A farmer from Madhya Pradesh eats a millet dish prepared in Tamil Nadu. Credit S. Priyam/ ASA

Current use of minor millets, trends, and potentials for enhanced consumption in central India

A case study in the programme "Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk"

Shambhavi Priyam

Contents

CONTRIBUTORS **3**
PROJECT COORDINATORS 3
ANALYSIS AND REPORT 3
CITATION 3
ABBREVIATIONS **4**
EXECUTIVE SUMMARY **5**
INTRODUCTION **6**
HARDY AND NUTRITIOUS MINOR MILLETS IN DECLINE 6
HOLISTIC VALUE CHAIN APPROACH 7
ASSESSING CURRENT AND POTENTIAL FOR INCREASED CONSUMPTION OF MILLETS 7
STUDY AREAS AND METHODS **8**
DIET STUDY OF RURAL COMMUNITIES IN MADHYA PRADESH 8
Evaluation of the role of millets in household diets *10*
CONSUMER SURVEYS IN URBAN CENTRES 10
Household survey *10*
Restaurants and retail outlet survey *11*
RESULTS **12**
RURAL CONSUMER SURVEY AND PERCEPTIONS OF MILLETS 12
Weekly household diets in Mandla and Dindori districts *12*
Consumption trends and perceptions on millets in rural Madhya Pradesh *14*
Nutrient contribution of millets to rural diets *15*
CONSUMER AND VENDOR SURVEYS IN BHOPAL AND MUMBAI 18
Cereal consumption by urban consumers *18*
Urban consumer awareness about kodo and kutki *19*
Willingness to use minor millets *20*
Willingness to pay for millets *20*
SURVEY OF MILLET VENDORS AND RESTAURANT KITCHENS 21
Restaurant kitchens *21*
Retail stores *21*
DISCUSSION **22**
ROLE OF MINOR MILLETS IN RURAL DIETS IN EASTERN MADHYA PRADESH 22
ROLE OF MINOR MILLETS IN URBAN DIETS IN BHOPAL AND MUMBAI 23
CONCLUSION **24**
REFERENCES **25**
ANNEXES **26**
ANNEX 1. NUTRIENT CONTENT OF CROPS CONSUMED IN RURAL EASTERN MADHYA PRADESH 26
ANNEX 2. DAILY NUTRITIONAL REQUIREMENTS 27
ANNEX 3. PRICES OF MILLETS 29

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) and Agriculture for Nutrition and Health (A4NH) from 2015-2018 and coordinated by Bioversity International and Action for Social Advancement (ASA).

Project coordinators

Stefano Padulosi (Global Project Coordinator, Bioversity International)

Ashis Mondal (Project Coordinator for India, ASA)

Analysis and report

Shambhavi Priyam (ASA)

Advisors

Somnath Roy (ASA)

Gennifer Meldrum (Bioversity International)

Acknowledgements

This report was successfully completed thanks to the support of the ASA field staff in the Mandla and Dindori offices, including Sharad Mishra, Brijeshanand Tiwari, Nilay Tiwari, Jaypal Bambale. Special mention to Sandahya Parte for helping with the data collection in Madhya Pradesh and for proving the immense help at very short notice.

Citation

Priyam, S. 2017. Current use of minor millets, trends, and potentials for enhanced consumption in central India: A case study in the programme "Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk". Rome, Italy: Bioversity International and Bhopal, India: Action for Social Advancement.

Abbreviations

A4NH	CGIAR Research Programme on Agriculture for Nutrition and Health
CCAFS	CGIAR Research Programme on Climate Change, Agriculture, and Food Security
CGIAR	Consultative Group for International Agricultural Research
ASA	Action for Social Advancement
IFAD	International Fund for agricultural development
INR	Indian rupees
NGO	Non-governmental organization
NIN	National Institute of Nutrition
PDS	Public Distribution System of India
Project	The IFAD and EU supported initiative “Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk”

Executive summary

Minor millets have high nutritional qualities and produce well under marginal conditions but they are not used to the extent that is possible. Through the Project "Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk", supported by IFAD and the European Union from 2015 to 2018, Bioversity International and ASA have been taking action to reverse the decline of millet cultivation in Madhya Pradesh to support climate change adaptation and build more resilient, nutritious food systems. The Project focuses on the entire value chain of millets from increasing supply to creating demand. This case study focused mainly on the demand aspect. Current use and perceptions use of minor millets were investigated among rural consumers in eastern Madhya Pradesh and in two cities (Bhopal and Mumbai) to build understanding of best strategies to promote these cereals.

The minor millets used to be the main source of food for tribal communities in Madhya Pradesh but their cultivation has been declining in past decades. This study showed a diminishing trend of millet consumption among rural consumers that matched the declining production. This trend was more notable in Mandla district than in the hillier and more marginal areas of Dindori district, where millets remained important in household diets. Increasing availability of rice from their own production and through the Public Distribution System (PDS) was a factor noted to demotivate women from carrying out difficult processing for millets. The rural consumers preferred the taste of their local rice varieties over millets. However, the quality of PDS grains was noted to be poor and they expressed feeling weaker since shifting to higher rice consumption, which could relate to its higher glycaemic index. Diet analyses showed millets to provide important contributions of fibre, energy, fat, and iron to local diets but some of these contributions were less substantial compared to other food groups, so millets should be promoted within balanced diets, including also other food groups.

The urban consumer surveys revealed different trends in Bhopal and Mumbai. Minor millets were consumed by mid- to high-income households in Mumbai who were motivated by their health benefits in addressing diabetes and other issues. Finger millet was the minor millet most consumed in Mumbai and there was generally low awareness about kodo and kutki millet in this context. In Bhopal, by contrast, consumers mostly knew of kodo and kutki but were not consuming them regularly or at all. One reason for low consumption in Bhopal was the lack of availability. Another reason was lack of awareness of their health benefits. After hearing about their health benefits, higher interest was seen in Bhopal than in Mumbai to introduce them in their weekly diets. The prices they were willing to pay were problematic, however, as low income households would not be able to afford current millet prices—especially when they can access subsidized rice and wheat from the PDS. Current prices also seemed too high for high income consumers.

This study revealed some entry points to promote millet use among urban and rural consumers. Addressing difficulties in processing is key for promoting millets among rural consumers. Introducing millets in the PDS through implementation of the National Food Security Act could be key in increasing consumption of millets among lower income urban households, as well as among rural consumers, especially if this supply can overcome the challenges in processing. Building supply of millets and organization of the value chain is necessary to bring millets to a more acceptable price point for mid and high income consumers. Stimulating income opportunity for millet production in marginal regions can be key for the economic empowerment of people facing high levels of poverty and stimulating a shift toward more nutritious, resilient agricultural systems.

Introduction

Hardy and nutritious minor millets in decline

Minor millets have long been a part of Indian diets. These dryland crops are grown in the mountain and hill agricultural regions of India and are traditional staples for several forest and mountain dwelling tribal populations. Two minor millets—kodo (*Paspalum scribiculatum*) and kutki (*Panicum sumatrense*)—were originally domesticated in India. Finger millet (*Eleusine coracana*, ragi) and foxtail millet (*Setaria italica*) are other minor millets that were domesticated in Eastern Africa and Central Asia, respectively, but have long been cultivated in India. These crops have a remarkable ability to survive under adverse weather conditions like limited rainfall, poor soil fertility, and hilly terrain (Chandel et al 2014). They can grow in areas with suboptimal soil, climate, and irrigation conditions for crop growth. In addition to their hardiness, because they mature faster, they can be used as relay crops. The minor millets have very small grains that can be stored easily for longer periods of time, ensuring food safety in seasons of crop failures. They are also useful as fodder and straw for cattle because of their grassiness and short slender culm.

Traditionally, it was common to find minor millets growing in forested agricultural lands of tribal peoples of central India, however one can see that the cultivation of these crops has slowly been fading where it was abundantly seen before. Factors like land conversion to paddy and easy availability of rice and wheat from the PDS have caused attention to be shifted away from traditional millets. This shift from millets to more ubiquitous grains like rice and wheat is associated with a substantial nutritional loss for consumers. A factor that sets millets apart is their high ash content (mineral composition). Minor millets are highly nutritious in iron, zinc, and calcium. The iron content of kutki is substantially higher than that of most cereals and finger millet is also rather special since it has very high calcium content. The grains of minor millets also a good source of vitamins like thiamine, riboflavin, folin, and niacin. The outer bran is rich in B-complex vitamins. The protein content of millets has a balanced amino acid profile, being good sources of methionine, cysteine and lysine. The main nutritional component of millets, like most other cereals, is starch but the carbohydrate contents are in the form of non-starchy dietary fibres, so one of the primary nutritional benefits of millets is their high fibre and low glycaemic index.

Because of their hardiness and nutritional values, revitalizing millet cultivation and use can be integral to enhanced food and nutrition security in India in the face of climate change. The use of millets could be key in enhancing nutrition of rural populations farming on marginal lands, as well as for urban consumers. These different populations can benefit from increased millet use in various and interconnected ways. Millets are traditional food items, but they can be used in modern food preparations that are acceptable to urbanites. Because of their high fibre and slower digestibility, urban populations are now becoming familiar with the benefits of millets for coping with rising issues with diabetes and other secondary metabolic diseases. Their nutritional and nutraceutical values give them a potential marketability, which farmers can capitalize upon. The income opportunity of millet production in marginal regions where rice is not easily cultivated can be key for the economic empowerment of people facing high levels of poverty. The nutrient benefits of millets may also be leveraged among rural populations who have been abandoning these cereals by addressing barriers to their use such as low yields and difficult processing.

Holistic value chain approach

To reverse the decline in use and encourage cultivation and use of climate-hardy and nutritious millets, Bioversity International and ASA have been working to overcome their constraints through the Project "Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk", supported by IFAD and the European Union from 2015 to 2018. A holistic value chain approach is being applied in the Project, which involves inter-disciplinary and inter-sectoral initiatives to raise supply and demand in tandem to support better nutrition and climate resilience.

The Project is addressing critical bottlenecks in the production, processing and commercialization of minor millets that have been leading to their abandonment. On the demand side, key actions involve raising awareness of both urban and rural consumers on the nutritional values of millets and addressing issues with processing, packaging and marketing to increase the attractiveness of these cereals for household use. Addressing issues such as difficult processing and low yields may be key for revitalizing millet use among rural communities. For urban consumers, barriers to use that may need to address for urban populations include raising awareness and availability of these cereals, and development of attractive modern recipes and products. Understanding trends, perceptions and norms of millet use in the rural communities targeted by the project is fundamental to guide approaches and strategies for leveraging these traditional cereals for better climate resilience, nutrition, income and empowerment. Building a similar understanding of urban consumers is also essential to guide approaches for these populations to benefit from the nutritional advantages of millets and to build market demand which can benefit rural producers on marginal lands.

Assessing current and potential for increased consumption of millets

This study assessed current levels of millet consumption, trends, and potentials for increasing millet consumption among rural populations in eastern Madhya Pradesh and urban consumers in a tier I and tier II city of India. The dietary characteristics of the populations in rural Madhya Pradesh where the Project is active were examined to build understanding of the role of minor millets in their nutrition and food security. Discussions explored trends in the use of millets over time and food preferences among different genders and age groups to reveal potentials for promoting their greater consumption. The study also scoped demand for millets among urban consumers in Bhopal and Mumbai through a household survey that evaluated the current use of minor millets, interest in incorporating these cereals in their diet for health benefits, and their willingness to pay for them. Interviews and evaluations with restaurants in these cities also revealed further detail on the state of millet use and potentials for enhanced consumption and marketing. The results were evaluated to advise marketing and promotional strategies for millets.

Study Areas and Methods

Diet study of rural communities in Madhya Pradesh

The Project is targeting villages in three blocks in Madhya Pradesh: Shahpura and Mehandwani blocks in Dindori District and Mandla block in Mandla District (Figures 1 and 2). The area receives about 2100 m of rainfall annually, has medium to shallow soil and 61% forest cover. Most of the families in the area belong to the Gond tribe (Table 1). Local livelihoods are dependent on agriculture, as they grow most of the food they have to eat. Farmers, particularly in Mandla district, have more recently started selling some of their production in order to increase their household incomes. According to the National Institute of Nutrition (NIN) survey 2011, 45 to 60% of children under five years of age are underweight in Mandla and over 60% in Dindori are underweight. In Mandla, 29.5% of children aged 0 to 59 months are severely underweight, the infant mortality rate is 71%, and the mortality rate for children below five is a grim 89% (Annual Health Survey 2011).

A diet assessment was performed through focus group discussions in four communities representing each of the three target blocks. One focus group was held in Mandla block with participants from Silpuri, Tikraberpani and Kudopani. One focus groups was held in Shahpura block with participants from Bhilai and Khursipar. Two focus groups were held in Mehandwani block, one with participants from Kathotiya and another with participants from Devgarah and Chanta. The villages where the focus groups were held were selected randomly from the set of 30 villages targeted by the project. The discussions took place over three days from 15-17 October 2015. Around ten individuals participated in each of the four discussions with a mix of men and women. Each group included at least one village elder above age of 60 and one child. The others were largely adults. The discussions focused on the current intake of food for their households. Each group estimated the quantity of specific foods an average household in their village consumes over one week, standardizing the amounts to a family of seven members (three adults and four children). In addition to the diet assessment, the discussion explored trends in consumption behaviour over time and food preferences for different genders and age groups.

Table 1. General statistics about the regions of Mandla and Dindori where the study was conducted

Indicator	*Mandla*	*Dindori*
Area (km^2)[a, b]	8771	7470
Literacy of total population in 2001 (%)[a, b]	60	54
Population of scheduled tribes (%)[a, b]	57.23	64
Literacy among scheduled tribes (%)[a, b]	51	49
Population per health care centre in 2006 (#)[c]	2720	3333
% area under forest [d]	49	37

[a] Mandla District Administration nd, [b] Census of India 2011, [c] Directorate of Health Services 2007, [d] Forest Services of India 2011

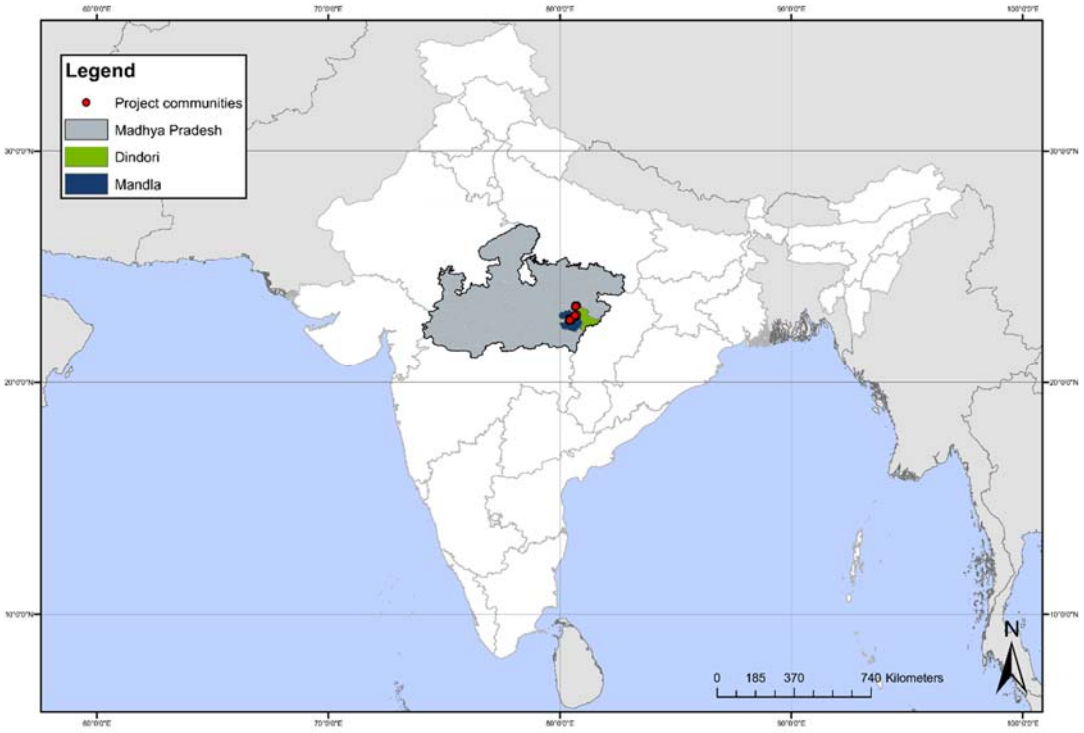

Figure 1. Target sites of the IFAD-EU NUS Project in Madhya Pradesh, India

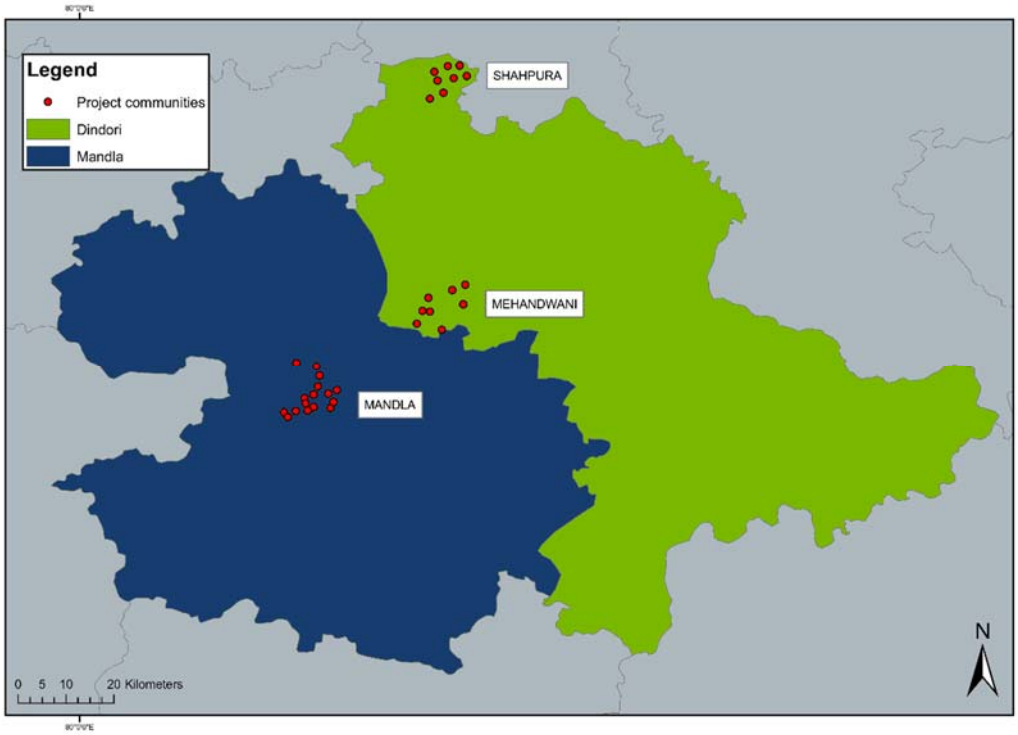

Figure 2. Blocks targeted in Mandla and Dindori districts of Madhya Pradesh, India

Evaluation of the role of millets in household diets

The focus group results on diet preferences and trends were assessed to evaluate perception on millets and changes in their consumption over time. In addition, specific questions in the focus groups explored how millets were commonly prepared and how people felt on days when they consumed millets as compared to rice.

The relative nutritional contribution of minor millets to household diets was explored by calculating the percent of daily nutrient requirements that were fulfilled by the various crops consumed in the quantities specified in the focus groups. The quantity of specific nutrients provided by the estimated levels of household consumption were calculated and compared to the daily household nutrient requirements. Nutrient values for the crops were used from Gopalan et al (1971), with the exceptiong of local leafy vegetables that were not documented in that source for which alternate sources of nutrition information were obtained from the literature (Vishwakarma and Dubey 2011; Islam 2013). The nutrient values used for the calculations and sources are documented in Annex 1. The daily nutrient requirements used were those specified by NIN (2009) (Annex 2). As the estimates for the household diets were given for a household of seven, with three adults and four children, the daily nutrient requirements for the household were calculated in a generalized manner to match the intake estimates, adding the daily required levels for one man, one woman, the average of one man and one woman, one infant, one child, one boy, and one girl. Because there is greater requirement for work in rural areas, the categories used were specifically for those that carry out heavy work. It is acknowledged that this is a very coarse assessment but it was useful to reflect on the roles of millets in local diets relative other crops.

Consumer surveys in urban centres

Household survey

The urban centres targeted by the study were Bhopal, Madhya Pradesh and Mumbai, Maharashtra. Formal one-to-one interviews were conducted with households in each city. The total sample size was 95 households, including 50 households in Bhopal and 45 households in Mumbai. These households were selected by proportional sampling from three neighbourhoods representing different income strata: families that earn less than 2.5 lakh INR (lower), between 2.5 and 10 lakh INR (middle) and more than 10 lakh INR (higher). In Bhopal, Char Imli Colony was surveyed for the high income strata, Gulmohar Colony for the middle income and slum areas in Bagsewaniya for the lower income strata. In Mumbai, Cuffe parade was surveyed for the high income group, Andheri for the middle income and slum area in Macchimar Colony Colaba for the low income group. The neighbourhoods in Mumbai were selected randomly from the municipal corporation database on income groups by subdivision. The neighbourhoods in Bhopal were selected based on local recommendations. Households in the neighbourhoods were selected based on availability and consent. The person interviewed was the female head of the household, who was in all cases the person who made decisions about the kitchen. In the lower income group, the interviewer was also the cook, while in middle and high income group households, there were household helps or cooks but they took direct orders from the female head of household.

The questionnaire covered questions about which cereals they consume on a weekly basis and their knowledge about two minor millets which are the main concern of this project (kodo and kutki). The respondents were then asked if they would be open to considering variation in their current diet regiments if they had options which were much healthier, more nutritious, and could be even cheaper compared to the cereals that they are currently consuming. All respondents were open to the idea and a brief introduction to minor millets was given in which they were told about their health and nutritional benefits. It was explained that the millets can be used as an easy replacement to rice which possess a lower glycaemic value and are gluten free. They were told about the cooking qualities of how the millets cook faster, and pictures were shown to them about the various dishes and preparations which can be created using the minor millet like *kheer, khichdi, upma,* among others. After this they were asked how often they would be willing to use the millets in their weekly diet regiment. The price they were willing to pay for these cereals was also assessed.

Table 2. Total population and sample size for the urban household surveys

	Bhopal	***Mumbai***
Population (2011 Census)	2,798,218	12,442,373
Total sample size for the survey	50	45
Low income group	15	10
Middle income group	20	15
High income group	15	20

Restaurants and retail outlet survey

In addition to the household survey, semi-structured interviews were conducted with restaurant kitchens and retail outlets to understand the market chain and the potential for selling cooked and raw millets. Five middle-range restaurants were interviewed for the purpose of this study: two in Bhopal and two in Mumbai. In both the cities, the restaurants studied were situated in office areas. Two supermarkets were also surveyed in both of the cities. In Bhopal, the chain supermarket *Apoorti* and the hypermarket *Reliance* were looked at, while in Mumbai *Godrej Nature's Basket* and *Sahkari Bhandar* were studied. All four of these retail outlets are part of a bigger franchise of chain supermarkets. It was assessed if these outlets sold millet products and semi-structured interviews were conducted to examine the staff perceptions about the millets and their potential commercialization.

Results

Rural consumer survey and perceptions of millets

Weekly household diets in Mandla and Dindori districts

The focus groups estimated the amount of different foods that were consumed by an average household in their village on a weekly basis. Table 3 shows the diet compositions that the participants documented. The consumption of meats and eggs were very infrequent and did not follow a weekly pattern, as was the consumption of fruits so these items were not included in the weekly household consumption tables. The fruits that were mentioned were tomato (*Solanum lycopersicum*), papaya (*Carica papaya*) and sitaphal (*Annona squamosa*) and the meats consumed were chicken, mutton, and pork. Meats were not mentioned at all in Mandla, while sitaphal was not mentioned in Shahpura. Furthermore, little oil was seen to be used in the study area for the preparation of meals, and hence was not included in the tables. Of the pulses, lentil (*Lens culinaris*) and chickpea (*Cicer arietinum*) were the most important. Pea (*Pisum sativum*) was also mentioned but it was consumed less frequently and so was not included in the diet composition tables. The diets in all sites were dominated by cereals, which made up roughly 65% of the average diet mass. Rice and maize (*Zea mays*) were the cereals consumed in largest amounts, while wheat (*Triticum aestivum*) was the cereal consumed in smallest quantities. In Dindori, kodo and kutki millets were consumed at an intermediate level relative other cereals and they composed around 28% of the cereals in the weekly diet. By contrast, in Mandla, the millets were infrequently consumed and thus were not included in the diet composition table.

Common preparations for the different foods were discussed in the focus groups. Rice and millets were most commonly consumed as simple boiled grains (*bhat)*. On special occasions millets are also prepared as *laddos* (sweets from kodo millet) and *kheer (*pudding made out of kutki). Wheat was most commonly consumed as flat bread (*roti)*. Maize was generally prepared as a soup (*pej*) composed of the boiled grains seasoned with salt. Rice or kutki grains are sometimes also added to the pej and occasionally the broth is thickened with flour—traditionally kodo flour but in more recent times, wheat or rice flour. Lentils were consumed as dal—boiled with spices—while chickpea was commonly consumed as *kadhi*—gravy with sour yoghurt. The vegetables were generally cooked with spices (*sabzi*). Meats were most commonly stewed.

In general, people in these communities were eating between two and four meals in a day. The morning or afternoon meal usually consisted of *penj*. The night-time meal was typically a *bhat* coupled with home grown vegetables and forest weeds like *chech bhaji* (likely *Corchorus sp.;* Shukla et al 2010; Chauhan et al 2014) and *chakora bhaji* (*Cassia tora)*. Traditionally the *bhat* was kodo and kutki. Rice was previously a luxury good and only consumed on special occasions but now the night-time meal often consists of rice—especially in Mandla district. In Dindori, where the cultivation of rice is more difficult, the people still give preference to kodo and kutki. Meals in addition to the morning and evening meal were not common in the all the sites and were not eaten by all household members. Men were said to have more meals than women in one of the focus groups in Mehandwani. Children were noted to eat more frequently, including a meal after school in the afternoon. In Mandla, additional meals were noted to be simple, such as plain rice.

Table 3. Estimated consumption of food items by households (kg per week). The overall weighted average summarizes consumption across the three blocks

Type	*Species name*	*Common*	*Mandla*	*Mehandwani 1*	*Mehandwani 2*	*Shahpura*	*Overall*
Cereals			**20**	**21.5**	**20**	**22**	**20.9**
	Oryza sativa	Rice	10	7	5	7	7.7
	Zea mays	Maize	7	7	7	7	7.0
	Triticum aestivum	Wheat	3	1.5	2	2	2.3
	Paspalum scrobiculatum	Kodo		3	3	3	2.0
	Panicum sumatrense	Kutki		3	3	3	2.0
Pulses			**1.5**	**1**	**1**	**2**	**1.50**
	Cicer arietinum	Gram	0.5	0.5	0.5	1	0.7
	Lens culinaris	Masoor	1	0.5	0.5	1	0.8
Leafy vegetables			**8**	**6.5**	**8**	**6.5**	**7.3**
	Amaranthus sp.	Amaranth	3	0.5	2	0.5	1.6
	Brassica juncea	Mustard	5	2	2	2	3.0
	Corchorus sp	Chech baji		2	2	2	1.3
	Cassia tora	Chakora		2	2	2	1.3
Other vegetables			**2**	**3**	**2**	**3**	**2.5**
	Solanum tuberosum	Potato	1	1	1	1	1.0
	Solanum melongena	Brinjal	1	2	0.5	2	1.4
	Brassica oleracea	Cauliflower			0.5		0.2

Table 4. Discussion on consumption patterns and food preferences

Theme	*Mandla*	*Mehandwani 1*	*Mehandwani 2*	*Shahpura*
Number of meals per day	2 meals, morning and evening. Sometimes 3 with rice consumption	3 to 4. Kids eat more meals, followed by men, followed by women	3 meals	2 meals, morning and evening. Children consume food in the afternoon after school
Gender preferences for food	None	None	None	None
Items given special preference for mothers and infants	Kodo rice: however this is not practiced very often because of lack of kodo	None	None	Kodo rice, cooked with jaggery to sweeten it
What children like to eat	Rice	No preference	No preference stated	Sweet things. Maize when it comes to cereals
How weekly consumption of food has changed in the last 10 years	People do not consume kodo and kutki very frequently anymore because the practice of growing them has stopped	More and more rice being eaten	Eating more from the PDS. The overall amount of consumption of food has decreased, consumption of broken wheat (*daliya*) has increased.	Eating more from the PDS

Consumption trends and perceptions on millets in rural Madhya Pradesh

A decreasing trend of millet consumption was apparent across the sites in Mandla and Dindori, while the consumption of rice was increasing. This trend was most notable in Mandla district, where they said they consumed millet very infrequently. In Dindori, households noted increasing consumption of subsidized rice and wheat from the PDS but in this district millets were still a central component of weekly household diets.

People observed that their local varieties of rice taste better than millets and that it is hard to eat millets without a dal (sauce) or bhaji (fritter). Children prefer rice and maize and complain when millets are cooked, even calling them by unattractive names such as “ant eggs”. In addition to lower preference for taste, millets were observed to take more energy to prepare because threshing them is highly drudgerous. The easy availability of food grains in the PDS is decreasing women’s’ motivation to perform this task, even though the quality of the rice in the PDS was noted to be of substandard quality.

While they were less appreciated for their taste, the four focus groups agreed that they felt more energetic when they ate millets as compared to rice. People mentioned that they feel fewer hunger pangs and that their energy lasts longer when they eat millets. Some farmers said that they feel weaker since they have started eating more rice and reduced their millet consumption. Recognizing the nutritive value of millets, the focus groups in Mandla and Shahpura noted that kodo millet is given special preference for mother and infants.

Table 5. Discussion on consumption and preparation of millets

Theme	*Mandla*	*Mehandwani 1*	*Mehandwani 2*	*Shahpura*
Different items made with kodo and kutki	Boiled, laddu, kheer, kutki pej	Boiled, laddu, kheer	Boiled, laddu, kheer	Boiled, laddu, kheer
How does a day with consumption of rice differ from a day with consumption of millets	More energy in the body with millets and longer lasting energy. Less frequent hunger pangs with millets.	Get hungrier faster with rice. More energy with millet.	Rice gives less energy	Longer lasting energy with millets, more energy for manual labour.
Notes on millet consumption preferences	Kutki pej can be made but is not very popular. Harder to eat kodo and kutki without dal or bhaji	Rice (home grown not from the PDS) tastes nicer	Children call millets “cheenti ka anda” (ant eggs). Rice tastes sweeter. Have to eat dal or kadhi with millets	Children complain when millets are cooked. Dry millets hurt the throat
Notes on millet processing			Too much energy consumption in threshing millets. Easier to cook rice	Less energy used in cooking rice. Easy availability of PDS items causes less effort investment in millet threshing

Nutrient contribution of millets to rural diets

The estimates of nutrition contributions of the different crops to household diets indicate that the current amounts eaten of the specified foods would enable households to meet their daily intake requirements for protein, calcium and iron. Intake of energy was however insufficient according to the very coarse calculations made here with just 75% of household requirements satisfied. Intake of fibre and fat from the specified foods were also insufficient at just 59% and 28% of daily required levels. There were some notable differences in the nutrient intake between regions (Figure 3). In particular, households in Dindori district had notably higher consumption of calcium, fibre and fat as compared to households in Mandla district.

Table 6. Total daily intake and percent fulfilled of daily requirement of key nutrients for a household of seven people calculated from daily intake estimates from the focus groups, nutrient values for species from Gopalan et al (1971) and daily requirements in NIN (2009).

Species/type	Protein (g)	Fat (g)	Fibre (g)	Energy (kCal)	Calcium (mg)	Iron (mg)
Cereals	**271.3**	**64.5**	**82.9**	**10192.6**	**493.4**	**74.8**
Oryza sativa	74.8	5.5	2.2	3795.0	110.0	7.7
Zea mays	111.0	36.0	27.0	3420.0	100.0	23.0
Triticum aestivum	39.8	5.6	6.2	1120.4	157.7	16.1
Paspalum scrobiculatum	23.7	4.0	25.7	882.9	77.1	1.4
Panicum sumatrense	22.0	13.4	21.7	974.3	48.6	26.6
Pulses	**45.8**	**6.1**	**4.7**	**752.0**	**280.9**	**13.3**
Cicer arietinum	17.1	5.3	3.9	360.0	202.0	4.6
Lens culinaris	28.7	0.8	0.8	392.0	78.9	8.7
Leafy vegetables	**45.8**	**8.8**	**15.4**	**458.3**	**4029.1**	**193.4**
Amaranthus sp.	8.6	0.9	6.2	97.1	1080.6	47.8
Brassica juncea	17.1	2.6	3.4	145.7	664.3	69.9
Corchorus sp.	16.2	6.6	32.4	520.0	553.4	139.7
Cassia tora	9.3	1.5	3.9	91.0	965.7	23.0
Other vegetables	**5.8**	**0.9**	**3.5**	**195.1**	**59.7**	**1.8**
Solanum tuberosum	2.3	0.1	0.6	138.6	14.3	0.7
Solanum melongena	2.8	0.6	2.6	48.0	36.0	0.8
Brassica oleracea	0.7	0.1	0.3	8.6	9.4	0.4
Daily total for the household	**368.7**	**80.3**	**106.5**	**11598.0**	**4863.1**	**283.3**
Daily requirement for the household*	**293.1**	**300.49**	**234**	**16020**	**4500**	**134**
Percent of daily requirement met	**126%**	**27%**	**46%**	**72%**	**108%**	**211%**

* Based on a household with three adults and four children, calculated with the values for one man, one woman, and the average of one man and one woman, one infant, one child, one boy and one girl. It is acknowledged that this is a very coarse assessment.

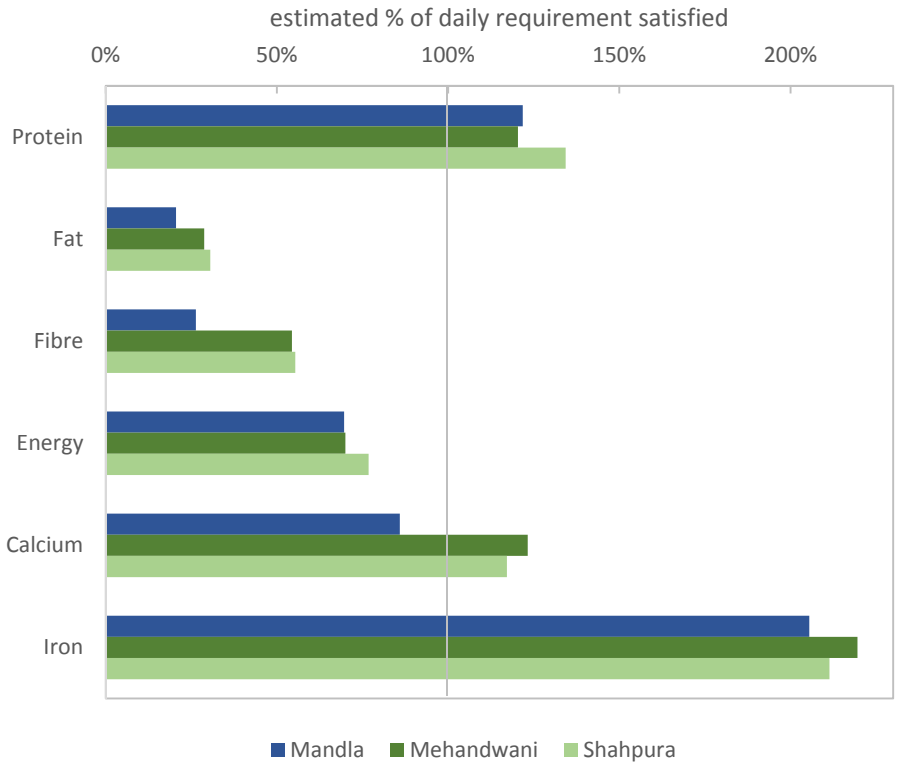

***Figure 3.** Coarsely estimated satisfaction of daily requirements for the household based on weekly diet estimations and dietary requirements for a household with three adults and four children*

The crops eaten in the different sites explain much of the difference seen in the nutrient levels of the diet. The difference in fibre content from site to site was largely due to the consumption of kodo and kutki millets. These cereals, consumed regularly in Dindori but in much smaller levels in Mandla, are highly fibrous with 11.7 and 9.9 times the levels in rice, respectively. Maize has a higher fibre content than kodo and kutki gram per gram but it was consumed at similar levels in both sites, hence the major difference in fibre between sites was attributable to millets. The millets—and in particular kutki—were also responsible for higher fat consumption in Dindori district, as kutki has 2.4 times the fat content of rice. This is noting that the fat content of diets in both districts was well below recommended levels considering the foods documented in the focus groups.

Kutki has exceptional levels of iron according to the values in Gopalan et al (1971) and it contributed a considerable amount of iron to diets in Dindori. This contribution was dwarfed however by iron intake from the leafy vegetables (Figure 4). The major sources of calcium were also leafy vegetables. In Mandla, the leafy vegetables consumed were mainly mustard and Amaranth. These leafy vegetables were eaten in smaller amounts in Dindori, while two other leafy vegetables—chech and chakora—were also consumed. Chech has a very high iron content and chakora has a very high calcium content and their consumption made a dramatic contribution to the mineral content of diets in Dindori.

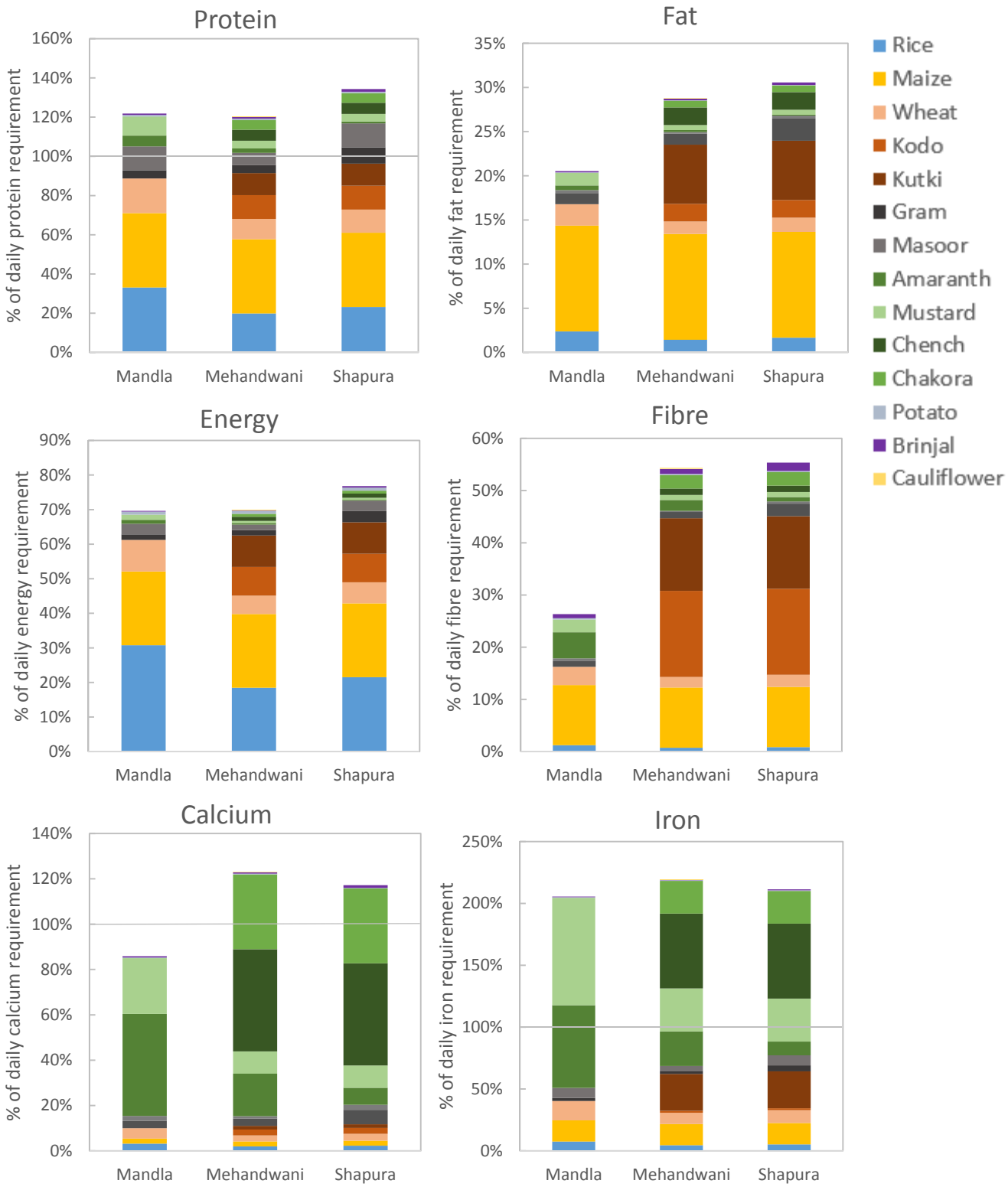

Figure 4. Coarsely estimated satisfaction of household daily nutrient requirement by different crops

Consumer and vendor surveys in Bhopal and Mumbai

Cereal consumption by urban consumers

Figure 5 shows the cereals which were consumed on a weekly basis by the respondents in Bhopal and Mumbai. In both cities rice and wheat were consumed by all respondents in all income categories every week. Maize was consumed by fewer households. Major (pearl millet and sorghum) and minor millets were consumed by the fewest households. In Bhopal, maize was mostly used by lower income households, whereas it was more often used by middle and high income households in Mumbai. In Mumbai, some households in middle and high income brackets were also consuming major millets. These millets were not consumed by the lowest income bracket in Mumbai but some of these households were consuming minor millets. Minor millets were also noted to be consumed by some high income households in Mumbai, whereas no household in the middle income bracket in Mumbai or any income bracket in Bhopal was observed to eat minor millets. In Bhopal, the major millets were eaten by a similar proportion of households across the income brackets. In Mumbai, The minor millet consumed was mainly finger millet. The lower income group individuals mentioned having access to finger millet from their native rural areas, while some of the higher income individuals had been prescribed finger millet from a dietitian or a doctor for health reasons. Those consuming minor millets in the higher income group mentioned that they purchased them mainly over the internet and a few got them in retail outlets.

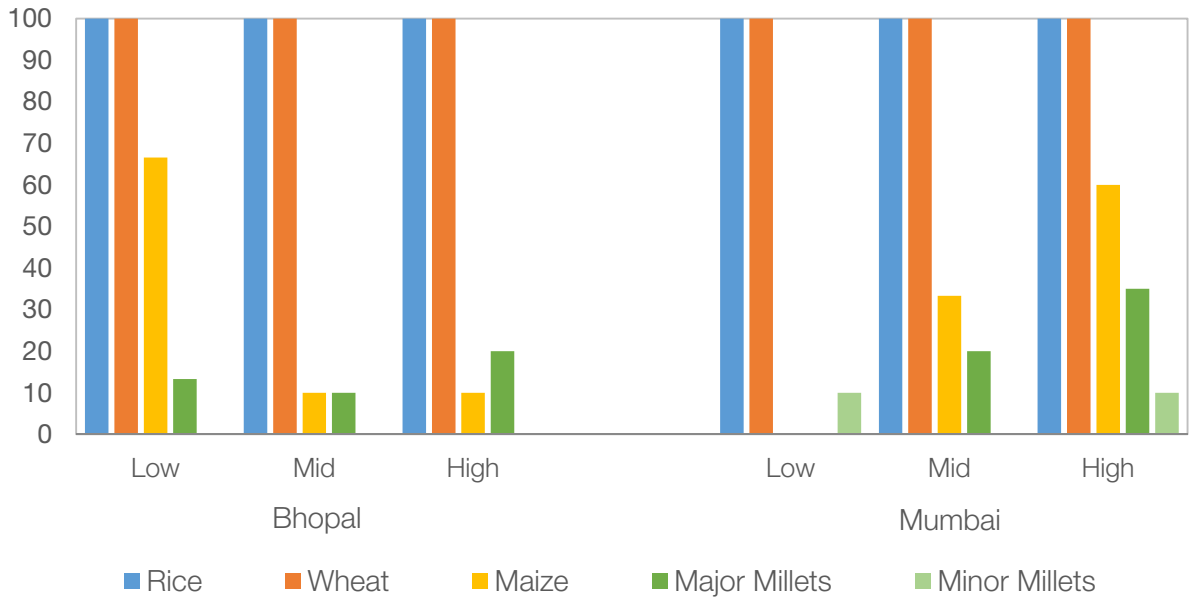

Figure 5. Percentage of respondents consuming different cereals over a week

Among the lower income group in Bhopal the reason stated behind their consumption of maize was the lower price as compared to rice and wheat. The high income group in Mumbai consumed maize to bring some variety to their diet. The same line of reasoning was used for the consumption of major millets. Women in both cities from the middle income group stated the importance of the fibre content of millets and mentioned that they use the millet flour to mix with normal wheat flour for multigrain bread (*roti*) for daily consumption.

Urban consumer awareness about kodo and kutki

The respondents were asked about the knowledge of the two minor millets which are the primary focus of this Project in Madhya Pradesh—kodo and kutki. It was seen that while many of the respondents in Mumbai had knowledge of finger millet, kodo and kutki were not well known. No respondent in the lower income group in Mumbai had heard of these cereals while a small number had heard of them in the middle and high income groups. In Mumbai, the respondents who were aware about kodo and kutki were those who had been instructed to consume food of a low glycaemic value and gluten-free nature. This news was propagated to them either by their dietitians or friends or their condition had led them to research the variety of options which can be used as rice replacement. Still, these minor millets were not a large part of their diets.

The low awareness of kodo and kutki in Mumbai was in stark contrast with the respondents from Bhopal, almost all of whom seemed to be aware of either one or both kodo and kutki. Some respondents in Bhopal mentioned that they had consumed these millets during childhood or some other point, but this had never been a steady part of their diets. Other respondents mentioned that they have seen people consuming them. The lower income group in Bhopal mentioned that they consume minor millets irregularly or not at all due to the non-availability of millets in the city markets.

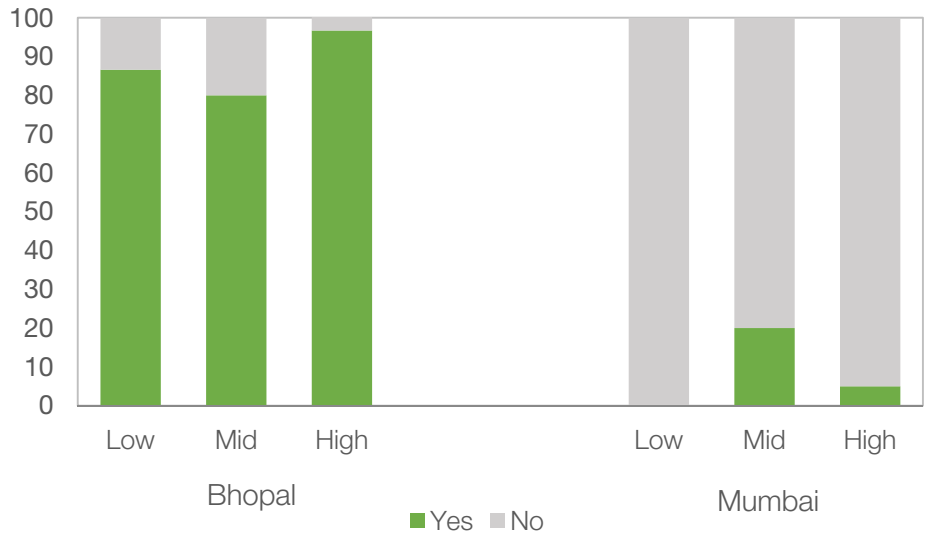

Figure 6. Are you aware of kodo or kutki?

Willingness to use minor millets

All of the respondents were interested in varying their diet if more nutritious options were available. After a short introduction on the nutritional values and health benefits of millets, they expressed how often they might be interest to consume these cereals. Figure 7 shows the potential acceptance of the millets in the diet plans of the consumers. Most of the respondents (80%) were only open to introducing the millets once per week in their diets—especially in Mumbai. Mid and high income respondents in Mumbai were more open to consume these cereals three time a week or more. In Bhopal, a larger number of people across the income categories were open to having the millets as part of their diet three or more times a week. In contrast to Mumbai, the highest interest for millet consumption was seen in the low income group.

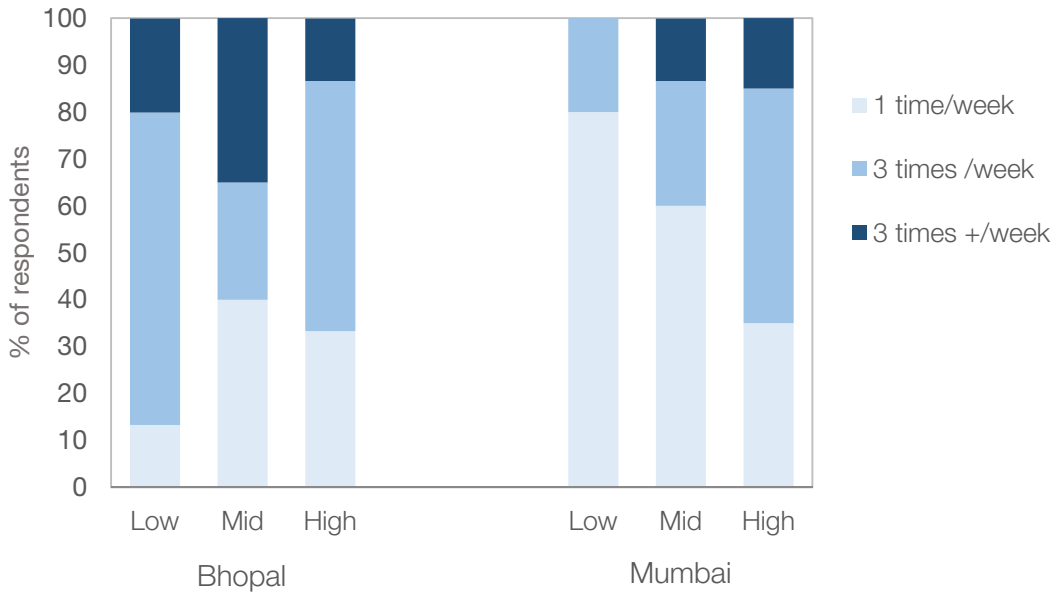

Figure 7. Percentage of People Willing to Cook Using Minor Millets

Willingness to pay for millets

The figure below shows the prices that consumers from the three income groups were willing to pay for a one kilogram package of millet grains. For the middle income group in both cities, the largest number would prefer paying 60-80 rupees. Yet, there was about a 20% of the population in both these areas which was willing to pay between 80 and 100 rupees for the same. A greater percentage of people were willing to pay 100-120 for the millets in Mumbai as compared to Bhopal. For the higher income group the perceived higher prices was not an issue as they mentioned paying higher prices for better quality of basmati rice. However because of the apprehensions attached with consuming such a product for the first time, the respondents, in both Bhopal and Mumbai, found themselves comfortable paying 80-100 for the packaged product.

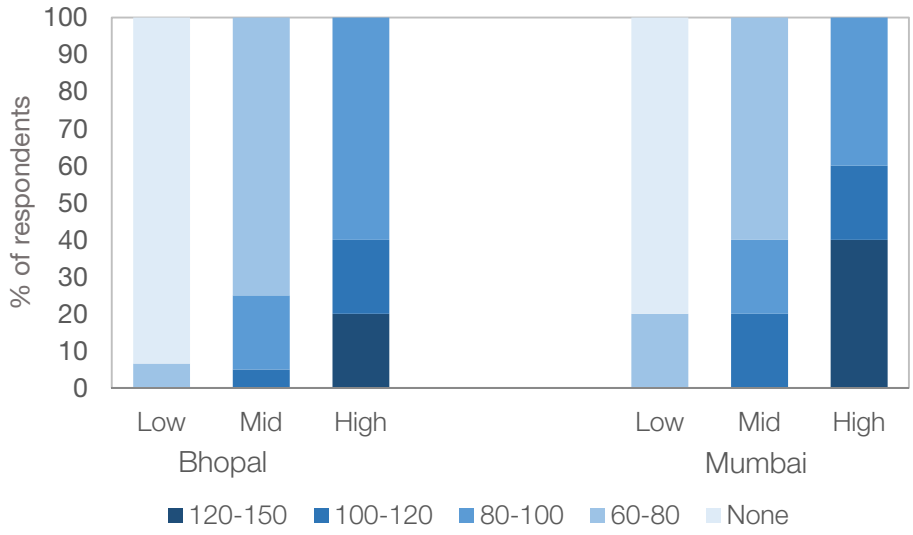

Figure 8. Prices ranges that consumers from different income strata in Bhopal and Mumbai were willing to pay for a one kilogram package of minor millets

Survey of millet vendors and restaurant kitchens

Restaurant kitchens

Out of the five kitchens which were interviewed, none had any items made from major or minor millets in their menus. Regarding their interest in introducing millets to their menus, the chefs responded by saying that the items currently present in the menu were those which were most demanded by the customers and including a specialty item in the menu would be both expensive and incongruent with the theme of their restaurants. The restaurants did not seem very pleased with the idea of introducing millet as a rice replacement option, because they mentioned that their consumers would not be informed enough to order these items. A major cost that the restaurants will have to incur should they choose to adopt millet rice in their menu is that of advertising the product by reprinting signs or menus. Moreover, the restaurants were sceptical of the fact that processed millet rice has a shelf life of only five months. Under the current circumstances where their consumers may not be aware about the products, they mentioned how buying mid-sized quantities of millets may be a sunk investment for them. It was mentioned that that a novelty restaurant specifically dedicated to millets would probably be more successful, considering people would come there specifically to eat items made with millets. This point was brought forward in both cities, however it was mentioned that the probability for success for such a venture would be substantially higher in a Tier 1 City like Mumbai, compared to a Tier 2 city like Bhopal.

Retail stores

The supermarkets surveyed in Bhopal (Apoorti and Reliance) carried major millets yet minor millet rice was not present. In one of the supermarkets, finger millet flour was being sold, yet when questioned the store

staff did not have their inventory details on the product or how frequently the product was purchased. The staff of the retail outlet mentioned that they will not particularly have problems displaying and selling small quantities of minor millet items if they are provided them in a timely manner, yet they want a take-back assurance. For creating in-store marketing and point of purchase stands or shelves, they pointed out that there may be a cost component attached.

In Mumbai, in the two stores visited, there was a general abundance of millets and coarse grains in both grain and flour form. Both of the stores surveyed (Godrej Nature's Basket and Sahkari Bhandar), located in the South Mumbai area, mentioned that they saw many customers who prefer eating food which is healthy in nature. The brand names which they were carrying were either organic or naturally produced. These food items were placed differently from the normal cereals and had a dedicated shelf area. There was finger millet in large quantities and foxtail millet was also seen. While one of the stores carried both kodo and kutki (under the names *vargu* and *samai*) they mentioned that the sale of the products was low as the store itself had very few steady customers.

What was remarkable in the stores in the two sites was a mention about who it is from the family that comes into the store to undertake shopping activities. The four stores had different demographics which were constant visitors. The smaller supermarket mentioned that often household helps come to the store to do the shopping activities, while in the hypermarket it is the consumer themselves that come. In Mumbai, it was mentioned that both helps and householders alternate in their visits to the market. This is notable because it may be more difficult to build a consumer awareness model in the in-store facility when the persons who come to the store, the helps, do not possess decision making authority in the kitchen.

Discussion

Role of minor millets in rural diets in eastern Madhya Pradesh

The diets of the communities surveyed in Mandla and Dindori blocks of Madhya Pradesh were heavily concentrated on cereals. The most common cereals consumed in all the blocks were rice and maize. Millets were consumed in smaller amounts by households in Dindori and very infrequently by households in Mandla. There was indication that millets have been declining in use and especially in Mandla where the landscape in Mandla is more suitable to rice cultivation. The blocks in Dindori have more marginal, steep lands that cannot deliver good rice yields and are more cut-off from the markets. As such, millet cultivation and consumption have remained a more prominent feature of their livelihoods. However in all sites the increasing availability of rice either from their own production or the PDS was a factor that was demotivating women to carry out the difficult processing that is required for millet consumption.

Kodo and kutki millet provide comparable levels of many nutrients to other cereals and they provide higher levels of some key nutrients (Annex 1). The high fibre, iron and fat content of millets made a notable contribution to diets in Dindori district. Nonetheless, millets and cereals in general are much poorer sources of protein, fat, and micronutrients as compared to other food groups. The contribution of iron and calcium to the diet from millets paled in comparison to the intake from leafy vegetables, which are a big part of the diet. Generally, the villagers consume leaves of plants like mustard, chakora, lentils, and others depending

on their seasonal availability. The mineral contribution from millets may be more critical in other seasons when leafy vegetables may be less abundantly consumed. However, a stock of dried leaves is stored for consumption in the off-season when the plants are not growing.The mineral content of millets may in fact be more critical for urban consumers who do not have access to the forest-collected vegetables that showed very high contributions of calcium and iron to the diets in rural Madhya Pradesh.

According to the very coarse estimates made in this study, energy content of the household diets in Mandla and Dindori was below required levels. Acknowledging many limitations with the methodology applied for calculating household intake and nutrient requirements, the estimates still show a broad trend of energy poor diets that is also supported by the poor nutrition status of the local populations. Millets could be key in increasing energy intake for these communities as they produce well on marginal soils and under difficult weather conditions, so can increase cereal availability. The lower glycaemic index of millets is also a factor that enables a slower release of energy compared to rice (Neelam et al 2013). It was common to hear from the farmers that their energy levels have decreased substantially since they stopped eating millets and increased their rice consumption and they noted that consumption of millets keeps them full for a longer period of time, as compared to the consumption of rice. Other energy-rich foods, like oils, pulses and meats will also be important for improving diet quality as very low levels of consumption were seen for these food groups. Due to the Hinduization of much of the tribal population, they have started moving towards vegetarianism and oils and pulses were also consumed in small amounts. Although protein intake was meeting daily intake requirements by the calculations made here, it is noted that this analysis did not consider the intake of specific amino acids, some of which are lacking in cereals and must be obtained either from pulses or meats. The key to good nutrition will be creating variety among the staple foods.

Role of minor millets in urban diets in Bhopal and Mumbai

Awareness about kodo and kutki millets was high in Bhopal because the crops are grown in the region but their consumption was nearly non-existent in this urban population. By contrast, in Mumbai, few people were aware of kodo and kutki because they are not commonly grown in the region, but there were some people aware of these cereals who were occasionally eating minor millets for health reasons. Most of the minor millet consumers in Mumbai were from middle and high income households. Millets have often been considered as ‘food of the poor’ which has posed a barrier to their wider use and promotion. However, the results of this study show that as health benefits of millets are becoming better known to urban populations this stigma is starting to be overcome. In Bhopal, awareness of the health benefits of kodo and kutki was limited so there would be scope to increase demand for these cereals by raising their awareness on health benefits. This potential for increasing use of millets in Bhopal is also supported by the greater interest seen in this city for introducing these cereals into their weekly diets on a more frequent basis than was seen in Mumbai.

Integration of millets in PDS should occur with the implementation of the National Food Security Act (2013), which will be an important factor to motivate consumption of millets among lower income consumers in both Bhopal and Mumbai. While respondents in lower income brackets were open to changing their diets for more nutritious options, this could not be the case with the respondents from the lower income groups. The reason for this is because the folks near and below the poverty line would have easy access to the grains available from the PDS at very cheap prices. Because the minor millets in consideration are not

included in the PDS of either of the two locations, it would not be possible to compete with the price factor of rice and wheat for the consumers below the poverty line.

Middle and higher income consumers were more willing to pay for millets. However, the prices they were willing to pay (from 60 to 150 INR per kg) were lower than many of the prices that were found for kodo millet in an online search (between 100 and 200 INR per kg; Annex 3), which was the way most consumers of minor millets in Mumbai had obtained them. The prices for millets are higher than rice evidently given the difficult processing of the millet products and the comparatively smaller economies of scale to rice. With development of the supply and value chain for these products the price could decrease to a level more acceptable to middle and high income urbanites.

Conclusion

This study revealed the current role, perceptions and potentials to promote millet consumption among some rural and urban consumers in India. It was seen that millets were declining in use among rural households in eastern Madhya Pradesh largely because of increasing availability of subsidized rice and wheat from the PDS and difficulties in processing the minor millets. Diets in the focal communities were dominated by staple cereals and were low in energy and fat. Although millets have some outstanding nutrition values it was seen that these cereals alone cannot satisfy the dietary needs and should thus should be made an important component of the diet, not the only component of the diet.

Enhancing demand for millets through public procurement and rising consumer demand in rural and urban areas can generate economic incentives and benefits for producers on marginal lands, while supporting more resilient, nutritious agriculture. In the light of the foregoing, it can be said that the marketing of the minor millets is a multidimensional problem which will have to assume a multidimensional approach to tackle. Addressing difficulties in processing is a key issue for promoting consumption of millets among rural consumers. Promoting millets for their nutritional values and higher quality compared to rice from the PDS is another key avenue for encouraging their use among communities in Mandla and Dindori. Implementation of the National Food Security Act (2013) to introduce millets in the PDS can be key in increasing consumption of millets among lower income urban households, as well as among rural consumers. The PDS would be particularly useful for millet promotion if this supply can overcome the challenges in processing by providing processed grains. Building supply and organization of the value chain could be fundamental for bringing the millets to a more acceptable price point for mid and high income consumers in urban centres. Because there is little awareness about the product in Mumbai and knowledge is being lost in the populations surveyed in Madhya Pradesh, it will be difficult to break the current cultural norms and start or reinitiate consumption of this grain. However, in the past few years, there have been observable changes regarding culture of consumption of oats and muesli among the Indian middle and upper classes. Hence, the way the product is promoted will be important in determining whether a new cultural setup can be introduced. The ideas which will have to be leveraged are the health, social, environmental aspects of the product. As was in the case of quinoa, a worldwide awareness rise about the grain could be extremely helpful in marketing of the product, which helps modify the cultural and environmental setup.

References

Census of India (2011) District Census Handbook (Dindori)

Chandel, G., Meena, R.K., Dubey, M., and Kumar, M. (2014) Nutritional properties of minor mllets: Neglected cereals with potentials to combat malnutrition. *Current Science* **107**(7): 1109-111.

Chauhan, D. Shrivastava, A.K. and S. Patra. (2010) Diversity of leafy vegetables used by tribal peoples of Chhattisgarh, India. International Journal of Current Microbiology and Applied Sciences 3(4):611-622.

Choudhary et al (2013) Nutritional profile of cultivated and wild jute (*Corchorus*) species. *Australian Journal of Crop Science* 7(13): 1973-1982

Directorate of Health Services (2007) Health Institutions in Madhya Pradesh [Online resource] Available from: http://www.health.mp.gov.in/institution/health-institutions.pdf

Forest Services of India (2011) India State Forest Report [Online resource] Available from: http://www.mpforest.org/pdf/ISFR_2011.pdf

Gopalan, C. Rama Sastri, B.V., Balasubramanian, S.C. (1971). Reprinted 1984. *Nutritive Value of Indian Foods*. Hyderabad: National Institute of Nutrition, 204 pp

Islam, M.M. (2013) Biochemistry, medicinal and food values of Jute (*Corchorus capsularis* L. and *C. olitorius* L.) leaf: A review. *International Journal of Enhanced Research in Science Technology & Engineering* **2**(11): 35-44

Mandla District Administration (nd) Mandla District Administration Website [Online resource] Available from: http://mandla.nic.in/District.htm

Misra, S. and Misra, M.K. (2014) *J. Nat. Prod. Plant Resour* **4**(1):23-28

Neelam, Y., Kanchan C., Singh, A., and Gupta, A. (2013) Evaluation of hypoglycemic properties of kodo millet based food products in healthy subjects. *Iosr Journal of Pharmacy* **3**(2): 14-20.

NIN (2009) *Nutrient requirements and recommended dietary allowances for Indians: A Report of the Expert Group of the Indian Council of Medical Research*. Hyderabad; National Institute of Nutrition.

Shukla, A.N., Srivastava, S., & Rawat, A.K.S. (2010) An ethnobotanical study of medicinal plants of Rewa district, Madhya Pradesh. Indian Journal of Traditional Knowledge 9(1): 191-202.

Vishwakarma, K.L. and Dubey, V. (2011) Nutritional analysis of indigenous wild edible herbs used in eastern Chhattisgarh, India. *Emir. J. Food Agric.* **23**(6):554-560

Annexes

Annex 1. Nutrient content of crops consumed in rural eastern Madhya Pradesh

Table 7 shows the nutrient values for crops consumed in the weekly diets of households in Mandla and Dindori district derived from Gopalan et al (1971), with the exception of Corchorus as noted. As multiple entries for different crops were available, the specifc values used are indicated. These entries were selected based on the knowledge of how the crops were consumed locally. The species of amaranth that were consumed were not specied. A study of tribal communities in nearby Chattisgarh revealed they were using four species of amaranth leaves (Chauhan et al 2014), so the average value for these species was used for the current analysis.

Table 7. Nutrient values per 100 g of crops consumed in weekly household diets in Madhya Pradesh

Species	*Value used*	*Protein (g)*	*Fat (g)*	*Fibre (g)*	*Energy (Kcal)*	*Calcium (mg)*	*Iron (mg)*
Cereals							
Oryza sativa	Rice raw milled	6.8	0.5	0.2	345	10	0.7
Zea mays	Maize dry	11.1	3.6	2.7	342	10	2.3
Triticum aestivum	Wheat flour (whole)	12.1	1.7	1.9	341	48	4.9
Paspalum scrobiculatum	Varagu	8.3	1.4	9	309	27	0.5
Panicum sumatrense	Samai	7.7	4.7	7.6	341	17	9.3
Pulses							
Cicer arietinum	Bengal gram whole	17.1	5.3	3.9	360	202	4.6
Lens culinaris	Lentil	25.1	0.7	0.7	343	69	7.6
Leafy vegetables							
Amaranthus sp.	Average of A. gangaticus (tender), A. spinosus, A tristis and A viridis.	3.75	0.38	2.73	42.5	472.75	20.9
Brassica juncea	Mustard	4	0.6	0.8	34	155	16.3
Corchorus sp.	*Corchorus trilocularis**	8.7	3.54	17.46	280	298**	**75.2**
Cassia tora	Fetid cassia fresh	5	0.8	2.1	49	520	12.4
Other vegetables							
Solanum tuberosum	Potato	1.6	0.1	0.4	97	10	0.5
Solanum melongena	Brinjal	1.4	0.3	1.3	24	18	0.4
Brassica oleracea	Cauliflower	2.6	0.4	1.2	30	33	1.2

* Nutrient values taken from Vishwakarma and Dubey 2011. Different species of Corchorus are used in India with different nutrient values (e.g. Choudhary et al 2013; Misra and Misra 2014), so uncertainty with these values is noted.
** Value for calcium for Corchorus taken from Islam 2013

Annex 2. Daily nutritional requirements

Table 8 outlines some of the major nutrients and their requirements by the different age and sex groups in NIN 2009. Because in rural areas there is greater requirement for work, the categories presented and used in the analysis in this study were specifically for those that carry out heavy work.

Table 8. Major nutrients and their requirements by the different age and sex groups in NIN 2009

Group (Heavy Work)	*Body Weight (kg)*	*Energy (kcal/d)*	*Protein (g/d)*	*Fat (g/d)*	*Calcium (mg/d)*	*Iron (mg/d)*	*Thiamine (mg/d)*	*Riboflavin (mg/d)*	*Niacin (mg/d)*
Man	60	3490	60	40	600	17	1.7	2.1	21
Woman	55	2850	55	30	600	21	1.4	1.7	16
Pregnant Woman	55	3200	82.2	30	1200	35	1.6	2.0	18
Lactating	55	3370	77.9	30	1200	25	1.7	2.1	20
Infants	8.4	80	1.69	19	500	05	0.3	0.4	650 µg/kg
Children	18	1350	20.1	25	600	13	0.7	0.8	11
Boy	47.6	2750	54.3	45	800	32	1.4	1.6	16
Girl	46.6	2330	51.9	40	800	27	1.2	1.4	14

Energy is needed to maintain temperature and metabolic activity, and carry out physical activity and growth. To maintain the balance, the input must equal the output. This need not happen on a daily basis because energy can be stored as fat.

Proteins are essential for growth and new tissue formation. Additional proteins are required during pregnancy and lactation period. The amino acids that they provide are important for synthesizing muscles.

Fats are essential to provide energy and for absorption of fat soluble vitamins. Fat enhances the flavor of food and reduces gastric emptying. Fat also helps store energy, and considering the population faces a malnutrition issue.

Fiber was viewed as a non-nutrient, but more recently its value in food has come into light. Fibers are those components of the diet which remain are resistant to digestion and absorption in the small intestine. They help maintain laxation and blood cholesterol.

Calcium is present in the bones, and an adult male of 60 kg has 1 kg of calcium in his body. Calcium is require for growth in children, and thus for lactating women. Calcium intake is required due to loss of calcium in urine, stool, bile and sweat. Calcium is essential for the Indian women who are highly susceptible to osteoporosis.

Iron: Anemia due to iron deficiency is among the top health issues in India affecting nearly 50 to 70% of the population. The problem affects both men and women in the country, and despite efforts there have been little decline seen[12]. Women above the age of 15 are more prone of iron deficiency issues.

Thiamine, riboflavin, and niacin constitute the important water soluble vitamins needed for the body. They play an important role in lipid and carbohydrate metabolism. Riboflavin is involved in antioxidant activities. A lack of riboflavin also affect the iron abortion and a greater risk of anemia. Niacin is important in tissue respiration and creation of macromolecules.

Annex 3. Prices of millets

Table 9 shows the average prices for the kodo millet as it is available on the online market of Amazon.com. Most of these products are certified organic products.

Table 9. Prices for 500g Packets of Organic Kodo Millets (Date: March 15th 2016)

Brand	*Price (INR)*
24 Mantra	95
BSP	65
Miltop	100
Amritha	52
4M Enterprises	100
Ekgaon	89

Bioversity International is a
member of the CGIAR Consortium.
CGIAR is a global research
partnership for a food-secure future.