanded the area to a crop	209	110	57	42
Introduced new crop species	27	21	3	3
Testing new crop species	22	21	1	0
Reduced the area to a crop	147	83	38	26
Stopped cultivating a species	196	103	47	46
Stopped cultivating a species in a specific season	8	7	1	0

In addition to changing varieties, many households had increased or reduced the area assigned to specific crops or had stopped growing certain crops (Table 71). Rice was the crop most often expanded or introduced (Table 72). A considerable number of households had stopped growing foxtail millet (38%), barnyard millet (21%), and finger millet (14%) and had reduced the area to kodo (26%) and kutki millet

(18%). Hence, there was a clear trend of rice cultivation expanding, while cultivation of millets was declining (Figure 46).

Table 72. Number of households modifying crop species cultivated

	Introduced new variety	Expanded the area to a crop	Introduced new crop species	Testing new crop species	Reduced the area to a crop	Stopped cultivating a species	Stopped cultivating a species in a specific season
Oryza sativa	195	184	13	1	16	1	
Paspalum scorbiculatum	29	22	1	2	77	33	2
Setaria italica	1				4	114	2
Panicum sumatrense	18	14	1	1	53	31	1
Echinochloa frumentacea		1		5	16	63	2
Eleusine coracana			4	12	5	41	2
Zea mays	36	6	2		10		
Cajanus cajan	3				3		
Glycine max			3	2			
Triticum aestivum	2	1	1		1		
Vigna mungo	2		1	1			
Hordeum vulgare	1	1				1	
Sorghum bicolor						1	
Lens culinaris					1		
Momordica charantia					1		
Solanum lycopersicum				1			
Vegetables		1					
Unspecified			1				

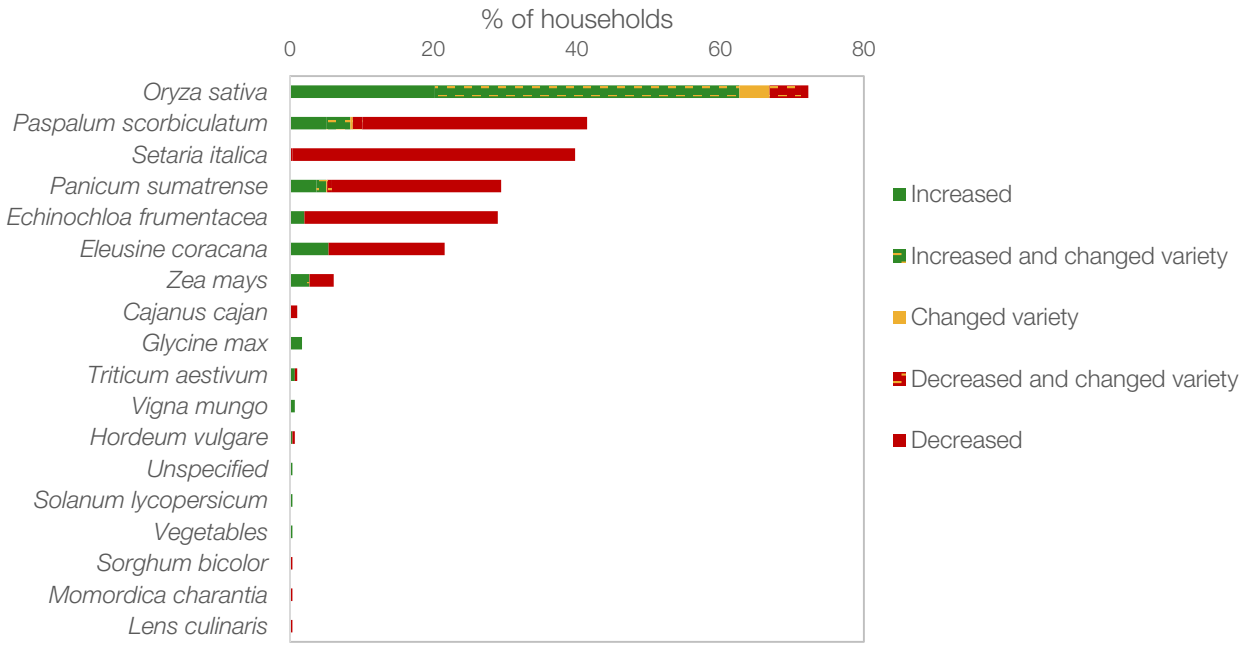


Figure 46. Percent of households that increased (introduced or expanded area) and decreased (stopped or reduced area) cultivation of specific crops, or had changed varieties

Households in Dindori more commonly introduced varieties that were pre-treated/improved, better quality or short-cycle (Figure 47). By comparison, households in Mandla more commonly introduced or were testing new crop species and had more commonly reduced area to a crop or stopped cultivating a crop.

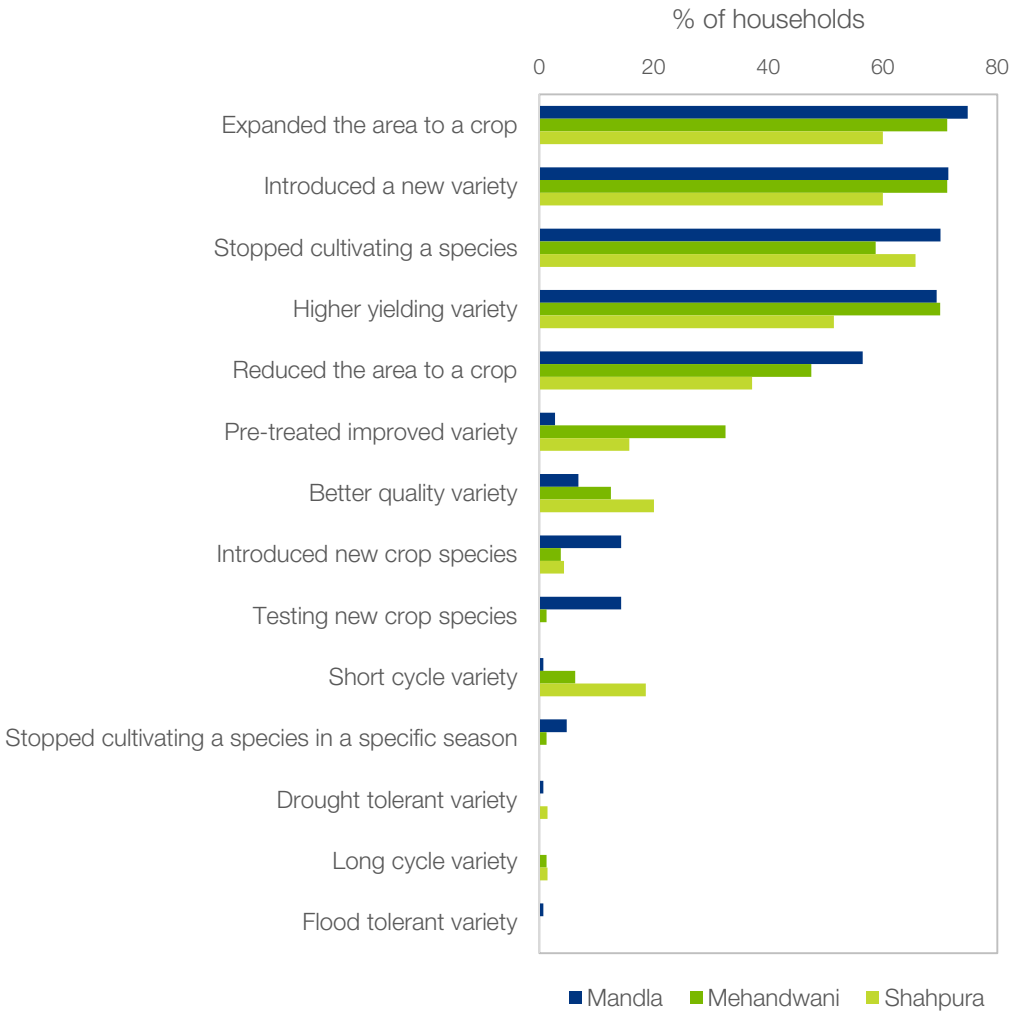


Figure 47. Changes in crops and varieties made in last three years to adapt to climate change

Changes in crop, land, soil, water, and pest management

Introduction of intercropping was a very common change in crop management seen across the sites (79%) and especially in Dindori district (Table 73). Earlier land preparation was also very common shift in practice (63%), particularly for households in Mandla (Table 74, Figure 48). Greater use of chemical and organic fertilizers was another common action, noting that increasing use of chemical fertilizers was much less common in Shahpura, while use of organic fertilizers was more common in this block (Table 75). Other common changes in practice across the sites were introduction of better drainage and crop rotation.

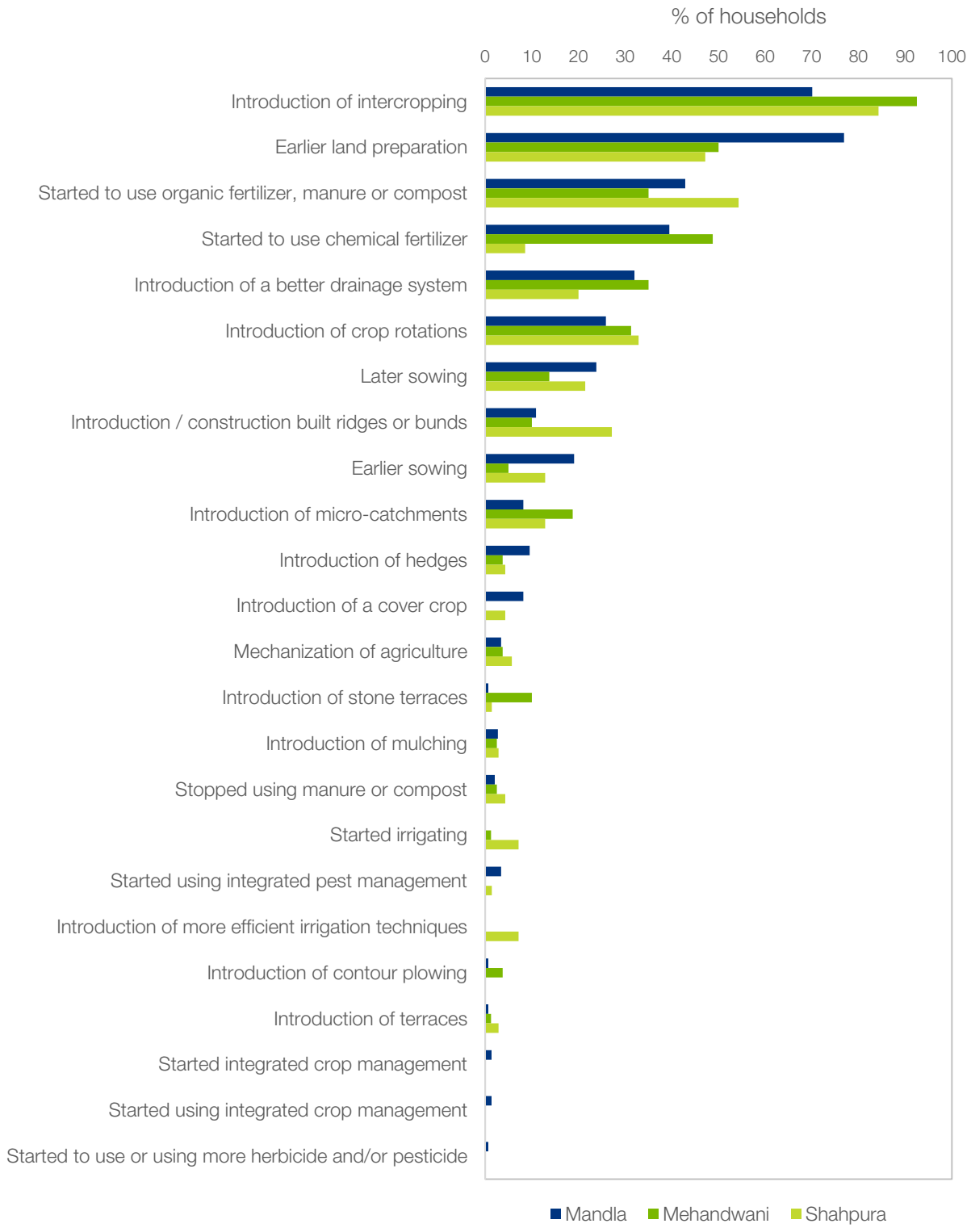


Figure 48. Changes in management of crops, land, soil, water, and pests and disease

Table 73. Change in crop, land and water management

	All	Man	Meh	Sha
Introduction of intercropping	236	103	74	59
Introduction of a better drainage system	89	47	28	14
Introduction of crop rotations	86	38	25	23
Introduction / construction built ridges or bunds	43	16	8	19
Introduction of micro-catchments	36	12	15	9
Introduction of hedges	20	14	3	3
Introduction of a cover crop	15	12	0	3
Introduction of stone terraces	10	1	8	1
Introduction of mulching	8	4	2	2
Started irrigating	6	0	1	5
Introduction of more efficient irrigation techniques	5	0	0	5
Introduction of contour plowing	4	1	3	0
Introduction of terraces	4	1	1	2

Table 74. Change in timing of activities

	All	Man	Meh	Sha
Earlier land preparation	186	113	40	33
Later sowing	61	35	11	15
Earlier sowing	41	28	4	9

Table 75. Change in inputs, mechanization and pest management

	All	Man	Meh	Sha
Started to use organic fertilizer, manure or compost	129	63	28	38
Started to use chemical fertilizer	103	58	39	6
Mechanization of agriculture	12	5	3	4
Stopped using manure or compost	8	3	2	3
Started using integrated pest management	6	5	0	1
Started integrated crop management	2	2	0	0
Started to use or using more herbicide and/or pesticide	1	1	0	0

Changes in livestock management

The most common changes in livestock management were adjusting herd sizes, most often reducing them but in some cases increasing herd sizes (Table 76). Introduction of stall keeping was also a common action, while other changes in fodder management (cut and carry, improved pastures, and growing fodder) were more rarely reported. Cattle were the animals most often targeted by these changes in management, and in rarer cases goats (Table 77). Reductions of herd sizes were more common in Shahpura than the other blocks (Figure 49). Stall keeping was more commonly introduced in Mehandwani.

Table 76. Changes in livestock management

	All	Man	Meh	Sha
Increase in herd size	24	10	9	5
Reduction in herd size	64	27	13	24
Stall keeping introduced	32	8	19	5
Cut and carry introduced	2	1	0	1
Growing fodder crops	3	1	0	2
Improved pastures	1	1	0	0
Other livestock management change	45	14	24	7

Table 77. Animals for which changes in livestock management were applied

	Bulls	Calves	Cows	Goats
Increase in herd size	13	3	22	3
Reduction in herd size	21		55	6
Stall keeping introduced	23	4	23	2
Cut and carry introduced			2	
Growing fodder crops			3	
Improved pastures	1			

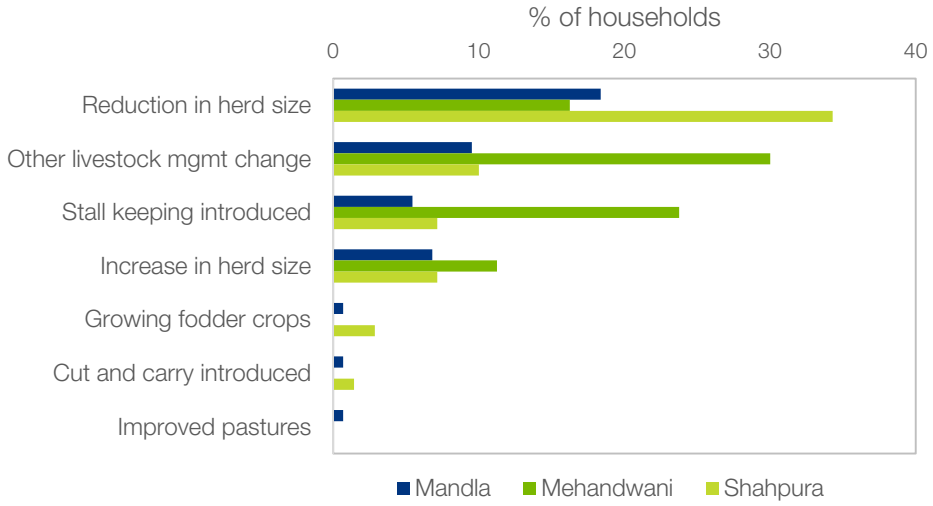


Figure 49. Changes in livestock management over last three years to adapt to climate change

Top adaptation actions

The most common actions taken to adapt to climate change were introduction of intercropping (80%), expanding area to a specific crop, usually rice (70%), stopping growing a crop, usually minor millets (66%), introducing higher yielding varieties, usually of rice (65%), and earlier land preparation (63%). There were some differences between districts in the application of these strategies (Table 78). For example, earlier land preparation was the most common practice in Mandla but was much less common in Dindori district. It is noted that “adaptation to climate change” from the farmers point of view may include more than just climate factors but also emerging market opportunities and other shifts in the social-ecological system.

Table 78. Most common adaptation actions

Rank	Overall	Mandla	Mehanwani	Shahpura
1	Introduced intercropping (79.5%)	Earlier land prep (76.9%)	Introduced intercropping (92.5%)	Introduced intercropping (84.3%)
2	Expanded area to a crop (70.4%)	Expanded area to a crop (74.8%)	Expanded area to a crop (71.3%)	Stopped growing a crop entirely (65.7%)
3	Stopped growing a crop entirely (66%)	Stopped growing a crop entirely (70.1%)	Higher yielding variety (70%)	Expanded area to a crop (60%)
4	Higher yielding variety (65.3%)	Introduced intercropping (70.1%)	Stopped growing a crop entirely (58.8%)	Started using manure/compost (54.3%)
5	Earlier land prep (62.6%)	Higher yielding variety (69.4%)	Earlier land prep (50%)	Higher yielding variety (51.4%)
6	Reduced area to a crop (49.5%)	Reduced area to a crop (56.5%)	Started/increased chem fertilizers (48.8%)	Earlier land prep (47.1%)
7	Started using manure/compost (43.4%)	Started using manure/compost (42.9%)	Reduced area to a crop (47.5%)	Reduced area to a crop (37.1%)
8	Started/increased chem fertilizers (34.7%)	Started/increased chem fertilizers (39.5%)	Started using manure/compost (35%)	Reduction in herd size (34.3%)
9	Introduced improved drainage (30%)	Introduced improved drainage (32%)	Introduced improved drainage (35%)	Introduced rotations (32.9%)
10	Introduced rotations (29%)	Introduced rotations (25.9%)	Pre-treated improved variety (32.5%)	Introduced/built ridges or bunds (27.1%)
11	Reduction in herd size (21.5%)	Later planting (23.8%)	Introduced rotations (31.3%)	Later planting (21.4%)
12	Later planting (20.5%)	Earlier planting (19%)	Other livestock mgmt change (30%)	Introduced improved drainage (20%)
13	Other livestock mgmt change (15.2%)	Reduction in herd size (18.4%)	Stall keeping introduced (23.8%)	Better quality variety (20%)
14	Introduced/built ridges or bunds (14.5%)	Testing a new crop species (14.3%)	Introduced micro catchments (18.8%)	Shorter cycle variety (18.6%)
15	Pre-treated improved variety (13.8%)	Introduced new crop species (14.3%)	Reduction in herd size (16.3%)	Pre-treated improved variety (15.7%)

Gendered access to information and institutions

Gendered access to information

The man or woman respondent had received information about adaptive farming practices for climate change in 64% of the households surveyed. Households were more commonly informed in Mandla (74%) than in Shahpura (56%) or Dindori blocks (49%). Women had more commonly received information about climate change (61%) than men (47%) (Table 79). This gender difference was most apparent in Mandla district (Figure 50).

Table 79. Number of men and women respondents that had received information on climate change

	All	Man	Meh	Sha
Men	137	76	34	26
Women	175	103	40	31

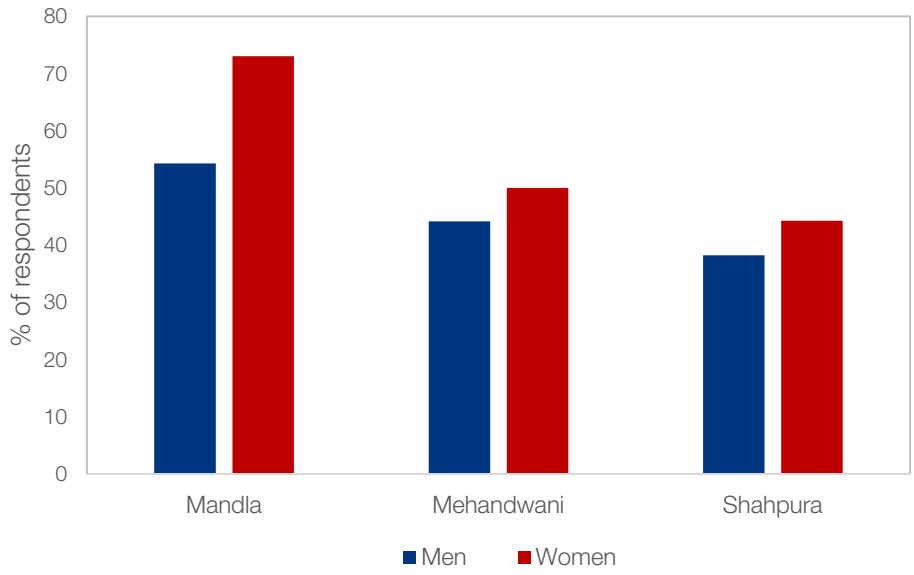


Figure 50. Percent of men and women respondents that had received information on adaptive practices for climate change

The most common source of information on adaptive farming practices for climate change was the respondents' self-help group, where they were informed by NGOs (Table 80). These groups were especially important for the women respondents, of whom 69% were informed by these groups. The self-help group was also an important source of information for men (46%) but men were also seen to obtain information on climate change from a diversity of other sources such as extension (9%) and media (6% newspaper, radio, television), which were more rare information sources for women (3% extension and 2% media). Farmer producer companies, the municipality (panchayat) and other sources were mentioned by few respondents. The sources of information were similar between sites (Figure 51).

Table 80. Sources of information on climate change

	All	Man	Meh	Sha
Men				
FPC	10	6	4	
Government	26	5	11	9
Media (newspaper, radio, tv)	17	6	6	5
Other	6	4	2	
Panchayat	4	1	1	2
SHG/NGO	134	65	48	21
Women				
FPC	6	1	2	3
Government	8	3	4	
Media (newspaper, radio, tv)	6	2	2	2
Other	7	3	1	3
Panchayat	2	2		
SHG/NGO	197	101	60	36

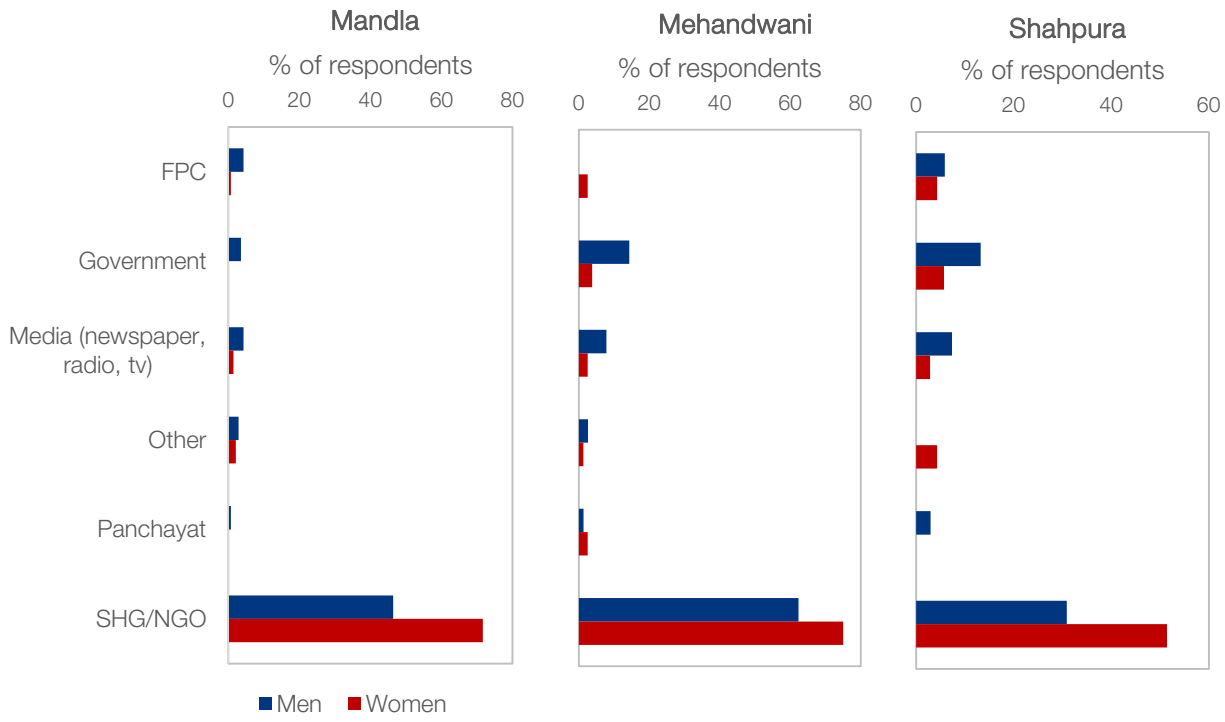


Figure 51. Information sources of male and female respondents

Gendered access to institutions

Eighty-one percent of households surveyed had at least one member involved in a community institution. Many of these households (65%) had at least one member with a leadership position. Slightly more households in Mandla (85%) had members participating in community institutions than households in Mehandwani (76%) or Shahpura (75%). More households had female members involved in community

institutions than male members in all three blocks (Table 81, Figure 51). A similar trend was seen for leadership positions (Table 81, Figure 52). The importance of women in community institutions certainly relates to the strong presence of self-help groups in the project area which have been promoted by the government and NGOs. However, an issue with methodology could also have contributed to the results. This question sought multiple answers for who is involved in community institutions, which would be compared to the household roster but the resulting data had only one entry for a single person in the household, while others are likely also involved.

Table 81. Access to institutions men and women respondents

	All	Man	Meh	Sha
Participate				
Men	16	10	5	1
Women	223	115	56	52
Leadership				
Men	20	12	5	3
Women	174	74	54	46

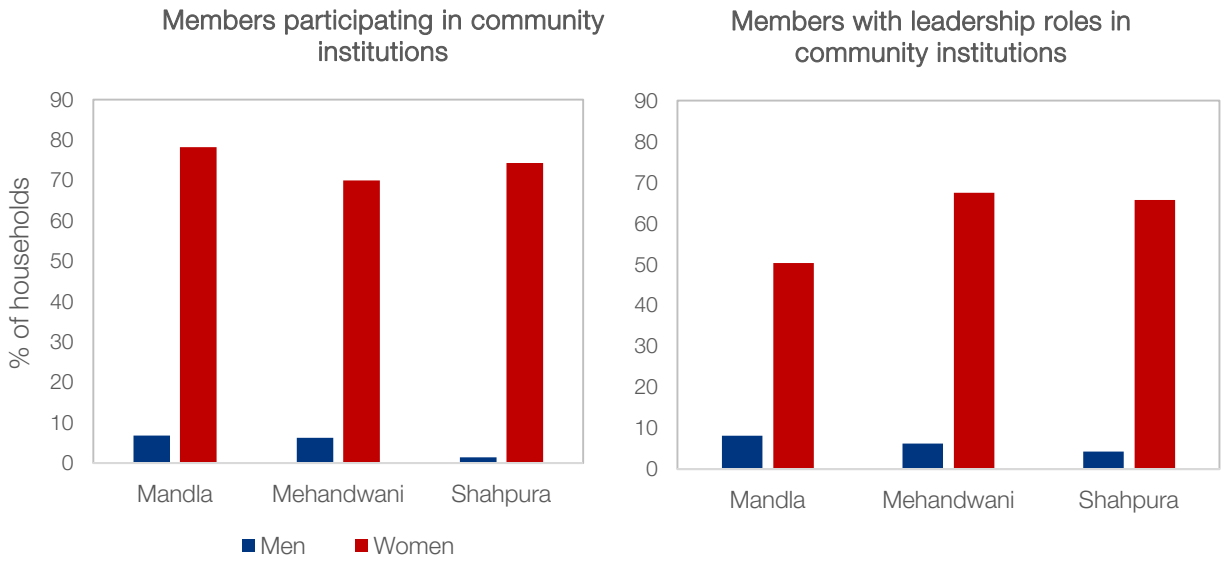


Figure 52. Percent of households with men and women participating in community institutions

Synthesis and closing remarks

The farmers in the thirty villages included in this study have integrated crop and livestock farming systems for a mix of subsistence and market production. Households maintained a mean of 1.4 livestock species and 4.0 crop species, meanwhile a total of 6 species of livestock and 33 crop species were documented across the communities. Crops and livestock were vital for subsistence and also were providing income to many households. Wild plant gathering and labor positions on other farms were other critical sources of income for many of the surveyed households. While agriculture was cited as a top income source by effectively all the households, there were no dominant cash crops in the area. The subsistence value of production was notable, meanwhile a total of 20 crops were noted to provide at least some income to some households. The primary crops grown by the most households and in largest areas were cereals—especially rice, maize, kodo millet, kutki millet, and wheat. Several vegetables and pulses were cultivated across the communities but in lower frequency and in much smaller area compared to the cereals.

Kodo and kutki millet

Kodo and kutki millet were significant in the livelihoods of the surveyed communities. 52% of households were growing kodo millet and 57% were growing kutki millet. Many households were cultivating both of these cereals (43%) and together kodo and kutki occupied on average 51% of their growers' landholdings. Kodo millet was grown by the majority of households in Shahpura block (83%), to a smaller degree in Mehandwani (56%), and by the fewest households in Mandla block (35%). Households in Shahpura also assigned larger areas to kodo than in the other two blocks (0.5 Ha vs 0.3). Kutki millet was more common than kodo millet in Mandla block (48%). However, overall, kutki cultivation was most common in Shahpura (74%), least common in Mandla, and intermediate in Mehandwani (55%), as was also the case for kodo millet.

Nineteen percent of households were making an income from kodo and/or kutki millet. More were making an income from kutki (16%) than from kodo (10%) and surprisingly, also rice (12%). In contrast to production trends, the highest level of commercial activity for kodo and kutki was seen in Mandla block, where 35% of growers reported making an income from kodo and 45% of growers made an income from kutki compared to 5% and 7% in Shahpura, respectively. As for production, the level of sale of millets was intermediate in Mehandwani. Across the blocks, farmers selling millets sold about half of their harvest. The mean income earned for kodo was 4,975 INR/Ha (approximately 9.95 USD/Ha) and for kutki was 8,730 INR/Ha (approximately 17.46 USD/Ha). In a context where the households had a 46% mean likelihood of living below the poverty line of INR 22.86/person/day for a rural setting (approximately 0.05 USD/day/person; Schreiner 2010), and households had an average of five members with a mean 1.9 hectares of land, it can be seen that these crops alone would be inadequate to enable households to overcome poverty. However, given that millets are typically grown in hilly, rocky land with minimal effort during cultivation, the income and food they do provide is likely an easy boost for the household.

The quality of land where kodo and kutki are produced (e.g. order in crop rotation), the varieties used, and the production techniques could be factors limiting returns on these crops. Kodo and kutki were strictly produced under rainfed conditions and in general they were produced without inputs. Effectively all the farmers sourced their seed from their own production and the varieties used were almost exclusively local varieties. One improved variety of kodo (Indra) was cultivated by two farmers in Mandla and seven farmers in

Shahpura. Mean yields of kodo millet were 623 kg/Ha and of kutki millet were 572 kg/Ha, noting that these are very coarse estimates dependent on the accuracy of farmers recall for area planted and mass harvested. The mean price achieved for kodo was 14 INR/kg (approx. 0.03 USD/kg). A slightly higher price was obtained on average for kutki at 20 INR/kg (approx. 0.04 USD/kg). Various prices were reported from different buyers in the local markets and at larger trading centers (mandi). No household reported selling processed kodo and kutki, which could bring higher returns. A more detailed value chain study will be conducted in the Project which will more clearly map the actors in the value chains of these species and identify the key bottlenecks in securing the full value of these traditional crops.

Underutilized crops in diet diversity and food security

Our survey took place in October when a majority (49%) of households were found to have an ‘acceptable’ diet according to the FCS, which considers the frequency of consumption of different food groups. Still 75% of the households interviewed had adopted one or more food security coping strategies in the last week as captured by the rCSI. The most commonly adopted coping strategy was eating less-preferred foods, which may include millets but could also include lower quality grains from the Public Distribution System or other foods. Several respondents (22%) had reduced their number of meals per day. Effectively all the respondents had eaten starchy staples every day of the week prior to the survey but the FCS indicator did not reflect whether the quantity was sufficient to meet energetic requirements. The number of households reducing the number of meals in this period suggests that quantities may not have been sufficient. The role of millets in the food security strategy of households in these districts deserves more attention, especially to understand if their increased production could help reduce the number of households facing staple food shortage. The peak period of consumption for millets was July to November when several households reported experiencing food insecurity.

Attention should also be given to enhancing consumption of other more nutrient-dense foods in these communities. While staple cereals were consumed effectively every day by all the households, pulses and vegetables were consumed only 4.4 days per week on average by most households. Fewer households consumed dairy, fruit and meat in the last week and these foods were consumed much less frequently by those who did consume them (1-3 times per week). Lower consumption of pulses and nuts, dairy, and vegetables were seen among those with a "poor" diet. Diet diversity broadly reflected the diversity of the local production systems, which were dominated by staple cereals. Vegetables and pulses had lower levels of production and were also consumed less frequently. Fruits had both negligible production and consumption. In addition to the crops that were cultivated, wild and purchased foods also contributed to diet diversity but were not well captured in the survey. The Public Distribution System likely contributed to the high consumption of starchy staples in the communities by providing subsidized grains. Dark leafy vegetables were the most common vegetables consumed but they were captured in negligible levels in the production system survey, suggesting they were likely collected from the wild. It is noted however that the production section of the survey was targeted at the male respondent, which may have limited the detail collected on vegetable production if women are the key actors growing vegetables in their home gardens. Further investigation is needed to understand the level of cultivation of vegetables and fruits and the level of wild collection for these foods.

Climate change adaptation

Sixty seven percent of the households surveyed had introduced new varieties in the last three years as an action to adapt to climate change. Most often new varieties were introduced for rice and less commonly for maize, kodo and kutki. The introduced varieties were mostly higher yielding and often pre-treated / improved or better quality varieties. Farmers more rarely introduced short-cycle, drought- and flood-tolerant varieties, which may be key in adapting to climate change, but these could be characteristics of the higher-yielding varieties. No households mentioned stopping growing a variety in the last three years, which suggests a trend toward varietal diversification. However, there was also a trend of simplification of these cropping systems with expanding rice cultivation with the abandonment of several crop species, notably foxtail millet, barnyard millet, and finger millet, and reducing area to kodo and kutki millet. The shift to rice production was most notable in Mandla, where we accordingly saw reduced millet cultivation relative to the sites in Dindori district. The shift to rice may be less related to climate adaptation than to taking advantage of opportunities presented by extension for trying new varieties (mostly developed for rice) and market bias toward rice over millet. Other common actions were introducing intercropping, earlier land preparation, use of fertilizers (organic and chemical), improving field drainage, introducing crop rotations, reducing herd sizes, and later planting.

The man or woman interviewed had received information on climate change adaptation practices in 74% of the households surveyed. The main source of information overall were self-help groups, which were especially important for women. In fact, more women overall had received information on climate change, likely because of the presence of these community institutions which are a node of contact between the women and local NGOs working on development issues. Men were less likely to have received information on climate change but they reported a wider range of information sources, more commonly receiving information from extension and the media as compared to women. Our results point to the success of the self-help group model in reaching women, but also highlights a risk in these communities of excluding men from accessing vital information.

Conclusions

This baseline household assessment provided an overview of the production and livelihood systems of thirty communities in eastern Madhya Pradesh, which are being targeted with activities to increase the cultivation, commercialization and use of kodo, kutki, and native vegetables to improve nutrition and climate resilience. The survey documented the level of cultivation, commercialization and consumption of these crops prior to the interventions. The study also revealed how these species contribute to the livelihoods of the surveyed communities and the roles they could have in further improving food security, nutrition, and incomes. Kodo and kutki millets stood out as key staples and income sources for the households surveyed and have potential to increase revenues through production and sale of value-added products. Fruits and pulses can be key in addressing nutrition gaps. Vegetables were consumed less commonly by households with a poor diet in Dindori district and may be in shortage at different times of year, meriting further investigation into season dynamics in their production and collection from the wild. This analysis is a beginning point for more detailed analysis on the value chains of our target species, the varieties cultivated and their unique characteristics, the native vegetables collected for consumption and sale, the relevance of these species in the livelihoods of men and women, and their adaptation to the threats of climate change.

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