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National Food Security Act Supports Climate Smart Agriculture in India by Stimulating the Sourcing of Small Millets

*An Evaluation of Bioversity's Efforts to Promote
Small Millets in India*

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Table of contents

EXECUTIVE SUMMARY	4
INTRODUCTION	6
BACKGROUND	8
THE IFAD-NUS PROJECT	8
THE BIOVERSITY-MSSRF COLLABORATION	9
THE NATIONAL FOOD SECURITY ACT OF 2013	10
<i>Box 1. Policy Precursors to the National Food Security Act</i>	11
PROJECT INTERVENTIONS	13
GENETIC CONSERVATION	13
AGRONOMIC INTERVENTIONS	14
SEED PRODUCTION AND MANAGEMENT	14
HOUSEHOLD CONSUMPTION AND MARKETING	15
OUTCOME ANALYSIS	17
TREATMENTS	17
BOX 2. DATA COLLECTION	18
AREA	19
PRODUCTION AND SALES	20
CONSUMPTION	21
INCOME	22
DISCUSSION	24
KEY FINDINGS	24
IMPLICATIONS	25
<i>Table 1. IFAD-NUS Grants, 2001-2018</i>	27
<i>Table 2. Methods, Tools, and Key Achievements of the Bioversity-MSSRF Project</i>	28
<i>Table 2 (cont'd)</i>	29
<i>Table 2 (cont'd)</i>	30
<i>Table 3. Seed Bank Transactions in Kolli Hills, 2001-2014 (kg)</i>	31
<i>Table 4a. Number of Households that Participated in Various Interventions, Kolli Hills</i>	32
<i>Table 4b. Number of Households that Participated in Various Interventions,, Kundura</i>	32
<i>Table 5a. Mean Area Under Different Crops in Kolli Hills (acres)</i>	33
<i>Table 5b. Mean Area Under Different Crops in Kundura (Kundura)</i>	34
<i>Table 6. Number of Farmers Growing Cereals and Average Area Cultivated Among Growers</i>	35
<i>Table 7a. Mean Production of Different Crops in Kolli Hills (kg)</i>	36
<i>Table 7b. Mean Production of Different Cereals in Kundura</i>	37
<i>Table 8. Size distribution of finger millet production</i>	38
<i>Table 9. Average Millet Sales</i>	38
<i>Table 10a. Mean Monthly Cereal Consumption in Kolli Hills (kg)</i>	39
<i>Table 10b. Mean Monthly Cereal Consumption in Kundura (kg)</i>	40
<i>Table 11a. Mean Annual Income from Various Sources in Kolli Hills (2010 Rupees)</i>	41
<i>Table 11b. Mean Annual Income from Various Sources in Kundura (2010 Rupees)</i>	42

<i>Table 12a. Participation and Mean Annual Income from Value-added Products in Kolli Hills (in 2010 Rupees)</i>	43
<i>Table 12b. Participation and Mean Annual Income from Value-added Products in Kundura (in 2010 Rupees)</i>	43
<i>Figure 1. Interventions of note in study villages</i>	44
<i>Figure 2. Timeline of Key Activities in Study Villages, 1999-2018</i>	45
REFERENCES	46
ANNEX A: CONTACTS	47

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EXECUTIVE SUMMARY

This study evaluates key outcomes associated with Bioversity's work promoting minor millets in India. That work, part of a broader IFAD-funded effort to promote neglected and underutilized species globally, has been pursued jointly with the MS Swaminathan Research Foundation (MSSRF), as well as with other partners. The Bioversity-MSSRF project has been on-going since 2001 and currently is in its fifth multi-year "phase."

Bioversity's interests in promoting neglected and underutilized species (NUS) generally, and minor millets in India specifically, relate to its core missions of conserving genetic resources, promoting biodiversity, and enhancing the welfare of limited resource farmers. Millet production in India has been declining for decades, replaced by other cereals (especially wheat and rice) or cash crops. Inter alia that meant a corresponding decline in the genetic diversity of the millets being produced, as well as the diversion of agricultural research resources toward more favored crops. Both of these tended to widen pre-existing gaps in the well-being of millet farmers vis-à-vis farmers in other, more favored production environments.

This evaluation was intended originally to examine outcomes from a particular policy achievement that is very much linked to the research and extension activities associated with the Bioversity-MSSRF project—namely, a key provision of India's National Food Security Act of 2013 that mandates millets as a scheduled commodity in India's public food distribution system. Specifically, the National Food Security Act established an enabling environment for government procurement of millets for purposes of distribution (through its Public Distribution System) to the hundreds of millions of India's poorer citizens. Clearly, this represents a potentially huge positive shock to overall demand for millets, with attendant benefits to millet producers.

However, early on in the course of this evaluation it became clear that those potential benefits are yet to materialize. Only one state (Karnataka) has actually incorporated millets into its public distribution system, and procurement of meaningful quantities only occurred in one year (2015) due to poor harvests in subsequent years (Rajshekar and Raju 2017). In short, it was determined that evaluating the outcomes of the National Food Security Act would be premature at this time.

Instead, the current evaluation describes key outcomes attributable to the efforts of the Bioversity-MSSRF project that have occurred in the sites in which the project was implemented. Village-level and household outcomes related to agricultural production, consumption, marketing, and income are analyzed. The basis for those analyses lies in a farm household data set that was collected in the summer of 2018 from two locations in southern India where Bioversity-MSSRF teams have been conducting research since the project's beginning. The survey used was based on similar surveys that were administered in 2007 and 2010 (at the beginning and end of Phase II of the Bioversity-MSSRF project).

Comparison of the 2018 data with the earlier data reveals that the many interventions promulgated by the Bioversity-MSSRF project have contributed to the scale, productivity, and diversity of millets production in the villages in which those interventions were undertaken:

- Generally speaking, uptake of improved agronomic practices was substantial and sustained, involvement in participatory varietal selection activities was extensive, and seed bank use was widespread.
- The importance of millets—as indicated by the number of farmers choosing to cultivate them and/or the variety in different types of millets cultivated—has risen over time.

- While finger millet continues to be the dominant type of millet grown in both locations, the area and production of little millet has increased significantly, particularly in one of the two study locations.

These findings bespeak significant success on the part of the Bioversity-MSSRF partnership in reaching key goals motivating the project—augmenting dwindling stocks of local genetic resources (through expanding the types and varieties of millets grown); and arresting the decline in the production of minor millets in India. At the same time, however, it is important to note that in both study locations, the scale of millet production is small by any reasonable standard. Farm sizes are small, and the footprint of millets on those farms—both in terms of area and output—remain relatively small compared to other crops grown.

Regarding contributions of millet production to income, the data are similarly quite clear that millets occupy a much less important position than other livelihood sources—both on-farm and off-farm—in both study areas. The composition of household earnings from agriculture production varies substantially from location to location. But the relative unimportance of millets' contribution to household overall earnings is consistent across areas. And while substantial fractions of households had engaged in value-addition, in the both areas earnings from value-addition were similarly modest in 2018. Finally, the evidence indicates quite clearly that rice remains, by far, the most important food consumed by surveyed households.

INTRODUCTION

This study evaluates key outcomes associated with Bioversity’s work promoting minor millets in India. That work, part of a broader IFAD-funded effort to promote neglected and underutilized species globally, has been pursued jointly with the MS Swaminathan Research Foundation (MSSRF), as well as with other partners. The Bioversity-MSSRF project, as I will refer to it throughout this document, has been on-going since 2001 and currently is in its fifth multi-year “phase.”

Bioversity’s interests in promoting neglected and underutilized species (NUS) generally, and minor millets in India specifically, date back to when it was known as the International Plant Genetic Resources Institute (IPGRI). Those interests relate to the Institute’s core missions of conserving genetic resources, promoting biodiversity, and—because millets in India tend to be grown in less-favored production environments by poor people—enhancing the welfare of limited resource farmers. As in other parts of the world, millet production in the sub-continent had been declining for decades, replaced by other cereals (especially wheat and rice) or cash crops (Grovermann, et al. 2018). Inter alia that meant a corresponding decline in the genetic diversity of the millets being produced, as well as the diversion of agricultural research resources toward more favored crops. Both of these tended to widen pre-existing gaps in the well-being of millet farmers vis-à-vis farmers in other, more favored production environments. Arresting and/or reversing these trends was identified as a means of achieving those missions (Bala Ravi, et al. 2010).

It bears mention at the outset that this current evaluation was intended originally to examine outcomes from a particular policy achievement that is very much linked to the research and extension activities associated with the Bioversity-MSSRF project—namely, a key provision of India’s National Food Security Act of 2013 that mandates millets as a scheduled commodity in India’s public food distribution system. Specifically, the National Food Security Act established an enabling environment for government procurement of millets for purposes of distribution to the hundreds of millions of India’s poorer citizens. Clearly, this represents a potentially huge positive shock to overall demand for millets, with attendant benefits to millet producers.

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Comparison of the 2018 data with the earlier data provides insights into the extent to which the Bioversity-MSSRF project has met the “meta-goals” of promoting genetic conservation of millets and improving livelihoods of limited resource millet farmers. It also enables us to make some salient observations on the

extent to which future demand increases for millet—e.g., due to government procurement for the PDS—may be met by the limited resource farm households that currently account for the bulk of millets production in India.

Carrying out this evaluation involved meeting with Bioversity and MSSRF personnel who had been involved in the project over the years; reviewing written outputs of the research; extensive email exchanges and telephone conversations with individuals having knowledge of the various research activities; and a field visit to India in December 2017. Interlocutors during the field visit included current and former Bioversity and MSSRF staff, government officials, academics, members of the international donor community, and villagers in one of the two study locations (Kolli Hills). Annex A provides a listing of these individuals.

The report is laid out as follows. The following section provides background information on the project. This section also discusses the National Food Security Act, focusing particularly on how the Bioversity-MSSRF project contributed to its salutary provisions with respect to millets. Following this, I explore the changes that have occurred in the study areas. Section 3 describes the various interventions that were promoted. Section 4 examines key village-level outcomes. The concluding section summarizes key findings and discusses what these outcomes imply as regards the welfare effects of future demand increases for millets on the kinds of limited resource millet farmers impacted by the Bioversity-MSSRF project.

BACKGROUND

The IFAD-NUS Project

Bioversity's collaboration with MSSRF on neglected and underutilized species (NUS) began in February 1999 when MSSRF hosted an IFAD-supported workshop on NUS at their headquarters in Chennai. That meeting, entitled "Enlarging the Basis of Food Security: The Role of Underutilized Species," was held under the auspices of the CGIAR's Genetic Resources Policy Committee, and was attended by representatives from IFAD (among other selected donors).

Subsequent to that meeting, IFAD indicated its support of a comprehensive global effort to promote research on neglected and underutilized species, as well as the extension of that research to various stakeholders (farmers, researchers, policymakers). Shortly thereafter, Bioversity—then the International Plant Genetic Resources Institute (IPGRI)—organized three regional exploratory workshops. Out of this background work emerged the first of several phases of a long-term program of grants from IFAD to a variety of institutions for purposes of promoting so-called "Neglected and Underutilized Species. Those grants continue to fund research undertaken by the Bioversity-MSSRF team up to the present (Table 1).

The IFAD-NUS grants target the conservation and use of neglected and underutilized species in Latin America, South Asia and Western Asia. Targeted crop species included Andean grains (quinoa and amaranth); medicinal and aromatic plants in West Asia; and minor millets¹ in South Asia. All of these target crops played a key role in nutritional security and/or income generation for specific limited-resource—and frequently culturally disadvantaged—rural populations.

As in other locations, the work on minor millets in India has been guided by a 'holistic value chain approach' that "sought to improve sustainability of production and income generation from target crops, as well as to secure nutrition benefits for local communities to achieve livelihood and conservation outcomes" (Bioversity International 2007). This has given rise to a range objectives—and attendant mechanisms for reaching them—across multiple dimensions (Bioversity International 2018):

- Increase the contributions of millets to **improved livelihoods**. The mechanisms for achieving this objective centered on promoting best agricultural practices for sustainably increasing productivity, maintaining local biodiversity, enhancing the capacities of stakeholders in value-adding technologies, and strengthening value chains within which millets and millet-based products are marketed.
- Identify the contribution that key species can make to **dietary diversity and to improved nutrition**, particularly in children and expectant women. In the case of millets in India, this included promoting small-scale technologies for processing millets that require substantially less effort on the part of women.

¹ Minor millets grown in India include finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), proso millet (*Panicum miliaceum*), kodo millet (*Paspalum scrobiculatum*), little millet (*Panicum sumatrense*), and barnyard millet (*Echinochloa colona*) (Riley, et al. 1993, pg. 557). Of these, finger millet is by far the most widely grown and has been the subject of most attention by crop breeders (including ICRISAT). Note that pearl millet is not considered a "minor millet." Throughout this report, I use the term "millets" to refer to the group of minor millets noted above.

- Integrate minor millets into an increased range of production systems, ensuring their improved use and **biodiversity maintenance** in these systems
- **Conservation of genetic resources** of millets, both on-farm and *ex-situ*.

Support the development of multi-sectorial **national policies** to promote an enabling environment for conservation, production, and profitability of millets, as well as to strengthen collaboration among institutions working on millets.

The Bioversity-MSSRF Collaboration

Bioversity's work on millet in India has been conducted in complete partnership with the MS Swaminathan Research Foundation. MSSRF entered that partnership having been involved in a variety of development projects in millet-growing areas.² These projects were centered around community development and women's empowerment, particularly as they related to the well-being of the limited-resource, culturally disadvantaged groups who remain the primary millet cultivators in India. In practical terms, this meant that MSSRF had solid working relationships with a large number of stakeholders multiple communities in many millet-growing regions.³

For its part, Bioversity brought a significant catalytic role, both scientifically and organizationally. On the science side, Bioversity provided a guiding hand in terms of overall research strategies, methodologies and approaches, monitoring of research activities, and synthesis of results. Organizationally, Bioversity facilitated collaborative partnerships with a variety of research institutions in academia, the CGIAR, government and the NGO sector.

The Bioversity-MSSRF collaboration sought to meet the objectives listed above by (a) developing networks providing participatory systems and procedures to support the improved production and use of millets; (b) forming operational alliances among selected network partners to overcome production and marketing constraints (e.g. seed supply systems, processing groups, distribution cooperatives); (c) linking to existing rural and economic development projects where millets contribute to incomes and nutrition; (d) increasing the capacity of marketing associations and producer groups linked to millets; and (e) raising awareness among policy-makers of issues and options for improved policies and laws affecting millets (IPRGR 2000).

A comprehensive overview of the many activities, achievements, and partners in the Bioversity-MSSRF project are laid out in Table 2, which is an adaptation of a somewhat more comprehensive listing in Padulosi, et al. (2015). The outcome analysis reported in Sections 4 and 5 presents information on the cumulative effect of these various activities.

² It should be noted that Bioversity has worked closely with other institutional partners as well in its efforts to promote millets in India. These include the Indian Council on Agricultural Research (ICAR), Action for Social Advancement (ASA), University of Ranicharui, and the Gene Campaign (Stefano Padulosi, *pers. comm.*).

³ Institutionally, MSSRF tends to orient its efforts more toward development and extension activities than research *per se*, according to several sources. By this accounting, the project's focus on the community development and women's empowerment issues were more in MSSRF's bailiwick, whereas facilitating research on farm-level productivity or production enhancement lay more in the wheelhouse of Bioversity.

The National Food Security Act of 2013

The National Food Security Act (NFSA) of 2013 enacted a sweeping rearrangement of India's Public Distribution System (PDS)—a keystone of India's social safety net for its hundreds of millions of eligible, poor people. The headline feature of the NFSA is that it institutionalized an entitlement of 5 kg per person per month for up to 75% of rural dwellers and 50% of urban dwellers.⁴ Subsequent refinements to the law, formalized in April 2018, explicitly mandated inclusion of sorghum, pearl millet, and minor millets into the Public Distribution System (PDS) and directed all States to take the necessary actions for incorporating those species into each state's food distribution programs.

Of key interest here is the fact that millets were included with rice and wheat as grains to be procured by the government and distributed through the PDS. This, of course, represents a potentially huge increase in demand for millets. In addition to changes to the PDS and the system of procurement that underpins it, the NFSA addressed a range of other safety net programs, most notably operation of Mid-Day (school) Meal scheme and the Integrated Child Development Services program serving pregnant women, lactating mothers, and children under 14 years of age. These, too, represent potentially very large sources of institutional demand for millet.

Inclusion of millets in the PDS represented the culmination of years of effort to promote millets by, among others, individuals associated with the NUS project under consideration here (see Box 1). In particular, Professor Swaminathan himself was a tireless advocate for millets. His advocacy was particularly effective due to his prominence as the "Father of the Indian Green Revolution," as well as his political connections (he served as a member of Parliament from 2007-2010, and chaired India's National Commission on Farmers from 2004-2014). But there is no doubt that the research-based evidence on the nutritional, environmental, and economic benefits of millet production developed as part of the NUS project greatly focused the power and persuasiveness of those advocacy efforts as well (e.g., Bioversity 2007; King, Nambi, and Nagarajan 2008; Padulosi, et al. 2009; Bhag Mal, Padulosi, and Bala Ravi 2010; Padulosi, et al. 2015).

The research forming the basis for these advocacy efforts touched on the various dimensions along which millets are superior dominant cereals cultivated in India (rice and wheat). These included:

- **Production benefits** – millets mature quickly, grow well under varying day lengths and soil quality.
- **Environmental benefits** – millets are less water-intensive than rice and wheat, and hence are less sensitive variable weather conditions than other cereals. They tend to be grown in rainfed conditions, so do not put pressure on groundwater resources like irrigated crops. They are also typically cultivated with minimal fertilizer inputs.

⁴ Note that under the NFSA, millions of below-the-poverty-line households covered under the pre-existing Antyodaya Anna Yojana program would continue to be eligible to receive their larger entitlements of up to 35 kg per household per month. Note further that the NFSA included a number of provisions related to logistics, organization, operation, and institutional accountability, all of which betokened an expansion of India's food security safety net (Government of India 2013).

- **Nutritional and health benefits** – compared with other cereals, millets possess superior nutritional characteristics due to greater availability of minerals, polyphenols, anti-oxidants, and soluble fibers.⁵
- **Social benefits** – millets are generally grown by limited resource—and commonly, socially disadvantaged (lower caste) farmers living in marginal production environments.

Box 1. Policy Precursors to the National Food Security Act

Key members of the Bioversity-MSSRF collaboration can credibly lay claim to having played an important role in the formation of several national agricultural policies related to plant genetic resources for agriculture (GPRFA).

- Biological Diversity Act of 2002
- Protection of Plant Variety and Farmers' Rights Act (PPV&FR Act) 2001
- Patents Act (most recently amended in 2005)
- Modifications to the Seeds Act (1966)
-

A recent paper by Notaro et al. (2017) discusses each of these specific policies in greater detail. In brief, these pieces of legislation represent successive (clarifying) components of the legal framework governing intellectual property rights in the areas of biodiversity and plant varietal protection.

Importantly, millets were included in the roster of covered crops in these Acts—in very large measure due to the persuasiveness and political influence of Professor Swaminathan himself. Indeed, one well-placed interlocutor contended that the “master plan” of Prof. Swaminathan was first to promote institutionalizing biodiversity protections—in the form of the Biodiversity Act and the PPV&FR Act, and then to promote greater government demand for millets (as manifested in the Food Security Act).

To date, there is no evidence of on-the-ground impacts of these pieces of legislation on growers of millets. I was told by a number of interlocutors that this is because there have been as of yet no legal tests of the IPR protections—i.e., that they remained “on paper” at least as of December 2017. Moreover, it remains highly unclear how to identify—let alone operationalize compensating for access rights—the “owners” of property rights over traditional varieties of millets that have been bred collectively over long periods of time.

While the NFSA was national legislation, it largely left the mechanics of its implementation of the India’s massive food safety net—both procurement and distribution—to individual states. On the demand side, States have substantive authority over:

- determining which households are eligible to participate;

⁵ Dr. Thingngann Longvah, Director of the National Institute for Nutrition (*pers. comm.*)

- what commodities to include in the foods made available to PDS recipients—i.e., whether or not to include minor millets;
- the size composition of food bundles available to PDS recipients (for example, at a PDS shop we visited in Bangalore PDS beneficiaries were entitled to monthly allotments of 5kg of rice and 2 kg of either wheat or finger millet); and
- the (subsidized) prices charged for different commodities made available to PDS recipients.

On the supply side, India's states have long had significant latitude in procurement of grains under the decentralized grain procurement scheme that was introduced in 1997 (Notaro, et al. 2017). In particular, states are authorized to offer commodity-specific premiums over nationally- determined minimum support prices that are announced annually for a range of cereals (including finger millet) and other crops. Such premiums are frequently required in order for State governments to meet procurement targets in a (relatively) timely fashion. Of particular relevance here is the fact that that MSPs for coarse grains (including millets) historically have been set at levels below prevailing market price in most years, and hence have been ineffective (Notaro, et al. 2017).

The NFSA was enacted into law in 2013. Since that time, Karnataka is the only State in India that has incorporated minor millets—specifically, finger millet—into the PDS.⁶ And to date there has only been one year in which meaningful quantities of finger millet were available to through the PDS (2014-15). Poor harvest in subsequent years severely curtailed the Government of Karnataka's ability to procure finger millet, and hence there was virtually none provided to PDS recipients.

Consequently, there is no scope at this time for *ex post* evaluation of the impacts of the NFSA on specific populations of interest; rather, the NFSA represents a source of potential impacts that merit future examination. Of particular interest here would be an evaluation of the extent to which different types of producers and consumers of minor millets will be affected by the NFSA, and by how much. In the next sections of this report, I take steps towards informing such an evaluation with regard to farmers reached by the Bioversity-MSSRF research teams in their work in the Tamil Nadu and Odisha.

⁶ Two other States—Tamil Nadu and Chhattisgarh—have engaged in procurement and distribution of pulses through the PDS. And pearl millet (jowar) has been procured and distributed in a number of states. But in general, rice and wheat are overwhelmingly the dominant commodities transacted through the PDS in all States.

PROJECT INTERVENTIONS

This section describes key interventions undertaken by the Bioversity/MSSRF project in two locations in South India: (a) the Kolli Hills area of Namakkal district, Tamil Nadu; and (b) Kundura tehsil of Koraput district, Odisha. Both locations have been the locus of research and extension activities since the outset of the project.

Kolli Hills is regarded as a secondary center of origin for minor millets. Prior to the initiation of the IFAD-NUS project, the area had seen a steady erosion of both area devoted to millets, and an attendant attenuation of genetic diversity of millet populations (Takeshima and Nagarajan 2012). Kundura is similarly an area in which a number of minor millets were grown historically and in which millet—particularly finger millet—is an important staple. The set of traditional agricultural practices in the Koraput region that includes Kundura has been designated a Globally Important Agricultural Heritage System by the FAO (Down to Earth 2015).

Both the Kolli Hills and Kundura are populated by limited resource farmers; tribal and scheduled castes compose the majority of populations in both areas. When the IFAD-NUS project was initiated, MSSRF had operated in both locations for a considerable amount of time, working directly with those limited resource populations on projects across a variety of areas related to biodiversity conservation, sustainable agricultural production, nutrition, and the building of grass-roots institution (Nampoori and Parida 2015). By all accounts, this pre-existing network of contacts and relationships greatly facilitated relatively smooth implementation the many household level research and extension activities associated with the project.

As noted earlier, the NUS project sought operated on four key dimensions: conserving genetic resources, enhancing the productivity of millet cultivation, promoting increased millet consumption, and facilitating expansion of commercial activity involving millets and millet-based products. Figure 1 provides a summary overview of the types of project interventions and activities related to these four dimensions. Figure 2 presents a rough timeline over which these activities occurred. Specific interventions are described below.

Genetic Conservation

At the initiation of the project, millet production had declined and relatively few varieties were being planted. Interventions related to genetic conservation sought to address this issue by evaluating, testing and promoting utilization of a broader array of germplasm resources. These included the following activities engaged in over the period from 2002 to 2007:

- **Collection and ex-situ storage of samples of local landraces of different millets.** In Kolli Hills these were primarily finger millet, little millet, and foxtail (Italian) millet; in Kundura they included finger millet and little millet.

- **Field testing of 6,000 varieties of finger millet, little millet, and foxtail millet.** In addition to local landraces, accessions of improved varieties were made primarily from ICRISAT's gene bank, but also from the All India Coordinated Small Millet Improvement Project (AICSMIP) and from the holdings of the University of Agricultural Sciences-Bangalore. Field testing of these varieties took place on farmers' fields.
- **Participatory varietal selection (PVS).** Joint—and largely congruent—evaluations by farmers and scientists, identified a number of varieties with desirable characteristics. These included some landraces and some improved varieties, depending on agronomic circumstances. Generally, landraces of little and foxtail millet were found to dominate improved varieties, whereas improved varieties of finger millet were generally favored.

Agronomic Interventions

A variety of participatory crop management experiments gave rise to a set of recommended agronomic interventions. As with PVS, the agronomic trials were conducted on farmers' fields, and subsequent determination of recommended practices were conducted over the period 2002-2010.⁷ Demonstrations on farmers' fields were oriented around comparing improved and traditional practices. Improved practices included the following (Bala Ravi, et al. 2010):

- Use of farmer preferred millet varieties
- Use of quality seed
- Row planting instead of broadcast sowing
- Altered (lower) seeding rates
- Standardized row ratios for intercrops
- Use of farmyard manure or fertilizer
- Regulating plant population density via thinning
- Inter-cultivation and (need-based) top dressing with fertilizers
- Novel intercrop systems—

Seed Production and Management

At the initiation of the project, the variety, quantity, and quality of available millet seeds was identified as a substantial constraint—both on efforts to conserve genetic resources, and on efforts to improve productivity. In response, quality seed production training was undertaken in the early years of the project. Those trainings included lessons on variety characteristics and optimal handling of seeds at various stages of production (harvest, threshing, drying and storage).

Following up on those training activities, the project has actively sponsored and promoted the institution, operation, and management of village seed banks. Seed banks handling quality seed of various types of

⁷ Note, however, that various agronomic field research projects occurred well beyond this period. For example, I observed on-farm pigeon pea-millet intercrop trials and bio-fertilization experiments during a site visit to the Kolli Hills in December 2017.

millet banks have been established in a number of village—typically under the aegis of local, cooperatively-managed self-help groups (SHG's). Seed banks generally operate under a system whereby individuals are required to return 2 kg of quality seed for each kg that they “borrow” from the seed bank. Most seed banks that have been established under the auspices of the project continue to operate to this day. Table 3 provides data on seed bank usage in the Kolli Hills between 2001 and 2014 (comparable data were not available for Kundura). These indicate that with the exception of a few years, seedbanks have been widely used throughout that time period. Most transactions involved little millet, foxtail millet, and finger millet, although small quantities of Kodo and Proso millets also have been transacted, particularly since 2010.

Household Consumption and Marketing

The preceding set of interventions related to millets production and the genetic resources that underpin it. Substantial effort has also been devoted to various aspects of household millets consumption and marketing. These centered around three areas of effort: (a) reducing drudgery associated with processing millet grain; (b) developing an array of millet-based products to be produced and sold from own-produced grain; and (c) nutritional training aimed at promoting in-home consumption of millets and millet-based products. Self-help groups were central to these consumption and marketing interventions. Generally composed of (and run by) women, participation in these SHGs was found to have empowered the participants via improved leadership qualities and enhanced self confidence (Vijayalakshmi, et al. 2010)

Processing. Historically, millets were an important staple in project areas. But household consumption has always been constrained by the fact that processing millet grain into flour by traditional means—i.e., via manual pounding and grinding—is physically demanding and highly time-consuming. The project invested in innovating small-scale processing machinery that was inexpensive and easy for limited resource persons to use. Diffusion of suitable processing machinery to villages was then facilitated by trainings, as well as through the development of cooperative SHG's to operate and manage village grinding mills.

Value-added products. An important driver of project activities is the belief that cultivating sustained demand for millet over the long run is essential to sustaining any advances made on the production side. Consequently, considerable attention was paid to building value chains for millets and millet-based products. At the village level, this involved substantial training of village women in the production of so-called value-added products—e.g., cookies, dumplings, malt beverages, cooked breakfast cereals. The focus of these trainings ranged from recipe development to use of mechanical inputs for production and packaging to marketing, generally under the aegis of dedicated SHG's.

Nutritional training. Training of village women on the nutritional benefits of millet consumption were a standard aspect of value-added trainings noted above. A goal of those trainings was to promote better nutrition (especially of children) via greater household consumption of millet products.⁸ In addition, on-going efforts promote substituting finger millet for rice in school lunches which, aside from promising nutritional

⁸ Interestingly, and somewhat paradoxically, nutritionists involved in these trainings would appear to have been simultaneously promoting two opposing uses (hopefully greater) of millet output: greater own-consumption and greater sales. Such an outcome is possible, of course; it would seem more likely, though, that households would simply gravitate toward one or the other.

benefits to children, would also hold the potential for cultivating an important source of institutional demand for millets.⁹

⁹ The idea of partially substituting finger millets for rice in school lunch programs as a means for the national government to promote (finger) millet value chains was a common discussion point in conversations with many persons interviewed during field visits, including the Secretary to the Minister of Agriculture, Dr. S.K. Pattanayak.

OUTCOME ANALYSIS

In this section I present information on village-level outcomes from a variety of interventions implemented by the Bioversity-MSSRF team in five villages in the Kolli Hills and six villages in Kundura (see Box 2 for a more detailed description of these data). The outcomes of interest relate to agricultural production, consumption, marketing, and income. The interventions of interest are those summarized in the previous section. These took place during the first two phases of the NUS project—i.e., the ones that had been the focus of the 2007 and 2010 surveys.

Treatments

Tables 4a and 4b indicate the number of households in each village that were involved in the various interventions. The 2018 survey asked respondents whether or not their household had ever had adopted a practice participated; and whether they were *still* involved in the practice. In general, these data indicate that substantial fractions of respondents had been exposed to, and had adopted some recommended practices, in most villages.

In the Kolli Hills, between one half and two-thirds of sample households took part in the participatory varietal selection (PVS) and seed quality training activities, depending on the village. Adoption of a couple of crop management activities—thinning and weeding—was even greater among surveyed households (80%), whereas for the other agronomic interventions listed adoption was rather low. There was some rather modest disadoption of improved crop management interventions in evidence; but depending on the intervention, roughly 80-90% of respondents who indicated that they had ever adopted were still engaged in the activity in 2018.

In Kundura, household participation in PVS and seed quality training was even greater than in Kolli Hills: 85% of surveyed households reported having participated, and participation was greater than 75% in all villages. As in Kolli Hills, some improved crop management practices were adopted by high proportions of the surveyed households, while others were not (in Kundura fertilizer use was more widely adopted, whereas thinning was less adopted). And as in the Kolli Hills, some disadoption of improved crop management techniques was reported in Kundura as well. But in general, uptake of improved crop management practices was substantial and sustained in both locations.

It is interesting to consider seed bank usage reported by survey respondents. Seed bank usage provides a signal as to the effectiveness of seed quality training, and the attendant knowledge transmitted about the benefits of good management of genetic resources. Roughly 60% of households in Kolli Hills reported that they had used community seed banks, compared with only about 21% of households in Kundura. Moreover, of the households in Kolli Hills that had ever “borrowed” from seed banks, 80% reported still utilizing them as a source of seeds. In Kundura, by contrast, most of the (relatively few) households who had ever used their community’s seedbank reported not using it in 2018.¹⁰

¹⁰ These differences across locations reflects more widespread development of SHG’s in Kolli Hills than in Kundura. Designated SHG’s for seed banks have proven to be a very effective approach to managing and operating seed banks (King, Kumar, and Padulosi 2015)

Box 2. Data Collection

Midway through this consultancy it became clear that it was premature to assess *ex post* the welfare effects on millet producers of the National Food Security Act of 2013, given that inclusion of minor millets in the PDS had only occurred in one State (Karnataka) in only one year. It additionally became clear that any assessment (*ex post* or *ex ante*) of how the efforts of the Bioversity-MSSRF project might contribute to the well-being of millet farmers directly affected by the NFSA would require detailed current information on how beneficiaries of the many project interventions had altered their production, consumption, and marketing behavior over time in response to those interventions.

Such detailed production, consumption and marketing data had been collected in 2007 and 2010 (instruments for those two surveys are contained in Attachments A and B)—i.e., at the beginning and end of Phase II of the IFAD-NUS project. These data were collected in two locations in which the participatory research, training and extension activities of the Bioversity-MSSRF teams were focused—Kolli Hills, Tamil Nadu and Kundura, Odisha. A total of 246 households were surveyed in 2007: 148 households in five villages in the Kolli Hills; and 98 households spread across 6 villages in Kundura. The 2010 survey re-surveyed 134 households in Kolli Hills and 87 households in Kundura. The surveys had collected information on production, consumption, income, and marketing both from households who had been involved in the project activities and from households who had not. Descriptive statistics derived using these data had been used to inform at least one publication (Padulosi, et al. 2015); but to the best of my knowledge there has been no comprehensive statistical analyses conducted using these data.

Examination of the data indicated that it had been competently assembled, and that it was presented in a way that was easily accessible. In short, it appeared to represent a useful benchmark against which to measure changes in household production, consumption and marketing behavior in areas which the Bioversity-MSSRF teams had been most active.

Following up on this discovery, in mid-January 2018 Bioversity contracted with MSSRF to oversee a follow-up study to collect comparable data from as many of the same households as could be located. A letter of agreement was signed on March 1. Over the next couple months the survey instrument was crafted (see Attachment C); and MSSRF hired and trained enumerators in the study locations.

Data collection took place in May and June. 202 of the 221 households that had been surveyed in both 2007 and 2010 were re-located—127 in Kolli Hills and 75 in Kundura. All agreed to participate in the 2018 survey. These data were cleaned and assembled in July, and the final data set was delivered at the beginning of August 2018.

Also of interest is that roughly one-fifth of households in Kolli Hills, and one-sixth in Kundura, reported having undertaken training in production of value-added products. As noted earlier, significant emphasis was placed on such value-added production as both an impetus to stimulating greater millet production and, relatedly, as a contributor to household incomes.

Before turning to considering what the data say about production, consumption and incomes, one caveat regarding the data merits mention. While there is a healthy mix of households that were and were not exposed to these various interventions, it is probably inappropriate to consider them as treatment and control populations in a quasi-experimental setting. Seed quality and value-added training activities extended knowledge that could easily be transferred to others afterwards (e.g., via participation in SHG's). Likewise, knowledge about improved crop management practices no doubt passed from neighbor to neighbor over the years. Knowledge of yield increases associated with varieties selected via PVS would no doubt be widely shared, as would access to those seeds (via seed banks as well as more informal mechanisms).

Instead, the approach taken here will be to examine mean outcomes on a village-by-village basis—i.e., I assess what might be termed “village treatment effects.” Our primary purpose is to track (a) trends in production, consumption, marketing of millets across the three survey years (2007, 2010, and 2018); (b) the relative importance of millets *vis-à-vis* other competing crops; and (c) the footprint of millets in household livelihood strategies—i.e., how earnings from millets cultivation (including value-added activities) compare to other sources of earnings. For all these purposes, examining central tendencies at village-level is appropriate.

Area

This section presents information gleaned from the surveys on trends in area cultivated in the various villages. For Kundura, only rice and millets production data were collected in the 2007 and 2010 surveys. The Kolli Hills data set contains a richer array of production data for all years. Of particular interest here is ascertaining the extent to which millet area increased over time (an explicit goal of the project); and also to gauge the relative importance of millet production *vis-à-vis* production of rice and, in Kolli Hills, cash crops.

It is important to note that in both areas—but particularly in Kolli Hills—farms are generally quite small. In 2018, for example, only 14 of 127 surveyed households in the Kolli Hills cultivated more than 5 acres (with the maximum being 9 acres); and 49—roughly 40% farmed less than 2.5 acre. Total area cultivated in Kundura is greater on average. But even there, roughly two-thirds of surveyed household operated 5 acres or less; and only 8 farms cultivated 10 acres or more (with a maximum of 17 acres).

Tables 5a and 5b present sample area means by village for the two locations. In the Kolli Hills sample, millets area more than doubled over time. There was some inter-village variation, but substantial percentage increases were observed in all villages. Finger millet has consistently been the dominant millet type grown, although modest increases in area under little millet and foxtail millet were in evidence as well. Note, however, that despite this increase in millet cultivation, the area devoted to millets in 2018 was considerably smaller than the area devoted to rice across all Kolli Hills households (and for all but one village). And the area devoted to cash crops—especially tapioca, but over time a more diverse mix—dwarfs area devoted to cereals.

In Kundura, where the average acreage cultivated is substantially larger than in Kolli Hills, a different pattern is evident in the data. In all villages, finger millet area was the same or less in 2018 than in earlier years—in several cases by quite a bit. Part of this decline represents switching into cultivation of little millet; but total

area under millets area fell in all but one village. Paddy area also displayed a similar pattern of declining acreage, but the decline in paddy acreage was not as steep. Interestingly, reported finger millet area had been greater than rice area in most Kundura villages in 2007, but by 2018 overall rice area exceeded that of finger millet area.

Another way of gauging changes in the importance of millets is represented by the number of farmers planting millets. The data suggest that the footprint of millets has definitely increased in each location, but in different ways. As indicated in Table 6, the number of Kolli Hills farms growing finger millet increased from 42 in 2007 to 76 in 2018; and average area devoted to finger millet among those farms was about three-tenths of an acre in 2018. The small number of Kolli Hills farmers growing little millets was the same in 2018 as it was in 2007, but average area planted on those farms doubled (from 0.33 to 0.66 acres); and about 5% of farmers had begun growing foxtail millet by 2018 (none was planted in earlier years).

In Kundura, both rice and finger millet were cultivated on nearly all farms in all years. Reported finger millet acreage fell over time. But this decline was paired with an increase in acreage devoted to little millet—in 2018, over half of the Kundura farmers interviewed reported growing little millet (none had grown any previously). Those farmers, all of whom also grew finger millet, appear to have substituted to some extent the little millet production for finger millet production. The indication here is that the importance of millets—both the number of farmers choosing to grow them and/or the variety in different types of millets cultivated—has grown over time. But the scale of millet production is small by any reasonable standard, a reflection of the socio-economic circumstances of the populations living in the study areas.

Production and sales

Tables 7a and 7b present data on output of the main crops grown. The quantity of millets produced has generally increased over time.¹¹ Consistent with area allocation patterns discussed above, finger millet output greatly exceeds output of other millets. Interestingly, more little millet was produced than finger millet in a couple Kundura villages in 2018.

However, it is also clear from Tables 7a and 7b that the output of millets is considerably smaller than that of paddy, a reflection of the fact that millet yields considerably lower than paddy.¹² In addition, the evidence from Kolli Hills highlights the fact that volumes of cash crops produced, especially tapioca, dwarf cereal production.

Additional insight into the size distribution of finger millet production across years and locations is presented in Table 8. There I have tabulated the number of households in each location growing different amounts of finger millets. In the Kolli Hills practically all finger millet-growing households produced less than 250kg in all three years. Production has clearly increased there, as evidenced by the substantially greater number of farmers growing more than 100 kg in 2018 compared with earlier years (as well as the larger number of finger millet producers). In Kundura, the pattern is a bit skewed by the fact that 2010 appears to have been a

¹¹ An exception to this is that most millet growers in Kundura produced very well in 2010. Paddy output in that year was also high relative to other years, suggesting that 2010 was a particularly good year for farming.

¹² In 2018, millet yields averaged 628 and 237 kg/acre in Kolli Hills and Kundura, respectively, among households growing millets. In comparison, paddy growers achieved average yields 1,106 and 1,256 kg/acre, respectively.

bumper year for finger millet production (with 12 farmers there reporting having harvested in excess of 1 ton in that year). Comparison of the distributions for 2007 and 2018 indicates that production outcomes were more widely dispersed in 2018: a substantially larger number of households produced more than 250 kg than in 2007; but at the same time, a larger number of households in 2018 reported producing very little output (less than 100 kg) compared with 2007.

Table 9 presents information on the millet sales. In line with production data, the number of households engaging in millet sales—and the average quantities sold—were substantially smaller in the Kolli Hills. In the Kolli Hills in 2018, only eight out of 76 finger millet producers sold any of their output. Among those who did sell, the average quantity sold was rather small (a little over 50 kg); and that average was dominated by one household that sold 140 kg (most of the rest sold about 30 kg). Both the number of sellers and the mean quantity sold were very similar to what was observed in 2007.¹³ Also in 2018, a couple farmers sold rather sizeable quantities of little millet (200kg and 300kg).

Compared with Kolli Hills, production and sales have consistently been greater in Kundura. Over 40% of finger millet producers in Kundura sold some fraction of their output in 2018. Of these, about half sold 100kg or less and about a quarter marketed 300 kg or more. Unlike the Kolli Hills, both the number of finger millet producers selling finger millets and the volume of those sales increased substantially compared to 2007.

The most striking aspect of the data presented in Table 9 is that marketing of little millets was substantial in Kundura in 2018. This is a striking result, given that no little millet production was observed in earlier years. 40 of the farms in our sample grew little millets in 2018. Nearly all of them (37 of 40) sold some of their output, and the fraction kept for home consumption was quite small: The entire group of sellers sold well over 90% of their output (and 20 of them so sold all of their little millet output). Moreover, average quantities sold were significantly greater than those for finger millets. Roughly 40% of selling households sold 100 kg or less; but substantial fraction (one-third) sold amounts exceeding 300 kg, and five households sold 500 kg or more. The clear implication here is that Kundura farmers growing little millet in 2018 were doing so for commercial—not consumptive—purposes.

Consumption

Tables 10a and 10b present information on average monthly cereal consumption for the two study locations. Focusing first on the 2018 data, it is clear that currently rice is a far bigger component of average diets than are millets. In Kolli Hills, households consumed roughly 14 times more rice than millet; in Kundura the ratio is six to one. Focusing on millets specifically, most consumption in 2018 was of own-produced (as opposed to purchased) finger millet. Finger millet is the only millet consumed in the Kolli Hills. A small amount of little millet consumption was reported in some villages in Kundura, but finger millet dominates there as well.

With regard to consumption trends, rather different patterns are in evidence between the two locations. In Kolli Hill average millet consumption has increased steadily over time in practically all villages. As noted above,

¹³ A somewhat greater number sellers were observed in 2010, and average amounts sold were smaller. Again, this is a reflection of the fact that 2010 appears to have been a year of good millet harvests in which some modest amount of surplus (over consumption demands) was available for sale.

though, millet consumption remained considerably less important than rice consumption, since reported rice consumption also increased over time.

In contrast, average millet consumption among surveyed households in Kundura was considerably smaller in 2018 than in previous years. What explains this fall is unclear. But one possibility that presents itself is that availability of rice through the PDS may well have contributed to a shift from millets to rice among some households. The data in Table 10b reveal that by 2018 the PDS replaced other market sources of rice pretty much completely in Kundura—hardly a surprise given the significant subsidies on rice purchased through the PDS. Households in Kolli Hills also procured substantial quantities of rice from the PDS. There, however, it would appear that PDS rice largely replaced own-produced rice.

Income

Surveyed households were asked to provide information on crop-specific cost of production and gross income.¹⁴ Gross income data were cross-checked against reported production and price information. Households were instructed to include the value of their own labor in their cost estimates, although it cannot be known how respondents valued their time. All data were deflated by the All-India Rural CPI (2010=100).

Tables 11a and 11b presents mean income by source and village. In both locations earnings from agriculture, both via net returns from farming and agricultural wage labor income, dominated overall earnings. Interestingly, in Kolli Hills the importance of (off-farm) agricultural wage income has grown considerably; by 2018 it had surpassed crop production as the number one source of earnings among sample households. This presumably reflects the fact that many individuals in the Kolli Hills routinely engage in seasonal migration to work on farms in other locations (O. King, pers. comm.).

Of particular note is that in both locations, earnings from cultivation of millets has consistently been much smaller than earnings from competing crops. In the Kolli Hills, cash crops like tapioca dominate total earnings from cultivation. But paddy production, too, appears to have been substantially more important income source. In Kundura, paddy production has been substantially more remunerative in nearly all villages in all years. For 2018—the only year for which production data were available for other crops in Kundura—net earnings from other crops also exceed earnings from millets production in four of six village.

Finally, relatively small value-added earnings were observed for 2018 in all villages in Kolli Hills, and all but one village in Kundura. In terms of overall averages, the scale of these earnings is low—but in Kolli Hill, of a comparable size to reported net returns from millets cultivation. Early adoption of production of value-added millet products was also observed in Kundura in 2010.

A more in-depth view of the footprint of value-added production is provided in Tables 12a and 12b. One-third of surveyed households in Kolli Hills indicated that they engaged in such activities; and earnings therefrom averaged under 500 rupees. For Kundura, fewer households engaged in value addition. but average earnings for those that did so were substantially higher—1,583 rupees in 2018 (largely due to large earnings from value-addition reported in one village in particular). Moreover, participation in this activity declined significantly in

¹⁴ Households were instructed to include the value of their own labor in their cost estimates.

Kundura over time: more than half of the households who had been involved in value-added production there in 2010 had ceased to do so by 2018.

DISCUSSION

Key Findings

The analysis presented in the previous section suggests that taken as a whole, the many interventions promulgated by the Bioversity-MSSRF project have contributed to the scale, productivity, and diversity of millets production in the villages in which those interventions were undertaken:

- Generally speaking, uptake of improved agronomic practices was substantial and sustained in both Kolli Hills and Kundura, involvement in participatory varietal selection was extensive, and seed bank use was widespread (more so in Kolli Hills).
- The importance of millets—as indicated by the number of farmers choosing to cultivate them and/or the variety in different types of millets cultivated—has risen over time.
- Historically, finger millet has been the dominant type of millet grown in both locations, and that continues to generally be the case. However, the data indicate that the area and production of little millet has increased significantly, particularly in a couple of villages in Kundura.
- In Kundura, where farm sizes and area under millets tends to be larger, the number of farmers selling millets (both finger millet and little millet) has risen over time; and in the case of little millets, these appear to have been largely grown for commercial purposes.

These findings bespeak significant success on the part of the Bioversity-MSSRF partnership in reaching key goals motivating the project—augmenting dwindling stocks of local genetic resources (through expanding the types and varieties of millets grown); and arresting the decline in the production of minor millets in India. The results summarized above indicate clearly that in the locations in which the project operated, the project’s participatory approaches to promoting millets have moved the needle in the desired direction.

At the same time, however, it is important to note that in both locations, but especially the Kolli Hills, the scale of millet production is small by any reasonable standard. Farm sizes are small, and the footprint of millets on those farms—both in terms of area and output—remain relatively small compared to other crops grown.

Regarding contributions to income, the data are similarly quite clear that millets occupy a much less important position than other livelihood sources—both on-farm and off-farm—in both study areas. The composition of household earnings from agriculture production varies substantially from location to location—cash crops and earnings from off-farm agricultural wage labor dominate in Kolli Hills; paddy cultivation and agricultural wage labor dominate in Kundura. But the relative unimportance of millets’ contribution to household overall earnings is consistent across areas. And while substantial fractions of households had engaged in value-addition, in the both areas earnings from value-addition were similarly modest in 2018—although a few households in one Kundura do seem to be earning sizeable profits from value-added production.

Finally, the evidence indicates quite clearly that rice remains, by far, the most important food consumed by surveyed households in both locations. Finger millet is the only minor millet consumed in the Kolli Hills, and its consumption has increased somewhat over time. In Kundura, a small amount of little millet consumption was reported in some villages, but finger millet dominates there as well. Average consumption of both types of millet actually declined in Kundura. Meanwhile, in both locations average rice consumption increased over

time. Interestingly, in 2018 households in both areas appear to have substituted rice purchased from PDS shops for rice that previously came from other sources (open-market purchases in Kundura, own-production in Kolli Hills). This bears implications for possible outcomes that might arise if and when millets were to become available in PDS shops in places like the study locations.

Implications

What then do these findings suggest for the future—in particular, a future in which substantial government procurement of millets (for provisioning PDS shops) were to take place. As has been noted, the inclusion of millets in the National Food Security Act represents a potentially huge boost to millet demand. So what might such an increase in demand mean for the sorts of limited-resource farmers that have been the beneficiaries of the Bioversity-MSSRF project?

To begin with, it is almost certainly the case that in the foreseeable future government procurement would concentrate on finger millet exclusively. There are a few reasons for this. First, in nearly all areas, production of finger millet is substantially larger than that of other minor millets. This reflects, among other things, the fact that varietal improvement research for finger millet has a longer and more successful track record (compared to breeding efforts other minor millets). Second, processing of finger millet is dramatically less difficult and costly (other minor millets require de-husking, whereas finger millet does not). And finally, finger millet is generally consumed much more widely than other minor millets throughout India.

As has been noted, the production of finger millets occurs at very small scales in the areas where the Bioversity-MSSRF project has taken place. But that is fairly representative: Millet production throughout India is stereotypically associated with small-scale production by limited resource farmers who market little if any of their millet output. Clearly, then, some sort of price premium would be required to incentivize those farmers to produce more marketable surpluses. Indeed, many interlocutors in India with whom I interacted over the course of this research argued that substantially increasing the minimum support price (MSP) for millets is an indispensable “requirement” for generating sufficient quantities of grain to meet government procurement targets.¹⁵

Note, however, that raising the MSP—or, as was done in Karnataka, paying a substantial premium over and above the national MSP—would benefit finger millet farmers, but *only* if they are selling millet. A difference in the level of market participation between the two study locations was evident. Predictably, more farmers sold finger millet in Kundura (where farm sizes are small, but much larger than the Kolli Hills). This carries implications for the distribution of benefits to farmers from boosting the price of finger millet, namely that more of those benefits would be felt in places like Kundura than in places like the Kolli Hills.

Finally, it is important to recognize that offering a higher producer price for finger millet might produce some impacts that are inimical to core goals of the Bioversity-MSSRF project, particularly those related to biodiversity and *in situ* conservation of genetic resources. First, an increased price of finger millet would likely motivate existing millet farmers to substitute away from other cereals—including other minor millets that they are

¹⁵ Corresponding to this point of view, subsidies that raised the price of finger millet 15% over the MSP were deemed essential by the Karnataka government in 2015 in order to generate sufficient marketed surpluses of finger millet (Rajshakar and Raju 2017).

currently producing—in favor of more acreage allocated to finger millet. In support of this contention, note that the outcome analysis indicated that where little millet production has expanded in Kundura, it has been grown for commercial—not consumption—purposes. Putative price increases for finger millet would tend to reverse the decision-making calculus that led to the switch toward little millet.

Second, and perhaps more importantly, higher prices for finger millet may be expected to generate production from new—i.e., non-traditional—growers. It is entirely likely that such new production would occur at larger scale, and on more favorable lands, than millet production in places like Kolli Hills and Kundura. Moreover, a reasonable case can be made that government procurement entities might be pre-disposed to favor such new millet producers, especially if those growers tended to produce larger quantities (that contribute to more efficient collection and bulking in procurement) and/or they are already served by government procurement entities for marketing other crops. In short, a potentially very large share of the pecuniary benefits of millet price subsidies might not go to sorts of limited-resource farmers that represent Bioversity's and MSSRF's core constituencies.¹⁶

Third, if government pricing policies were altered to promote cultivation of finger millet for commercial purposes, the varietal characteristics that such farmers would value most highly may be expected to skew toward production characteristics related to yield and yield stability, and less by consumption and other characteristics, than is currently the case. Importantly, the dominance of these production characteristics in farmers' varietal selection is commonly regarded as a key culprit underlying the dwindling genetic bases of major cereal crops like paddy and wheat.

Finally, if finger millet becomes available to millet farmers at subsidized consumer prices via the PDS—as is the case for rice in the study villages that have been analyzed here—then some existing millet farmers may simply choose to re-allocate land previously devoted to millets to other, more remunerative crops. Indeed, one of the more interesting findings related to rice consumption in the study areas is that PDS-sourced rice appears to have substituted to a significant extent for own-produced rice in the Kolli Hills. A similar substitution response among millet farmers would clearly be at odds with the goal of expanding the scale millet production in such locations.

¹⁶ One can imagine mechanisms like Geographic Indication systems, Fair Trade certification, or even targeted subsidies potentially being implemented by the Indian Government to counter this phenomenon. Those sorts of policy interventions would require government determination that the critical role that existing, small-scale millet producers play in safeguarding on-farm diversity would outweigh any gains in productive efficiency enjoyed by larger-scale millet production.

Table 1. IFAD-NUS Grants, 2001-2018

Phase	Years	Title of Project	Total Budget	Target regions	Target countries	India Budget (USD)
I	2001-2005	<i>Enhancing the contribution of neglected and underutilized species to food security, and to incomes of the rural poor</i>	1,410,000 USD	North Africa, West and South Asia, Latin America	Egypt, Yemen, Nepal, India, Peru, Bolivia, Ecuador	156,000
II	2007-2010	<i>Empowering the rural poor by strengthening their identity, income opportunities and nutritional security through the improved use and marketing of neglected and underutilized species</i>	1,400,000 USD	West Asia and South Asia, Latin America	Yemen, India, Peru, Bolivia	224,491
III	2011-2015	<i>Reinforcing the resilience of poor rural communities in the face of food insecurity, poverty and climate change through on-farm conservation of local agrobiodiversity</i>	975,000 USD	South Asia and Latin America	India, Bolivia, Nepal	259,997
IV	2013-2015	<i>Improving smallholder farmers' food and nutrition security through sustainable use and conservation of agrobiodiversity</i>	500,000 USD	South Asia and Latin America	India, Bolivia, Nepal	Incorporated with previous grant
V (I)	2015-2016	<i>Linking agrobiodiversity value chains, climate adaptation and nutrition: empowering the poor to manage risk</i>	1,000,000 USD	West and South Asia, Latin America	Mali, Guatemala, India	136,000
V (II)	2016-2018	<i>Linking agrobiodiversity value chains, climate adaptation and nutrition: empowering the poor to manage risk</i>	1,500,000 Euros	West and South Asia, Latin America	Mali, Guatemala, India	100,000 (2016) 71,000 (2017)
Total budget provided to India						\$947,488

Table 2. Methods, Tools, and Key Achievements of the Bioversity-MSSRF Project

Value Chain Portion	Activities	Participants	Achievements
Genetic Diversity	Survey and collection of target crop diversity in situ (Focus Groups, discussions, base line surveys)	MSSRF, Self Help Groups (SHGs), communities, farmers' clubs, women's assn's	Understanding of existing diversity on farms; access to wider genetic diversity by user groups
	Map out existing crop diversity, assess threats and vulnerability status (via Focus Group Discussions, base line surveys)	MSSRF, SHGs, Communities, farmers' clubs	Distribution maps of crops and varieties; status of conservation and use; status of vulnerability and loss
	Introduction of varieties from <i>ex situ</i> gene banks	MSSRF, SHGs, communities, ICRISAT, farmers' clubs, women's assn's	Wider basket of diversity options to farmers
	Participatory documentation of useful traits (Focus Group Discussions)	MSSRF, SHGs, communities, farmers' clubs, women's assn's, value chain actors	Identification of traits useful for cultivation and use by households and markets
	Conservation <i>ex situ</i> and in situ (on farm), via creation/strengthening of SHGs and farmers' clubs	MSSRF, SHGs, farmers' clubs, women's assn's, custodian farmers, community gene banks	Conservation of crop diversity as key asset for building resilient livelihood systems
	Organize seed/food fairs for exchange of seeds and knowledge among users (via engaging SHGs and local authorities)	Communities, local leaders, SHGs, farmers' clubs, women's assn's, value chain actors	Exchange of seeds and IK among users which also helps safeguard a community's identity and food culture associated to nutritious millets
	Train trainers on new methods and tools in target communities	MSSRF, SHGs, communities, women's assn's, Universities of Bangalore, Dharwad, and Uttarakhand, farmers' clubs, women's assn's, value chain actors	Strengthening skills of user groups, esp. women and vulnerable groups, in conservation practices and use enhancement of millets; training in seed collection, PVS, quality seed production, seed bank management, agronomic techniques, using tools to minimize drudgery, use of processing equipment, value addition methods, product development and marketing

Table 2 (cont'd)

Value Chain Portion	Activities	Participants	Achievements
Selection and cultivation	Participatory Variety Selection (PVS)	MSSRF, communities, SHGs, Universities of Bangalore, Dharwad, and Uttarakhand, farmers' clubs, women's assn's, value chain actors	Selection of varieties (landraces or HYVs) showing best yields and best traits in terms of cultivation, processing, and food preparation
	Production of high quality seed of selected varieties	MSSRF, communities, SHGs, farmers' clubs, women's assn's	Availability of high-quality seed of selected varieties to farmers
	Enhancement of agronomic practices (e.g., change of crop distances in planting, crop rotation, introduction of mechanical weeding, crop rotation, vermicomposting)	MSSRF, communities, SHGs, Universities of Bangalore, Dharwad, and Uttarakhand, farmers' clubs, women's assn's	Reduction of drudgery in cultivation of millets
	Train trainers on new methods and tools in target communities	MSSRF, communities, SHGs, farmers' clubs, women's assn's	Enhanced skills of farmers in cultivating millets. Skills in using machinery, product development, and marketing. Involvement in value addition and marketing of millets. New products reach markets. Private initiatives are booming.
Harvest	Improvement of harvest improvement methods	MSSRF, communities, SHGs, farmers' clubs, women's assn's	Reduced drudgery and grain loss in post-harvest operations
Value Addition	De-huller machine (specify target species and level of efficacy); Pulverizer machine(specify target species and level of efficacy)	MSSRF, communities, SHGs, Universities of Bangalore and Dharwad, farmers' clubs, women's assn's	Reduced /elimination of drudgery in processing millets
	Development of enhanced food preparations and novel food recipes	MSSRF, communities, SHGs, Universities of Bangalore and Dharwad, farmers' clubs, women's assn's, schools, and hospitals	Easier food preparation that eliminates drudgery and produces food items more attractive to younger generations and modern lifestyles.
	Creation of SHGs to manage community-based processing centers	MSSRF, communities, farmers' clubs, women's assn's	Enhanced capacity of communities in processing and using millets for domestic or market uses

Table 2 (cont'd)

Value Chain Portion	Activities	Participants	Achievements
Marketing	Strengthening marketing products via creation or strengthening of SHGs	MSSRF, communities, farmers' clubs, women's assn's	Enhanced capacity of communities in marketing millets, market orientation, exposure visits to different streams of markets, provision of market information through information and communication
	Train trainers/SHGs on new methods, tools and practices in target communities (incl. packaging, branding and ways to obtain Government's required certificates for marketing)	MSSRF, communities, SHGs, farmers' clubs, women's assn's	Training in marketing and entrepreneurship; development of Kolli Hills Natural Foods Brand; Quality Control and Food Safety certification
	Building platforms and linkages among actors of value chains (incl. with restaurants)	MSSRF, communities, SHGs, farmers' clubs, women's assn's	Linkages with mainstream markets; establishment of producer groups; product branding for products; product diversification; identification of niche markets; market assessments; interest free loan support programs; infrastructure development; management skills development
Final Use	Collection of traditional food recipes and dissemination of recipe books	MSSRF, communities, SHGs, farmers' clubs, women's assn's	Popularization of drudgery-free and more attractive food preparations for nutritious millets; contribution in safeguarding food culture and identity. Documented traditional recipes, promote some as marketable products
	Food festivals, public campaigns, involving school children, religious groups, and policy makers (via fact sheets, articles in the press, TV interviews, etc.)	MSSRF, communities, SHGs, farmers' clubs, women's assn's, schools, policy makers, religious groups	Popularization of millets among younger generations and decision makers, as religious offerings in temples.
	Promotion of millets in school feeding programs	MSSRF, Universities of Bangalore and Dharwad, schools, policy makers	Awareness raised in decision makers over the importance of millets in school meal programs
	Lobbying at the Indian Parliament for the amendment of the National Food Security Bill	Prof. MS Swaminathan, other MPs, government officials	Awareness raised among key decision makers over the strategic role of millets in India for adaptation to climate change, nutrition security, and income generation; amendment of the bill through the inclusion of minor millets in the Public Distribution System

Source: Adapted from Padulosi, et al. (2015).

Table 3. Seed Bank Transactions in Kolli Hills, 2001-2014 (kg)

Year	Little millet	Foxtail millet	Finger millet	Kodo millet	Proso millet	All millets
2001	900	1,089				1,989
2002	1,389	987		24		2,400
2003	453	357	227			1,037
2004	508	435	240			1,183
2005	510					510
2006	95	279	172	43	27	616
2007	8					8
2008	17					17
2009	57	18	113	5	5	197
2010	306	55	519	20	11	911
2011	298	150	232	10	10	700
2012	176	63	246	5	7	497
2013	197	81	270	10	15	573
2014	432	353	562	15	35	1,397

Source: Padulosi, et al. 2015

Table 4a. Number of Households that Participated in Various Interventions, Kolli Hills

<i>Intervention</i>	<i>Padasolai</i>		<i>Puliampati</i>		<i>Sempathuvalavu</i>		<i>Thuvarapallam</i>		<i>Tirupuli</i>		<i>All Villages</i>	
	Ever?	Still?	Ever?	Still?	Ever?	Still?	Ever?	Still?	Ever?	Still?	Ever?	Still?
Seeds												
Varietal selection	28	22	10	6	13	12	14	2	12	3	77	45
Seedbank use	24	21	8	8	12	12	16	13	13	4	73	58
Seed quality training	28	-	10	-	14	-	16	-	11	-	79	-
Crop Management												
• Thinning	34	26	13	9	19	15	19	18	19	16	104	84
• Interculture/weeding	36	28	14	14	19	18	20	20	19	17	108	97
• Interculture machine	9	9	8	8	7	7	11	10	8	7	43	41
• Fertilizer after weeding	3	3	6	6	2	2	4	4	5	5	20	20
Value-Added training	4		4		1		12		4		25	
Total no. of households	45		14		19		26		23		127	

Table 4b. Number of Households that Participated in Various Interventions,, Kundura

<i>Intervention</i>	<i>Banuguda</i>		<i>Bhadraguda</i>		<i>Chendiahilingan</i>		<i>Dholijhiligan</i>		<i>Heruguda</i>		<i>Kaudiaguda</i>		<i>All Villages</i>	
	Ever?	Still?	Ever?	Still?	Ever?	Still?	Ever?	Still?	Ever?	Still?	Ever?	Still?	Ever?	Still?
Seeds														
Varietal selection	9	3	8	4	15	13	14	2	5	4	12	5	63	31
Seedbank use	0	0	5	0	10	5	0	0	0	0	1	1	16	6
Seed quality training	8	-	6	-	15	-	11	-	5	-	13	-	58	-
Crop Management														
• Thinning	6	5	8	8	4	4	2	2	5	5	3	3	28	27
• Interculture/weeding	12	10	7	6	15	14	14	14	4	4	14	13	66	61
• Interculture machine	4	3	7	6	14	8	5	5	4	4	7	4	41	30
• Fertilizer after weeding	10	9	6	5	14	13	13	11	4	4	14	13	61	55
Value-Added training	3		4		1		0		4		1		13	
Total no. of households	12		9		15		16		5		18		75	

Table 5a. Mean Area Under Different Crops in Kolli Hills (acres)

Crop	<i>Padasolai</i>			<i>Puliampati</i>			<i>Sempathuvalavu</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Total Area	2.4	1.9	3.0	2.6	1.5	3.6	3.2	1.8	3.3
Paddy	0.28	0.14	0.31	0.30	0.20	1.83	0.20	0.11	0.35
All millets	0.08	0.05	0.21	0.15	0.04	0.44	0.18	0.12	0.24
- Finger	0.06	0.04	0.18	0.12	0.04	0.29	0.18	0.12	0.23
- Little	0.01	0.01	0.03	0.0	-	0.15	0.00	-	-
- Foxtail	0.00	-	0.01	-	-	-	-	-	0.01
Cash Crops									
- Tapioca	1.39	0.97	2.28	1.77	0.89	0.43	2.04	0.75	0.32
- Coffee	-	0.05	0.95	-	0.06	0.98	-	0.05	-
- Banana	0.05	0.00	0.14	0.04	-	0.09	0.04	0.04	0.21
- Pineapple	0.14	0.03	0.14	0	-	0.01	0.25	0.11	0.18
- Pepper	-	-	0.54	0	-	0.96	-	-	0.26
N		45			14			19	

Crop	<i>Thuvarapallam</i>			<i>Tirupuli</i>			<i>All villages</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Total Area	2.3	1.6	3.0	2.9	2.0	3.1	2.6	1.8	3.1
Paddy	0.14	0.13	0.14	0.47	0.38	0.31	0.28	0.18	0.45
All millets	0.05	0.03	0.17	0.09	0.02	0.15	0.10	0.05	0.22
- Finger	0.03	0.03	0.11	0.09	0.02	0.15	0.08	0.05	0.18
- Little	0.02	-	-	-	-	-	0.01	0.00	0.03
- Foxtail	-	-	0.06	-	-	-	0.00	0.00	0.02
Cash Crops									
- Tapioca	0.99	0.62	0.50	1.78	1.15	0.27	1.52	0.89	1.06
- Coffee	0.04	0.04	0.27	-	0.10	0.04	0.01	0.06	0.51
- Banana	0.02	0.04	0.18	0.09	-	0.29	0.05	0.01	0.18
- Pineapple	0.42	0.29	0.52	0.17	-	0.37	0.20	0.09	0.25
- Pepper	0.00	0.00	0.04	0.0	-	0.09	0.00	0.00	0.36
N		26			23			127	

Table 5b. Mean Area Under Different Crops in Kundura (Kundura)

Crop	<i>Banuguda</i>			<i>Bhadraguda</i>			<i>Chendiahilingan</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Total Area	4.6	4.6	4.8	2.6	4.5	2.7	5.1	7.0	7.7
Paddy	2.2	2.5	2.0	1.4	2.8	1.4	2.2	3.9	2.2
All millets	2.4	2.0	1.0	1.2	0.9	1.4	2.8	1.9	2.2
- Finger	2.4	2.0	0.6	1.2	0.9	0.9	2.8	1.9	1.1
- Little	-	-	0.4	-	-	0.6	-	-	1.1
Other crops*	n/a	n/a	1.7	n/a	n/a	0.7	n/a	n/a	0.9
N		12			9			15	

Crop	<i>Dholijhiligan</i>			<i>Heruguda</i>			<i>Kaudiaguda</i>			<i>All Villages</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018	2007	2010	2018
Total Area	6.2	6.1	4.9	6.4	6.4	5.2	6.7	6.9	4.3	5.4	6.1	5.1
Paddy	2.1	2.5	1.4	2.6	3.2	1.5	3.8	3.9	2.3	2.5	3.2	1.9
All millets	4.4	1.7	1.8	2.8	1.1	1.6	2.9	1.8	0.7	2.9	1.7	1.4
- Finger	4.4	1.7	0.9	2.8	1.1	1.2	2.9	1.8	0.5	2.9	1.7	0.8
- Little	-	-	0.9	-	-	0.4	-	-	0.1	0.0	0.0	0.6
Other crops*	n/a	n/a	0.9	n/a	n/a	1.8	n/a	n/a	0.4	n/a	n/a	0.9
N		16			5			18			75	

Table 6. Number of Farmers Growing Cereals and Average Area Cultivated Among Growers

Crop	<i>Kolli Hills (N=127)</i>			<i>Kundura (N=75)</i>		
	2007	2010	2018	2007	2010	2018
Paddy						
- No. of growers	111	104	105	66	69	73
- Avg. area (ac.)	0.32	0.22	0.55	2.83	3.49	1.90
Finger millet						
- No. of growers	42	47	76	74	74	71
- Avg. area (ac.)	0.26	0.12	0.30	2.96	1.71	0.86
Little millet						
- No. of growers	5	1	5	0	0	40
- Avg. area (ac.)	0.31	0.25	0.66	not grown	not grown	1.12
Foxtail millet						
- No. of growers	0	0	6	0	0	0
- Avg. area (ac.)	not grown	not grown	0.33	not grown	not grown	not grown

Table 7a. Mean Production of Different Crops in Kolli Hills (kg)

Crop	<i>Padasolai</i>			<i>Puliampati</i>			<i>Sempathuvalavu</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Paddy	n/a	8	361	n/a	63	377	n/a	27	498
All millets	28	17	78	35	31	190	104	55	176
- Finger	24	16	72	26	31	109	102	55	91
- Little	4	1	6	9	<1	61	2	0	0
- Foxtail	<1	0	<1	0	0	0	0	<1	1
- Other	n/a	0	0	0	0	19	0	0	84
Cash crops									
- Tapioca	n/a	75	3,169	n/a	78	1,411	n/a	58	2,663
- Coffee	n/a	21	59	n/a	11	14	n/a	28	17
- Banana	n/a	9	183	n/a	0	154	n/a	6	1,481
- Pineapple	n/a	2	395	n/a	0	0	n/a	24	1,834
- Pepper	n/a	2	219	n/a	2	38	n/a	4	58
N		45			14			19	

Crop	<i>Thuvarapallam</i>			<i>Tirupuli</i>			<i>All villages</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Paddy	n/a	23	339	n/a	219	507	n/a	58	405
All millets	32	13	56	29	7	74	41	21	100
- Finger	23	12	28	28	6	50	37	21	66
- Little	9	0	0	0	0	0	5	<1	9
- Foxtail	<1	1	1	0	1	0	<1	<1	<1
- Other	0	0	27	0	0	24	<1	<1	24
Cash crops									
- Tapioca	n/a	47	11,052	n/a	81	1,513	n/a	68	4,159
- Coffee	n/a	27	25	n/a	21	1	n/a	22	30
- Banana	n/a	3	530	n/a	0	743	n/a	5	540
- Pineapple	n/a	22	3,065	n/a	0	1,180	n/a	9	1,236
- Pepper	n/a	3	20	n/a	5	41	n/a	3	93
N		26			23			127	

Table 7b. Mean Production of Different Cereals in Kundura

Crop	<i>Banuguda</i>			<i>Bhadraguda</i>			<i>Chendiahilingan</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Paddy	408	1,758	1,867	139	2,300	1,233	423	3,323	3,437
All millets	127	740	122	92	605	1,234	154	784	556
- Finger	127	721	82	92	568	267	154	762	290
- Little	0	19	40	0	37	967	0	19	40
Maize	0	11	1,088	0	29	114	0	11	1,088
N		12			9			15	

Crop	<i>Dholijhilingan</i>			<i>Heruguda</i>			<i>Kaudiaguda</i>			<i>All Villages</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018	2007	2010	2018
Paddy	153	2,175	1,569	280	2,260	880	526	3,556	3,300	344	2,690	2,319
All millets	130	801	389	180	599	456	87	735	112	123	735	314
- Finger	130	631	167	180	590	400	87	713	70	123	681	182
- Little	0	171	222	0	9	56	0	22	42	0	54	132
Maize	0	35	0	0	0	0	0	23	0	0	0	0
N		16			5			18			75	

Table 8. Size distribution of finger millet production

<i>Location</i>	<i>2007</i>	<i>2010</i>	<i>2018</i>
Kolli Hills			
< 100 kg	21	40	30
100-249 kg	18	6	44
250-499 kg	2	1	1
500-749 kg	1	0	1
750-999 kg	0	0	0
1,000-2,000 kg	0	0	0
3,000 kg	0	0	0
Kundura			
< 100 kg	16	1	26
100-249 kg	54	7	27
250-499 kg	4	18	10
500-749 kg	0	25	6
750-999 kg	0	11	2
1,000-2,000 kg	0	10	0
3,000 kg	0	2	0

Table 9. Average Millet Sales

	<i>2007</i>		<i>2010</i>		<i>2018</i>	
	No. of Sellers/ Growers	Mean quantity sold (kg)	No. of Sellers/ Growers	Mean quantity sold (kg)	No. of Sellers/ Growers	Mean quantity sold (kg)
Kolli Hills						
- Finger millet	8/42	55	13/47	27	8/76	54
- Little Millet	0/1	-	0/5	-	2/5	250
Kundura						
- Finger millet	16/74	47.9	41/74	347.0	30/71	177.3
- Little Millet	not grown	not grown	not grown	not grown	37/40	237.0

Table 10a. Mean Monthly Cereal Consumption in Kolli Hills (kg)

Cereal	<i>Padosolai</i>			<i>Puliampati</i>			<i>Sempathuvalavu</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Rice	43.3	52.8	46.3	44.2	48.4	70.6	46.0	51.5	49.5
- Own	18.5	30.3	13.3	14.1	21.4	14.6	20.3	30.9	10.4
- Purchased	24.8	22.5	7.8	30.1	27.1	28.9	25.7	20.6	22.8
- PDS	0	0	25.2	0	0	27	0	0	16.3
Finger millet	1.4	3.8	5.1	1.2	2.3	4.4	2.8	2.1	2.9
- Own	1.4	1.5	4.8	1.2	1.1	4.4	2.8	1.6	2.6
- Purchased	0.0	2.4	0.3	0	1.1	0	0	0.5	0.4
Little millet	0.1	0	0	0.4	0	0	0	0	0
- Own	0.1	0	0	0.4	0	0	0	0	0
- Purchased	0	0	0	0	0	0	0	0	0
Wheat	0	1.8	3.6	0	1	4.5	0	2	4.6
- Purchased	0	1.8	0	0	1	0	0	2	0
- PDS	0	0	3.6	0	0	4.5	0	0	4.6
N		45			14			19	

Cereal	<i>Thuvarapallam</i>			<i>Tirupuli</i>			<i>All villages</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Rice	42.6	47.8	43.1	56.5	55.0	65.3	46.1	51.5	52.3
- Own	12.1	28.7	3.1	32.6	31.1	16.6	19.5	29.2	11.5
- Purchased	30.5	19.1	20.0	23.9	23.9	28.8	26.5	22.3	18.7
- PDS	0	0	20	0	0	19.9	0	0	22.0
Finger millet	1.0	1.8	2.7	1.9	2.2	2.2	1.6	2.7	3.7
- Own	1.0	0.7	0.9	1.8	1.3	0.4	1.6	1.3	2.8
- Purchased	0	1.1	1.8	0.1	1.0	1.7	0	1.4	0.8
Little millet (own)	0.4	0	0	0	0	0	0.2	0	0
Wheat	0	1.4	3.8	0.1	1.6	4.0	0.0	1.6	4.0
- Purchased	0	1.4	0	0.1	1.6	0.2	0	1.6	0
- PDS	0	0	3.8	0	0	3.7	0	0	3.9
N		26			23			127	

Table 10b. Mean Monthly Cereal Consumption in Kundura (kg)

Cereal	<i>Banuguda</i>			<i>Bhadraguda</i>			<i>Chendiahilingan</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Rice	13.3	39.2	55.9	15.1	43.9	57.8	20.3	40.7	58.5
- Own	13.3	25.0	28.0	13.9	21.1	27.8	19.3	24	46.8
- Purchased	0	14.2	0	1.2	22.8	0	1	16.7	0
- PDS	0	0	27.9	0	0	30	0	0	11.7
Finger millet	21.6	49.2	6.4	17.8	48.3	6.8	18.5	45.9	16.5
- Own	21.6	49.2	5.6	16.7	46.1	6.8	18.5	45.9	16.5
- Purchased	0	0	0.8	1.1	2.2	0	0	0	0
Maize*	0	22.1	0	0	21.7	0	0	12.7	0
Little millet*	0	0	0	0	0	0	0	0	0.6
N		12			9			15	

Cereal	<i>Banuguda</i>			<i>Bhadraguda</i>			<i>Chendiahilingan</i>			<i>All Villages</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018	2007	2010	2018
Rice	17.3	32.2	46.0	13.0	42.0	38.0	22.5	38.6	49.2	18.0	38.6	51.7
- Own	14.5	14.1	25.1	13.0	24.0	20	22.5	17.5	40.3	17.0	20.1	33.5
- Purchased	2.8	18.1	8.7	0	18.0	0	0	21.1	0	0.9	18.5	1.9
- PDS	0	0	12.2	0	0	18	0	0	8.9	0.0	0.0	16.3
Finger millet	20.8	42.5	6.0	21.8	40.0	6.0	22.5	47.8	5.4	20.6	46.0	8.1
- Own	20.8	42.5	6	21.8	40	6	22.5	47.8	5.1	20.4	45.8	7.9
- Purchased	0	0	0	0	0	0	0	0	0.3	0.1	0.3	0.2
Maize*	0	26.3	0	0	4	0	0	21.1	0	0.0	19.6	0.0
Little millet *	0	0	1.2	0	0	0	0	0	0	0.0	0.0	0.4
N		16			5			18			75	

* All little millet and maize consumption was met from own-production

Table 11a. Mean Annual Income from Various Sources in Kolli Hills (2010 Rupees)

Source	<i>Padasolai</i>			<i>Puliampati</i>			<i>Sempathuvalavu</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Livestock	3,220	3,156	2,001	3,634	286	2,042	5,235	1,805	1,959
Ag. Wages	7,175	1,088	22,712	9,796	43	29,652	1,204	43	27,134
Nonfarm	5,817	1,047	1,627	0	154	10,231	18,807	13,148	0
Crops	15,033	23,203	10,163	25,860	29,942	5,333	21,787	22,120	25,753
- Paddy	-100	1,442	750	103	2,193	468	-109	2,458	1,135
- Tapioca	14,452	19,374	2,905	26,279	26,718	4,892	21,483	16,084	4,921
- Millets	80	-13	364	173	280	202	-279	494	166
- Other*	681	2400	6,065	-695	751	-229	692	3,084	19,531
VA products	0	0	165	0	0	174	0	0	94
N		45			14			19	

Source	<i>Thuvarepallam</i>			<i>Tirupuli</i>			<i>All villages</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Livestock	3,468	1,404	1,168	4,535	543	1,890	3,856	1,806	1,809
Ag. Wages	2,071	171	30,181	4,879	2,775	30,582	5,110	934	27,093
Nonfarm	17,538	9,437	3,012	13,482	22,967	259	10,907	8,446	2,368
Crops	24,525	20,586	30,056	19,624	25,602	21,958	20,012	23,682	18,172
- Paddy	36	1,487	202	-481	2,767	192	-120	1,926	563
- Tapioca	13,261	12,790	6,533	15,909	21,037	6,293	16,828	18,645	4,782
- Millets	78	33	-48	34	23	3	28	111	167
- Other*	11,176	6,276	23,369	4,162	1,775	15,470	3,276	3,001	12,660
VA products	0	0	149	0	0	188	0	0	156
N		26			23			127	

* Includes peppers, pineapple, coffee, banana, primarily.

a. These are wages received from off-farm sources.

b. These combine both non-farm wage income and self-employment income.

Table 11b. Mean Annual Income from Various Sources in Kundura (2010 Rupees)

Source	<i>Banuguda</i>			<i>Bhadraguda</i>			<i>Chendiahilingan</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018
Livestock	449	0	695	523	311	596	1,498	630	1,032
Ag. Wages^a	1,133	3,117	8,988	2,692	2,094	7,941	2,602	2,363	9,381
Nonfarm^b	0	0	620	748	5,422	0	0	5,160	1,588
Crops	n/a	n/a	21,512	n/a	n/a	19,178	n/a	n/a	30,730
- Paddy	523	8,954	11,490	-527	13,128	6,419	728	16,038	22,573
- Millets	-39	2,983	1,226	-124	3,217	4,308	77	3,747	5,765
- Other [*]	n/a	n/a	8,796	n/a	n/a	8,451	n/a	n/a	2,392
VA products	0	25	25	0	100	132	0	227	1,032
N		12			9			15	

Source	<i>Dholijhiligan</i>			<i>Heruguda</i>			<i>Kaudiaguda</i>			<i>All Villages</i>		
	2007	2010	2018	2007	2010	2018	2007	2010	2018	2007	2010	2018
Livestock	930	125	637	269	300	0	2,393	0	174	1,225	210	567
Ag. Wages^a	2,229	2,594	4,906	1,211	3,300	2,144	2,019	3,739	7,131	2,066	2,893	7,168
Nonfarm^b	0	3,281	0	0	0	0	0	10,222	1,476	90	4,836	771
Crops	n/a	n/a	23,044	n/a	n/a	24,384	n/a	n/a	20,682	n/a	n/a	23,394
- Paddy	-777	9,381	10,702	-603	7,470	4,610	1,937	16,194	19,009	425	12,602	14,276
- Millets	25	2,663	3,259	502	2,900	4,765	-522	4,411	1,052	-92	3,433	3,132
- Other [*]	n/a	n/a	9,083	n/a	n/a	15,009	n/a	n/a	621	n/a	n/a	5,986
VA products	0	0	0	0	0	60	0	567	271	0	197	295
N		16			5			18			75	

* "Other" includes grams, maize, cashews, pumpkin, mango, cowpeas and eucalyptus. Other crop income only available for 2018.

a. These are wages received from off-farm sources.

b. These combine both non-farm wage income and self-employment income.

Table 12a. Participation and Mean Annual Income from Value-added Products in Kolli Hills (in 2010 Rupees)

	<i>Padasolai</i>	<i>Puliampati</i>	<i>Sempathuvalavu</i>	<i>Thuvarapallam</i>	<i>Tirupuli</i>	<i>All Villages</i>
Mean income from VA products, 2018	621	306	596	774	309	473
No. of participants/Total sampled hh's	12/45	8/14	3/19	5/26	14/23	42/127

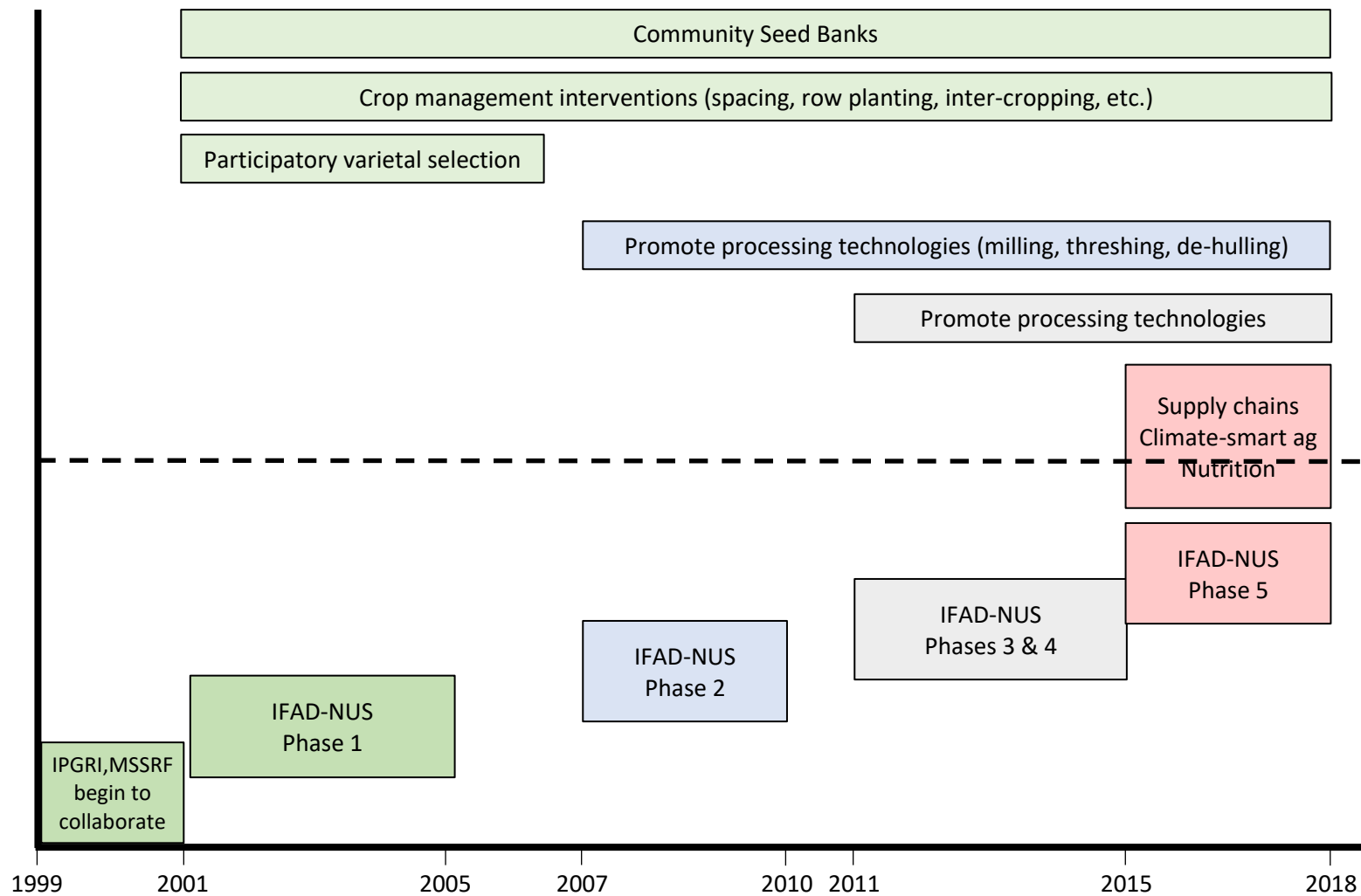
Table 12b. Participation and Mean Annual Income from Value-added Products in Kundura (in 2010 Rupees)

	<i>Banuguda</i>	<i>Bhadraguda</i>	<i>Chendiahilingan</i>	<i>Dholijhiligan</i>	<i>Heruguda</i>	<i>Kaudiaguda</i>	<i>All Villages</i>
Mean income from VA products, 2018	298	596	3,871	0	298	814	1,583
No. of participants/Total sampled hh's	1/12	2/9	4/15	0/16	1/5	6/18	14/75
Mean Income from VA products, 2010	300	225	340	0	0	600	462
No. of participants/Total sampled hh's	1/12	4/9	10/15	0/16	0/5	17/23	32/75

Figure 1. Interventions of note in study villages

Conservation <ul style="list-style-type: none">• Seed identification• Accessions• Seed banks	Cultivation <ul style="list-style-type: none">• Participatory varietal selection• Quality seed production• Crop management research
Consumption <ul style="list-style-type: none">• Diffusion of small-scale processing machinery• Nutritional training	Commercialization <ul style="list-style-type: none">• Value-added training• Larger-scale processing• Supply chain management• National Food Security Act

Figure 2. Timeline of Key Activities in Study Villages, 1999-2018



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