Socioeconomics
Discussion Paper Series

Series Paper Number 33

Sorghum in Semi-arid Subsistence Agriculture: The Case of Central Mozambique

T. W. Tsusaka, H. W. Msere, S. Homann-KeeTui, A. Orr, P. Ndolo

ICRISAT, Lilongwe, takuji.tsusaka@gmail.com

5/19/2015

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This work has been undertaken as part of the CGIAR RESEARCH PROGRAM ON Policies, Institutions and Markets

Acknowledgements

The study was financed by CGIAR Research Program on Dryland Cereals. The study was implemented in Marara, where the ADA-funded project MOREP has identified research needs on options for improving sorghum production. The authors are grateful to Elias Machava who served as an excellent supervisor during the survey program. He also translated the survey instrument into Portuguese. Julio Rainde (IIAM/ICRISAT) substantially helped with local resource mobilization. Anacleta Mugabe (IIAM) contributed by assisting Elias Machava. Gray Nanthoka (ICRISAT) provided translation during the focus group discussions (FGDs), as well as logistical support. Rui Joaquim (SDAE) arranged and participated in the FGDs. We appreciate the efforts made by the team of enumerators: Angelo Traquino, Auria Frechauth, Cristo Sampio, Edma Murmamad, Jordao Almeida, Pedro Sulemane, Rui Joaquim, and Victoria Maria. The survey data were encoded by Kelita Phambala (Bunda College) and Ruth Phiri (Bunda College). Mary Mgonja and Patrick Audi participated in the scoping study. Lastly, Hazel Warren (ICRISAT), Baleke Kachale (ICRISAT), and Sunganani Bakali (Mane Car) gave administrative assistance.

Acronyms

ADA	Austrian Development Agency
FGD	Focus Group Discussion
IIAM	Instituto de Investigação Agrária de Moçambique
MOREP	Developing Resilient and Profitable Rural Livelihood Systems in Semi-arid Mozambique: A Conceptual Approach
MT	Mozambican Metical
SDAE	District Services of Economic Affairs
SLP	Systemwide Livestock Programme
TIA	Trabalho de Inquérito Agrícola (Integrated Agriculture Survey)

Exchange Rate

USD 1 = MT 32.0 as of 1st September 2014

Abstract

Based on the recommendations from the 2013 sorghum scoping study in Mozambique, a focused survey on smallholder sorghum growers was conducted in Marara District, Tete Province, Mozambique, during September 2014, funded by the CGIAR Program for Dryland cereals. 142 households were interviewed, which is a subsample of the 2013 MOREP survey funded by the Austrian Development Agency and CRP Dryland Systems. The study characterizes the current practices of sorghum and pearl millet farming in the area, in terms of use of inputs and outputs, cropping patterns, and profitability of sorghum and pearl millet in comparison with maize. It is found that the marginalized production environment in the studied villages is not appropriate for maize-dependent farming, but sorghum and pearl millet perform fairly. The benefit-cost analysis reveals that sorghum and pearl millet are increasingly advantageous over maize in more marginalized environments, for the given set of agro-ecology and technologies. On the other hand, the major constraints to production of these crops are frequent recycling of seeds, bird pests, and lack of integration with livestock farming. Some gender gap in rates of improved varieties adoption is also observed. The estimated production function indicates that there may be growth potential for sorghum in increasing the seed rate, while the marginal product of labor seems to have reached nil, suggesting the abundance of labor in subsistence agriculture. It is noted that consumers in the Central Zone have different habits of cooking and eating sorghum, as compared with Northern Zone. Sorghum is pounded and cooked into hard porridge in the Central Zone while it is consumed like a rice dish in the Northern Zone. Only a small share of sorghum and pearl millet production is sold. Engagement in off-farm activities and distance to markets are two factors that are likely to affect the likelihood of participation in sorghum commercialization. One notable way sorghum is marketed is in the form of beer, produced primarily by women at household level. A set of R&D activities are recommended with respect to smallholders' capacity development and seed adaptation research. Training programs for capacity development need to cover the following subjects: (1) seed quality, (2) seed rate, (3) bird control, (4) crop-livestock integration, and (5) access to markets. The crop improvement efforts need to address the following aspects: (1) location-specific adaptation of grain quality to suit the local dietary habit, (2) grain taste adjustment to incorporate consumers' general preference for maize porridge to sorghum and pearl millet porridge, and (3) developing sorghum varieties with good malting qualities.

Keywords: sorghum, pearl millet, maize, food security, subsistence farming, Mozambique.

JEL classification: N57, Q12, Q16

Contents

1. Introduction

While there have been calls for the development of smallholder agriculture to be market-driven, subsistence crop farming still dominates in sub-Saharan Africa (SSA) (Staatz et al., 2007). There is an urgent need to significantly enhance the productivity of subsistence agriculture to ensure long-term food security and development in SSA (Baiphethi et al., 2009). However, there are severe limitations to smallholder agriculture in the region. Lipton (2010) describes subsistence farmers as smallholders who rely mainly or wholly on family labor producing primarily staple foods in amounts that are barely sufficient to feed their families. Typical subsistence farmers suffer low yields due to insufficient use of modern inputs, a single growing season with unreliable rainfall, poor soil quality, limited market infrastructure, and lack of access to extension services (Hanson, 2008). In particular, where climatic conditions limit the potential for higher-yielding crops such as maize, farmers have no option but to rely on lower-yielding yet stress-resistant crops that can grow even under a harsh agro-ecology, such as sorghum and pearl millet.

Sorghum is the fifth most important cereal crop in the world and the second most important in sub-Saharan Africa. Sorghum is a versatile cereal crop that can be used for food, fodder, fuel, and construction materials. Sorghum requires only 400-750 mm of annual rainfall, whereas maize requires 900 mm or more.[1] Sorghum is also resistant to heat and waterlogging in comparison with major cereals (Tsusaka and Otsuka, 2013). A Green Revolution in Africa that includes marginal areas, therefore, cannot afford to neglect sorghum and millet, traditionally “orphan” crops that have received the least attention from R&D (Africa Harvest, 2015).

The CGIAR Research Program for Dryland Cereals has identified Mozambique as a target country for sorghum (ICRISAT, 2010). In mid-2013, ICRISAT and the Institutio de Investigacao Agraria de Mozambique (IIAM) conducted a scoping study that identified the need for a baseline survey to provide information on the role of sorghum at the farm level (Orr et. al., 2013). Although socioeconomic reports on Mozambican agriculture abound, most focus either on the entire agricultural sector or on the main crops such as maize and cassava. Information on sorghum is limited.[2] To fill this knowledge gap, ICRISAT jointly with IIAM conducted a small-scale baseline survey on sorghum in Mozambique.

[1] The popular maize varieties in Marara District, where our survey was conducted, are bred for drought tolerance and are supposed to have lower rainfall requirements.

[2] IIAM provides a partial budget for sorghum but this involves the use of tractors which is rare in smallholder agriculture. We did not locate any previous study on the profitability of sorghum compared to other crops.

Given limited resources, the baseline survey was conducted in Marara District, Tete Province, in the Central Zone, which is the center of sorghum production in Mozambique. The survey was conducted in September 2014 and covered 142 households. Marara District is predominantly a dryland subsistence farming system where the major crops are sorghum and pearl millet grown mostly for home consumption. Other minor crops include maize, groundnut, and cowpea. The baseline survey focuses on, sorghum and pearl millet, with reference to maize.

The general objective of this paper is to assess the role of sorghum and pearl millet in the farming system and in the farm household. The specific objectives are to:

1. Measure the adoption of improved varieties and identify adoption constraints;
2. Compare the profitability of sorghum, pearl millet, and maize; and
3. Identify the main end uses and constraints on commercialization.

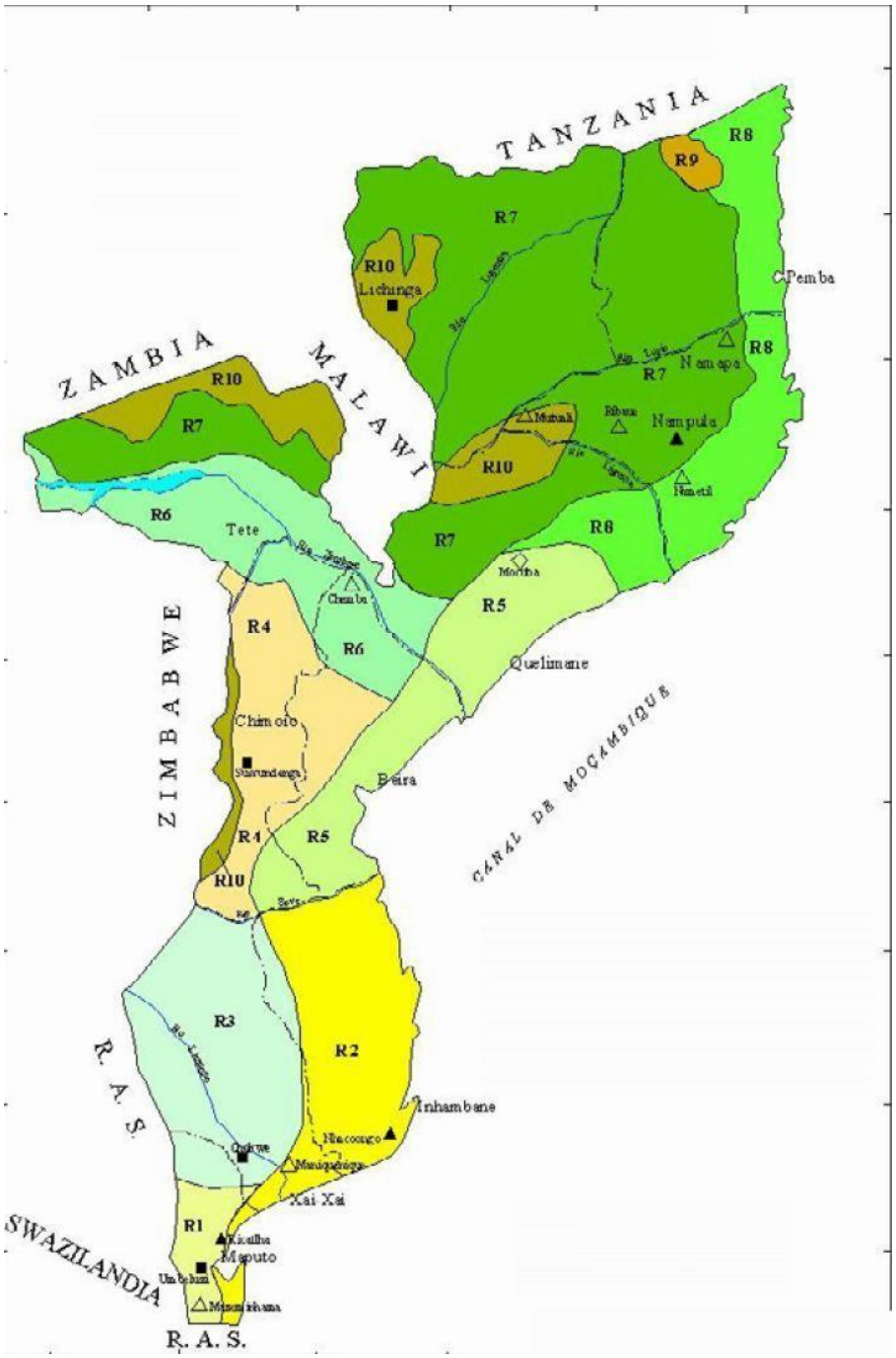
Following this introduction, the rest of the paper is organized as follows. Section 2 reviews how sorghum is positioned in Mozambique by showing production statistics and agro-ecological status. Section 3 outlines the methodology. Section 4 describes the findings from the survey. Lastly, Section 5 outlines the implications of the research findings for the CGIAR Research Program.

2. Sorghum in Mozambique

Agriculture is the mainstay of the economy, and the country has a great potential for growth in the sector. Agriculture employs more than 80 percent of the labor force and provides livelihoods to the vast majority of over 23 million inhabitants. Agriculture contributed 32 percent of the national GDP in 2009, and 20 percent of the total export value originated from the agricultural sector (FAO, 2010). Agricultural potential is high, particularly in the fertile northern regions, which account for the bulk of the country's agricultural surplus. Across the nation, however, the use of improved seeds, irrigation, mechanization, and animal traction has not changed substantially over time. Moreover, since most of agricultural production is rainfed, weather variability has masked any detectable positive trends in cereal production. Consequently, although the economy has grown by seven percent per annum over the past two decades, growth in agriculture has been eclipsed by the performance of other sectors. Rural poverty has fallen in some provinces, such as Inhambane and Tete, but in other provinces such as Sofala and Zambezia, rural poverty has actually increased (Walker et al., 2015).

2.1. Sorghum Production Environment

Mozambique can be divided into ten agro-ecologies. The classification, which is derived from the work of the National Institute of Agronomic Research (INIA),[3] is mapped in Figure 1, while the characteristics of the 10 zones are summarized in Table 1.



Source: Walker et al. (2006)

Figure 1: Distribution of the Ten INIA Agro-ecologies in Mozambique

[3] INIA is one of the institutional precursors to IIAM.

Table 1: INIA Agro-ecological Zones

Zone	Description	Rainfall (mm/year)	Soil Type
R1	Semi-arid Interior South	570	Sands
R2	Semi-arid Coastal South	500-600	Deep Sands
R3	Arid Interior South	400-600	Loamy-clays
R4	Mid-elevation Central	1,000-1,200	Clays
R5	Coastal Central	1,000-1,400	Vertisols and Fluvisols
R6	**Dry Semi-arid Tete & Zambézia**	**500-800**	**Sands-clays**
R7	Interior Central and North	1,000-1,400	Sands-clays
R8	Coastal North	800-1,200	Mostly Sands, Clays on a Small Scale
R9	Interior North of Cabo Delgado	1,000-1,200	Limes and Sands
R10	High Altitude	>1,200	Hard Ferralsols

Source: Ministry of Agriculture and Fisheries

The climate is humid tropical in the northern and costal zones, and dry tropical in southern and interior zones. The rainy season starts in November-December and lasts until March-April. Annual rainfall varies from 0-400 mm (in the south and central western parts) to more than 1200 mm. Generally, the average annual temperatures are cooler (18-20 °C) during the dry season and warmer (26-30 °C) during the wet season. Fertile soils with good agricultural potential are found as light clays in the north and most of the central and western parts of the country and as alluvial soils along the coast and alluvial flood plains. Sandy soils with limited agricultural potential are found in the low plateau in the southern part of Mozambique.

Agro-ecological Zone R7 produces the largest quantity of sorghum, followed by Zone R6. High-yielding, short-stature, photoperiod-insensitive varieties are not well adapted to the growing season conditions of northern Mozambique, where rainfall at planting is uncertain and the risk of rainfall at harvesting is high (Walker et al, 2006). The districts shown in Table 5 are mostly upland, over 200 m above MSL. Levels of rainfall in these areas vary across districts, with the average of more than 1000 mm per year. Sorghum varieties that will grow in areas where rainfall is below 500 mm per year are being developed.

Figure 2 shows the area suitable for rainfed sorghum production in Mozambique, based on climatic and soil data (IIAM, 2010). The major sorghum producing areas including Marara District fall in the moderately appropriate areas. The map suggests that the coastal north (R8) may have great potential left for the expansion of sorghum. Drawing on the information from the map, IIAM defines three target domains for sorghum research with desirable sets of traits for each domain (Table 2). Figure 3 shows the total area planted to sorghum and the average rainfall by target domain, which indicates that the Central Plateau is not endowed with as much rainfall as the Northern Plateau.

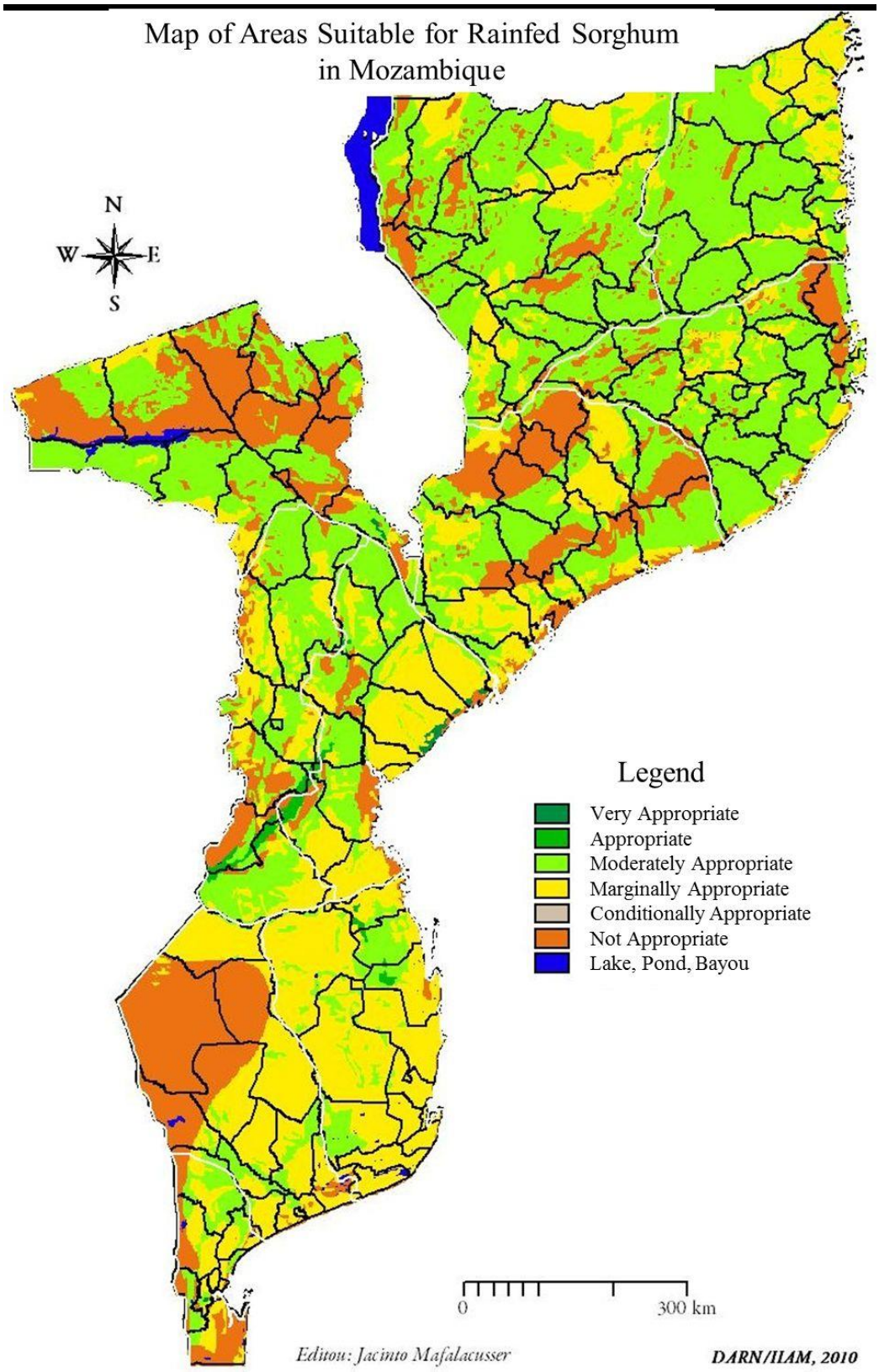
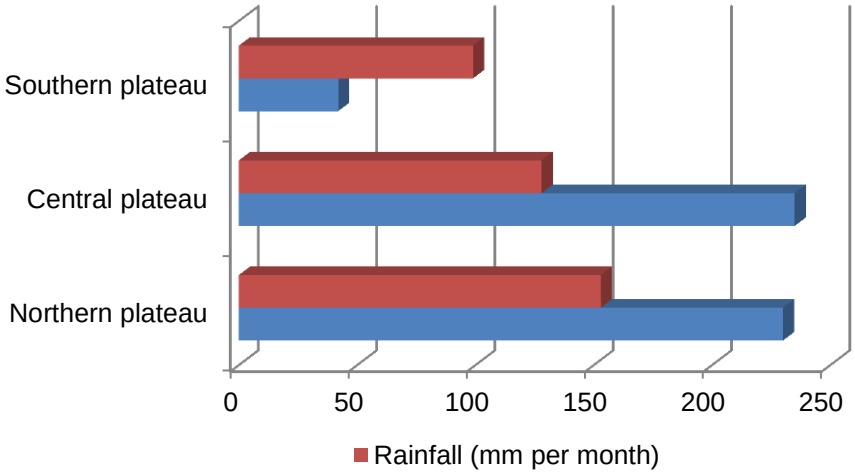


Figure 2: Area Suitable for Rainfed Sorghum in Mozambique

Table 2: IIAM's Three Research Target Domains for Sorghum

Target Domain	Provinces	Desirable Traits
Southern Plateau	Gaza, Inhambane	Early maturing; drought tolerance; resistance to stem borer, midge, shoot fly, aphids, and mildew
Central Plateau	**Tete**, Manica, Sofala, Zambezia	Medium maturity
Northern Plateau	Cabo Delgado, Nampula	Late maturing varieties



Source: Adapted from INTSORMIL (2006)

Figure 3: Area Planted to Sorghum and Average Rainfall by Target Domain

2.2. Crop Production

National production and cultivated area for different crops in Mozambique are summarized in Table 1. Cropping is dominated by cassava and maize, which together account for nearly 50 percent of the value of agricultural production value in the small and medium farm sector. Forty-nine percent of farmers reported maize as their most important staple crop, followed by cassava (40 percent), and rice (a distant third at eight percent). Sorghum was in fourth place at only three percent. Pearl millet and sweet potato accounted for the remaining responses (less than one percent each). In terms of volume, sorghum has been either the 4th or 5th most important crop over the years. Nonetheless, Table 3 shows that production as well as area fluctuates substantially by year.

Table 3: Production and Area for Different Crops in Mozambique, 2005-2008 and 2012

Crop	Production (000 ton)					Area (000 ha)				
	2005	2006	2007	2008	2012	2005	2006	2007	2008	2012
Cassava	4782	5481	4959	3839	4099	1108	858	994	953	763
Maize	942	1395	1134	1214	1177	1852	1664	1664	1965	1572
Orange (non sweet)	430	577	678	458	454	62	64	70	48	55
Cotton	114	128	93	70	157	230	156	133	104	207
Sorghum	**115**	**202**	**167**	**126**	**139**	**381**	**406**	**384**	**384**	**307**
Orange (sweet)	79	101	184	102	133	9	16	17	16	17
Pigeonpea	36	62	71	64	113	158	170	199	190	249
Rice (milled)	65	98	103	88	102	318	358	362	311	363
Groundnut (small)	58	60	70	71	88	294	223	273	323	286
Cowpea	49	71	62	62	85	369	351	371	353	347
Butter Bean	50	50	55	53	55	117	93	95	107	85
Sesami	20	21	19	41	34	72	69	74	119	99
Groundnut (large)	27	25	31	31	25	131	100	124	135	103
Pearl Millet	**15**	**22**	**25**	**15**	**22**	**56**	**57**	**53**	**59**	**55**
Tobacco	81	93	34	46	21	90	56	48	63	35
Bambaranut	9	12	20	13	19	64	62	90	78	79
Soybean	3	4	5	7	5	9	7	8	14	8
Sunflower	1	4	6	3	3	4	10	9	10	6

Source: Data extracted from TIA (Trabalho de Inquérito Agrícola) Survey

Table 4 shows agricultural yields for different crops. Among the staples, cassava has the highest yield, while others have extremely poor yields, even by African standards. This reflects the low levels of input use and adoption of improved technology throughout the country. The yield for sorghum in 2012 was 0.45 ton/ha, which is much lower than either the world average (1.53 ton/ha) or the African average (1.04 ton/ha) due partly to the low and erratic rainfall patterns in sorghum producing areas. The sorghum yield has indeed fluctuated between 0.3 and 0.5 ton/ha in recent years.

Table 4: Yield for Different Crops in Mozambique, 2005-08 and 2012.

Crop	Yield (ton/ha)				
	2005	2006	2007	2008	2012
Orange (non sweet)	6.98	9.02	9.74	9.52	8.29
Orange (sweet)	8.58	6.31	10.59	6.31	8.04
Cassava	4.32	6.39	4.99	4.03	5.38
Cotton	0.50	0.82	0.70	0.67	0.76
Maize	0.51	0.84	0.68	0.62	0.75
Butter Bean	0.43	0.54	0.57	0.49	0.65
Soybean	0.37	0.59	0.68	0.52	0.62
Tobacco	0.90	1.66	0.70	0.74	0.61
Pigeonpea	0.23	0.37	0.36	0.34	0.46
Sorghum	**0.30**	**0.50**	**0.43**	**0.33**	**0.45**
Sunflower	0.24	0.41	0.64	0.34	0.44
Pearl Millet	**0.27**	**0.39**	**0.47**	**0.25**	**0.40**
Sesami	0.28	0.30	0.25	0.34	0.34
Groundnut (small)	0.20	0.27	0.26	0.22	0.31
Rice (milled)	0.20	0.27	0.28	0.28	0.28
Cowpea	0.13	0.20	0.17	0.18	0.25
Bambaranut	0.14	0.19	0.22	0.16	0.24
Groundnut (large)	0.21	0.25	0.25	0.23	0.24

Source: Data extracted from TIA (Trabalho de Inquérito Agrícola) Survey

Mozambique is divided into three broad regions: the North (Niassa, Cabo Delgado, and Nampula Provinces), Central (Tete, Zambezia, Manica, and Sofala Provinces), and South (Inhambane, Gaza, and Maputo Provinces). Table 5 presents the quantity of sorghum produced and area cultivated to sorghum by province. While Nampula Province produces the largest quantity, the central zone comprising Sofala, Manica, and Tete is the highest producing zone. Moreover, in terms of average production over the years in question, Sofala (29,900 tons) and Manica (29,700 tons) surpass Nampula (22,400 tons), which highlights the relevance of sorghum to the Central Zone. On the whole, both production and area fluctuate considerably.

Table 5: Production and Area for Sorghum by Province, 2005-2008 and 2012

Zone	*Province*	Production (000 ton)					Area (000 ha)				
		2005	*2006*	*2007*	*2008*	*2012*	*2005*	*2006*	*2007*	*2008*	*2012*
Northern	Nampula	16.7	32.7	21.2	15.0	26.3	54.4	65.7	69.6	61.7	61.4
	Cabo Delgado	30.5	25.9	17.7	16.8	17.6	73.7	60.5	57.1	50.7	40.9
	Niassa	6.6	13.1	7.7	13.1	6.8	24.4	36.1	34.4	27.9	17.1
	subtotal	53.8	71.7	46.6	44.9	50.7	152.5	162.3	161.1	140.3	119.4
Central	Sofala	16.5	39.6	36.2	31.7	25.2	62.7	67.6	60.2	88.9	50.3
	Manica	22.2	45.5	43.8	15.4	21.3	68.9	67.4	73.4	42.8	40.2
	Tete	**9.3**	**27.4**	**22.0**	**13.6**	**20.8**	**41.5**	**51.1**	**40.9**	**38.8**	**37.9**
	Zambezia	12.1	14.7	14.0	17.4	20.4	44.5	43.0	29.7	52.9	53.3
	subtotal	60.1	127.2	116	78.1	87.7	217.6	229.1	204.2	223.4	181.7
Southern	Inhambane	0.4	2.3	3.2	2.3	0.8	6.2	9.8	15.7	12.0	4.8
	Gaza	0.2	0.6	0.9	0.8	0.1	5.0	4.8	2.7	7.7	1.2
	Maputo	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1
	subtotal	0.6	2.9	4.1	3.1	0.9	11.2	14.7	18.5	19.7	6.1
	Grand Total	114.5	201.8	166.9	126.2	139.3	381.3	406.2	383.9	383.5	307.3

Source: Data extracted from TIA (Trabalho de Inquérito Agrícola) Survey

Table 6 shows the average sorghum yield by province. As already mentioned, the yield is significantly low across the nation. Nonetheless, the provinces in the Central Zone (Tete, Sofala, and Manica) achieve yields better than the national average, in spite of the harsh climatic condition.

Table 6: Sorghum Yield by Province, 2005-2008 and 2012

Province	Yield (ton/ha)				
	2005	*2006*	*2007*	*2008*	*2012*
Tete	**0.22**	**0.54**	**0.54**	**0.35**	**0.55**
Manica	0.32	0.67	0.60	0.36	0.53
Sofala	0.26	0.59	0.60	0.36	0.50
Cabo Delgado	0.41	0.43	0.31	0.33	0.43
Nampula	0.31	0.50	0.30	0.24	0.43
Niassa	0.27	0.36	0.22	0.47	0.40
Zambezia	0.27	0.34	0.47	0.33	0.38
Inhambane	0.06	0.23	0.20	0.19	0.17
Maputo	0.00	0.14	0.08	n/a	0.09
Gaza	0.05	0.13	0.33	0.11	0.08
Total	0.30	0.50	0.43	0.33	0.45

Source: Data extracted from TIA (Trabalho de Inquérito Agrícola) Survey

Within provinces, sorghum production is concentrated within specific districts. In Nampula Province, for example, sorghum is not widely grown in Nampula District, but in

districts 100-200 km distant. Table 7 shows the main sorghum growing districts in Mozambique.

Table 7: Sorghum Growing Districts

Province	Main Sorghum Growing Districts
Tete	**Marara**, Changara, Zumbo, Cahora Bassa (Songo area)
Sofala	Caia, Gorongosa, Maringue
Manica	Cataudica, Sussemdinga, Tambara, Macossa
Nampula	Mucuburi, Ribaue, Malewa, Lalauo

2.3. Crop Sales

Maize is by far the most marketed crop in Mozambique (Table 8). Unfortunately, the figures for the latest few years are not reported. Groundnut takes a distant second place. Sorghum and pearl millet are not major crops in the marketplace, with only 3,000 and 1,000 tons marketed in 2008, respectively.

Table 8: Quantity Sold by Crop, 2002-2003 and 2005-2008

Crop	Sales of Different Crops (000 ton)					
	2002	*2003*	*2005*	*2006*	*2007*	*2008*
Maize	121.5	157	140	148.6	173.5	209.4
Groundnut (small)	16.6	n/a	13.6	12.9	20	23.8
Butterbean	10.8	12.9	23.8	18.7	22.5	20.8
Pigeonpea	0.5	12.2	8.1	18.9	13.5	20.5
Cowpea	5.3	9.2	7.6	9.2	10.6	9.3
Rice (milled)	12.1	15	10	12.1	8.2	8.5
Groundnut (large)	7.3	n/a	6.9	7.9	8.6	7.6
Sorghum	**2.9**	**7.1**	**3.9**	**4.9**	**4.4**	**3.3**
Bambara nut	0.5	0.7	0.6	0.6	1.6	1.6
Pearl Millet	**0.0**	**0.3**	**0.6**	**0.4**	**0.1**	**0.8**

Source: Direcção de Economia & Departamento de Estatistica (2008)

Table 9 shows the proportion of crop production sold in 2005-2008, indicating that although maize dominates crop markets, the majority of the maize production is unsold and consumed by producers themselves. Nearly one third of the production of legumes such as groundnut, butterbean, and pigeonpea is found to be sold. Among the crops, sorghum and pearl millet have the lowest proportion of sales, confirming their role as food security crops.

Table 9: Percentage of Production Sold, by Crop, 2005-2008

Crop	Sales / Production (%)			
	2005	*2006*	*2007*	*2008*
Maize	14.9	10.6	15.3	17.3
Groundnut (small)	23.3	21.5	28.5	33.4
Butterbean	47.3	37.7	41.3	39.5
Pigeonpea	22.2	30.4	18.9	32.0
Cowpea	15.6	12.9	17.0	14.9
Rice (milled)	15.5	12.4	8.0	9.6
Groundnut (large)	25.2	31.9	27.5	24.5
Sorghum	**3.4**	**2.4**	**2.6**	**2.6**
Bambara nut	6.7	5.2	7.9	12.7
Pearl Millet	**3.9**	**1.8**	**0.4**	**5.5**

Sources: Authors' calculation from Direcção de Economia & Departamento de Estatistica (2008) and Data extracted from TIA (Trabalho de Inquérito Agrícola) Survey

3. Methodology

3.1. Site Selection

ICRISAT's research agenda in Mozambique includes activities under CRP WLE (Water, Land and Ecosystems), CRP DS (Dryland Systems) (using ADA project sites), CRP DC (Dryland Cereals), USAID, and the McKnight Foundation (Table 10). CRP DS conducted baselines on the crop-livestock system in Marara and Manica in 2013.[4] CRP WLE has one technician based in Angonia, Tete Province.

Table 10: Research Sites under Different Ongoing or Recent ICRISAT Projects

Project	Research Sites		Farming System
	Province	District	
CRP WLE	Tete	Angonia	Maize based (high potential)
CRP WLE	Tete	Moatize	Sorghum-Livestock system
SLP/CRP DS/**CRP DC**	Tete	Marara	Sorghum-P.Millet-Livestock system
ADA/CRP DS	Manica	Manica	Dryland Crops
ditto	Tete	Marara	Sorghum-P.Millet-Livestock system
USAID	various	various	Maize-Legume
McKnight Foundation	various	various	Maize-Legume

The IIAM North-East Zone Research Centre was the focal point for ICRISAT research on sorghum between 2006 and 2008. However, it would make sense for ICRISAT to use its limited resources to concentrate research efforts at specific sites. This would mean focusing research on sorghum in one of the sites listed in Table 10. Language is another factor. The Chichewa spoken in Lilongwe where ICRISAT Malawi is based and Nyungwe in Tete

[4] At that time, Marara District was still part of Changara District.

Province are strikingly similar. Given limited resources, these factors determined the choice of Tete Province as the site for this baseline survey.

3.2. Study Site

Marara District, which was separated from Changara District in 2014, is located in Tete Province, Central Western Mozambique. The climate is hot semi-arid, with an expected rainfall of 630 mm a year, beginning with a few showers in November and accelerating to a rainy season usually lasting from December to early March, when the rains taper off. . There are severe dry spells during the rainy season, restricting water for crops and livestock. There is practically no rainfall outside the unimodal rainy season (WMO, 2015). Soils in Marara are predominantly sands of typically low mineral content, due to low clay and organic matter contents (FAO, 2006). The typical natural vegetation is savannah woodlands and natural grasses. Villages are sparsely located while farm households are relatively dispersed within villages. Most farmers in Marara fall under the “very resource-poor” and “resource-poor” categories (Homann-KeeTui et al., 2014). Access to farm inputs is poor, and land use is extensive rather than intensive. Farmers face cash constraints and find it difficult to reinvest in agriculture. Relatively successful farmers, as a minority, are those that are capable of risk diversification and investing in and integrating crops and livestock as a system.

3.3. Survey

The survey used a sub-sample of farmer households surveyed by the MOREP project in 2013. Seven villages were selected within the district, and 7 to 30 households were interviewed from each of the seven villages: Bairro (n=7), Migosa (n=26), Mpadue (n=11), Mufa (n=25), Mulatho (n=17), Nhadsanga-sul (n=26), Nhandunduma (n=30), forming a sample of 142 households. Households were not purposively selected to be sorghum growers. The survey was conducted in August-September 2014 by nine trained enumerators using a structured questionnaire. The questionnaire was administered in Portuguese and an English version is provided in Appendix 1.

3.4. Focus Group Discussions

To gain general insights into local farming practices prior to the survey, we held Focus Group Discussions (FGDs) with separate groups of men and women from in Mulatho Village. Forty farmers (14 male and 26 female) participated in these discussions. Information from the FGDs was used to help understand the survey findings.

3.5. Analysis

Descriptive statistics were used to provide the socioeconomic profile and the farming practices of the sampled farmers. Benefit-cost analysis was used to present the partial budget for sorghum and pearl millet production. Most of the statistics for the two crops were shown with reference to maize. Drought-tolerant maize varieties seem to be expanding as farmers prefer to consume maize and now have access to the seed at local markets. Econometric analysis was used to estimate production functions for cereal crops, adoption of improved varieties, and determinants of crop sales. The factors for technology adoption and commercialization are examined by the probit model.

4. Results

4.1. Focus Group Discussions

Important crops: According to the women participants, the crops grown are, in order of importance (1) sorghum, (2) pearl millet, (3) groundnut, and (4) cowpea. Despite the dry climate, some farmers grow maize as they prefer eating maize. The four crops are grown predominantly for home consumption. Planting starts in October with pearl millet, then sorghum, groundnut, and cowpea in that order. Once every 4-5 years, the temperature becomes very high. Forty percent of the women rear small livestock (i.e., goats and chicken). For men, the important crops are (1) sorghum, (2) pearl millet, (3) groundnut, and (4) cowpea, (5) watermelon, and (6) pineapple. Although not listed, we are aware that maize also has certain importance in this area. Crops are mostly used for home consumption. The important livestock animals are (1) goats, (2) cows, (3) pigs, and (4) chickens. The main item for sales in this area is livestock. According to the participants in the male FGD, livestock is more consumed than sold. However, various surveys including ours indicate that the offtake rates of livestock are quite high.[5]

Off-farm income: Eight percent of the women are single, and make sorghum beer at home for sale to fellow villagers. Married women do not make sorghum beer and their husbands tend to engage in piecework. The main source of off-farm income is agricultural labor (ridging and weeding) and selling charcoal. Brewing *kachasu* (local spirits) is a family-based business where men supply cash for inputs and women make the product.

***Sorghum*:** Women perceive sorghum as more drought resistant than pearl millet. Pearl millet is also perceived as more labor intensive than sorghum because of the smaller grains,

[5] It was observed that the participants in FGDs, both male and female, had a tendency to pretend to look poorer than they actually were by understating their involvement in livestock production and sales.

but less labor intensive than groundnuts. Allegedly, 25 percent of pearl millet crop is lost to damage by birds and insects, and the loss is greater than for sorghum. They use a gun to scare away birds. There is a gender division of labor. According to men, land preparation, harvesting the stalks of sorghum and pearl millet is done primarily by women, while weeding is mostly performed by men. Men insisted that 50 percent of sorghum and pearl millet production is lost to bird attacks.

***Consumption*:** Sorghum and pearl millet are consumed in the form of *nshima* (hard porridge). The grains are pounded into flour at a mill within the village in exchange for a nominal amount of grain as payment. They are also eaten as fresh grain in field. However, farmers in this area do not consume these crops like rice as found in Nampula Province. The usual relish eaten together with hard porridge is cowpea. The favorite relish is okra grown in the village. They also purchase food items from the market, especially maize, sorghum, and pearl millet, which is made possible through livestock income. They go to the local market to buy food approximately once a month, though the nearest local market is 16 km away.

***Sorghum Varieties*:** The popular sorghum variety planted is what they perceive as Macia (the local name is "Kagipi"). Men suspect what they think is Kagipi may actually be Mussequesse. Apart from own and locally traded recycled seed, seed is sourced from the local market, local agro-dealers, and government extension officers. Both Kagipi and a tall stalk variety are grown, because a combination of Kagipi (short duration) and the tall stalk variety (long duration) reduces risk. Kagipi is generally perceived as more stress tolerant. For pearl millet, local seeds tend to be preferred. Seeds of pearl millet are mostly local varieties. Men estimated that half of the seeds for sorghum and pearl millet are locally traded among farmers, while groundnut seeds are provided by the government workers. After a drought, however, the government provides seeds of sorghum and pearl millet as well. Men perceived that seed supplied by the government perform better than recycled seed.

***Investments*:** Participants were asked: "If you were given MT 1,500 of cash, how would you invest that money?" [6] Women claimed that they would buy sugar, produce *kachasu*, sell it, and use the income to buy household items. This suggests that there is a means of amplifying money once some capital is provided?" Men mentioned rearing goats and chicken for sale, and small business, but no specific idea was presented.

[6] USD1=MT32 as of the time of the study.

4.2. Smallholder Socio-economic Profile

Table 11 summarizes the key demographic variables for the sample farmers. The average age of the household head is 50. Most household heads in Marara are above 40. The average years of schooling of the household head is 3.6, which contrasts with 6.0 in southern Malawi (Msere et al, 2015), indicating the inadequate primary school system in Mozambique several decades ago. The average household size is 6 persons. Seventy-eight percent of the respondents are male, while 77 percent of the respondents are currently married. Unsurprisingly, male-headed households tend to have a larger household size, which is the case with all the 7 villages. There is no statistically significant inter-village mean difference in these variables except for gender of household head.

Table 11: Demographic Profile of Sampled Farmers, Marara District (n=142)

	Age of HH Head	Education of HH Head (years)	HH Size (headcount)	Gender of HH Head (1=male)	Marital Status (1=married)
Mean (StDev)	49.82 (15.93)	3.61 (3.04)	6.07 (2.86)	0.78	0.77
ANOVA by Village: P-Value	0.576	0.179	0.311	0.015	0.208

Source: Survey Data

4.3. Crop Farming Practices

Table 12 confirms that the majority of the farmers in the study villages grew sorghum and pearl millet. Nonetheless, 40 percent of farmers also grew maize, which can act as a point of comparison for sorghum and pearl millet farming in this area. The table further shows that the production statistics per grower for each of the three crops. Maize and sorghum growers allocate an average of 1.4-1.5 hectares of land to each crop, whilst pearl millet producers allocate less than one hectare for pearl millet. The pearl millet yield is the highest of all, followed by sorghum. The maize yield is rather low, which may be explained by the harsh environment for this crop. Furthermore, maize growers are presumably in relatively favorable production environments as well as being richer in resources. There is no statistically significant mean difference in any of the production statistics across villages, suggesting the fairly homogeneous production environment in the sampled areas.

Table 12: Production Statistics (mean per grower) for Sorghum, Pearl Millet, and Maize in Marara, 2013/2014

Crop	N	% of HH growing [a]	Mean per grower [b]		
			Area (ha)	Yield (kg/ha)	Production (kg)
Maize	62	43.7	1.5 [0.80]	279 [0.31]	404 [0.45]
Sorghum	115	81.0	1.4 [0.97]	326 [0.17]	459 [0.51]
Pearl Millet	108	76.1	0.8 [0.53]	549 [0.52]	428 [0.69]

Source: Survey Data
a: The percentages do not sum up to 100 as each respondent can grow multiple crops.
b: P-Values for village-level ANOVA are in the brackets.

Much of the crop area is intercropped or mixed cropped, in particular, between sorghum and pearl millet (Table 13). Farmers reported that this practice reduced the risk of crop losses in drought years.

Table 13: Area under mono-cropping, intercropping, and mixed-cropping, for Sorghum, Pearl Millet, and Maize in Marara (mean per grower), 2013/2014

Crop		Total Area	Mono-cropped	Inter-cropped	Mixed-cropped	Main partner crops for inter- and mixed-cropping
Sorghum	ha	1.45	0.11	0.79	0.56	1. Pearl Millet, 2. Maize
	%	100	7.3	54.2	38.6	
Pearl Millet	ha	1.41	0.19	0.67	0.55	1. Sorghum, 2. Maize
	%	100	13.5	47.6	38.9	
Maize	ha	0.78	0.11	0.15	0.52	1. Sorghum, 2. Pearl Millet
	%	100	14.0	19.6	66.5	

Source: Survey Data

4.4. Loss by Birds

Yield losses caused by birds were a major constraint on production. Approximately 9 to 10 percent of production was estimated to be lost to birds (Table 14). Reportedly, the only effective measure to mitigate this loss was scaring off birds using family labor. Surprisingly, farmers reported that maize incurred the same level of loss from birds from birds as sorghum.

Table 14: Estimated Yield Loss by Pest Birds per Grower, for Sorghum, Pearl Millet, and Maize in Marara, 2013/2014

Crop	Estimated Loss by Pest Birds	
	Kg	% of Production
Sorghum	38.8	9.6
Pearl Millet	39.9	8.7
Maize	41.9	9.8

Source: Survey Data

4.5. Profitability of Sorghum and Pearl Millet vs. Maize

. Table 15 summarizes the itemized mean costs of inputs per grower for the production of the three crops. The total production cost does not differ much across crops, though this implies that the cost per unit area is higher for maize, since the area planted to maize is smaller than for sorghum or pearl millet. Almost no chemical inputs were applied, indicating that smallholders in this area still depend on the traditional low-input farming practice to produce their main staple crops. Maize is relatively input intensive, involving greater expenditure on chemicals and hired labor.

The opportunity cost of family labor is later estimated to be around 15 percent of hired labor wage level. Hence, this rate is used in the calculation for Table 15. Bird scaring is an important part of a family's farming activity in traditional African agriculture (Doggett 1957), which is still a common practice in this area. Farmers in Marara protect their crops from birds by frightening birds by shouting, making noise with as bottles and cans, and throwing stones.[7] In particular, for sorghum, 21 percent of the production cost is devoted to efforts to scare off birds, which is higher than 14 percent for maize and 11 percent for pearl millet.

[7] These traditional frightening methods can provide some protection when bird numbers are low and farmers are protecting their own small fields (Pepper 1973; Ruelle and Bruggers 1982).

Table 15: Mean Cost per Grower of Production for Maize, Sorghum, and Pearl Millet in Marara, 2013/2014

	Maize (N=62)		Sorghum (N=115)		Pearl Millet (N=108)	
Cost Item	Mean Cost(MT)	% of Total	Mean Cost(MT)	% of Total	Mean Cost(MT)	% of Total
Seed	837	17.9	475	10.8	1406	26.3
Fertilizer	8	0.2	0	0.0	0	0.0
Herbicide	0	0.0	1	0.0	0	0.0
Pesticide	3	0.1	2	0.0	2	0.0
Hired Labor	1820	39.0	1240	28.2	1316	24.7
-Land preparation	411	8.8	414	9.4	368	6.9
-Planting	253	5.4	80	1.8	110	2.1
-Weed control	392	8.4	414	9.4	435	8.1
-Harvesting	446	9.6	156	3.6	203	3.8
-Bird Scare	188	4.0	117	2.7	74	1.4
-Threshing	131	2.8	58	1.3	126	2.4
Family Labor*	1997	42.8	2676	60.9	2613	49.0
-Land preparation	369	7.9	391	8.9	485	9.1
-Planting	306	6.5	400	9.1	402	7.5
-Weed control	311	6.7	447	10.2	550	10.3
-Harvesting	325	7.0	329	7.5	412	7.7
-Bird Scare	456	9.8	822	18.7	504	9.4
-Threshing	230	4.9	288	6.5	260	4.9
Total Production Cost	4296	100	4198	100	4090	100

Source: Survey Data
The costs presented are sample means per grower for each crop.
Seed, fertilizer, herbicide, and pesticide costs: Reported cost of inputs used.
Hired labor costs: Person days (8 working hours per day) multiplied by the wage paid.
Family labor costs: The opportunity cost assumed as person days (8 working hours per day) multiplied by 15% of hired labor wage.

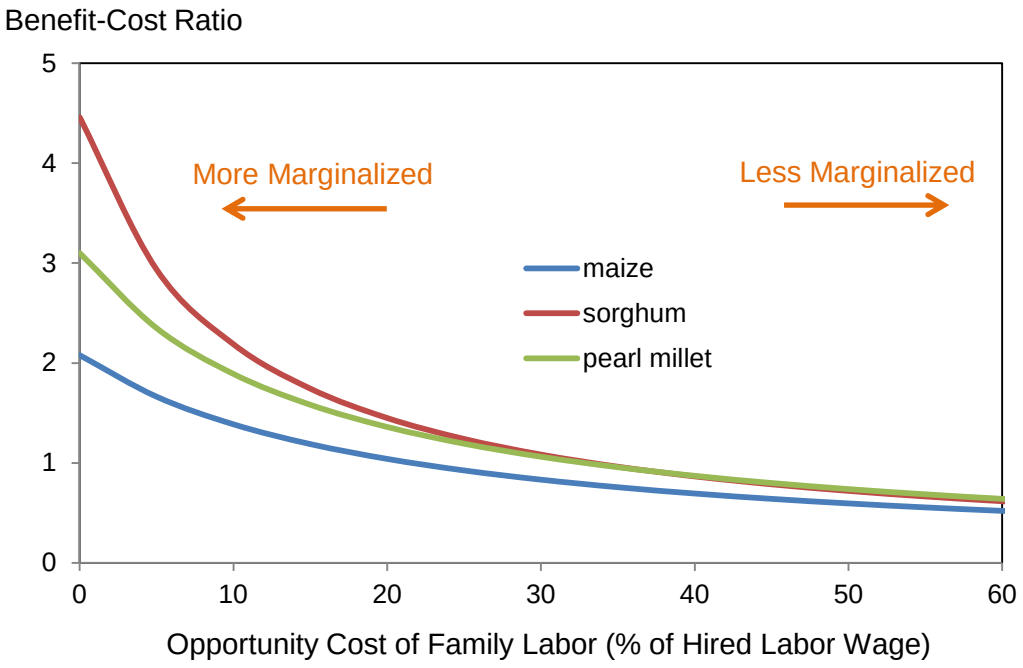
Based on the production costs in Table 15, a benefit-cost ratio (BCR) is calculated for each crop and the result is summarized in Table 16. As we see the farms as enterprises and consider only the cash flows, the bottom line turns out to be negative, as indicated by the enterprise BCR being smaller than unity for all the three crops since most of the production is unsold. By contrast, if we take account of the total value of production, including the volume consumed, recycled, barter-traded, etc., the net benefits are positive for all three crops (i.e., the total BCR is greater than unity), which provides a necessary condition for the growers to grow these crops. The difference between the two types of BCR basically captures the food security aspect of each crop. According to the total BCR, which incorporates the contribution to food security, sorghum and pearl millet were significantly more 'profitable' than maize, in the given production environment. In addition, the two crops are considered to be more resilient to weather related risk. These factors explain the dominance of these crops in the study area.

Table 16: Profitability of Production of Maize, Sorghum, and Pearl Millet in Marara

Benefit Cost Item	Unit	Maize	Sorghum	Pearl Millet
Explicit Costs	MT	2669	1718	2723
Explicit Costs + Opportunity Cost*	MT	4665	4394	5337
Production	kg	973	499	603
Quantity Sold	kg	331	42	34
Selling Price	MT/kg	5.7	15.4	14.0
Sales Revenue	MT	1887	645	476
Total Value Produced	MT	5545	7661	8442
Enterprise Benefit-Cost Ratio		0.71	0.38	0.17
Total Benefit-Cost Ratio		1.19	1.74	1.58

Source: Survey data
*Opportunity cost is estimated to be 15% of hired labor wage.

To examine the sensitivity of the benefit-cost ratios to varying opportunity cost levels, Figure 4 plots the ratios against opportunity cost of family labor by crop. The fact that these crops are actually grown in the area implies that the average opportunity cost level is unlikely to be as high as 25 percent, since the benefit-cost ratio must stay above one. On the other hand, the average opportunity cost level also cannot be as low as zero, which makes the benefit-cost ratio unrealistically high. These observations give the idea of where the opportunity cost lies, and it is likely to be in the range of 10 to 20, which is the foundation for the 15 percent assumption used in Tables 15 and 16.



Source: Authors' Creation from Survey Data

Figure 4: Benefit-Cost Ratio for Crop Production at Different Levels of Opportunity Cost of Family Labor

One way to interpret the horizontal axis in Figure 4 is to regard it as an indicator of how marginalized the farmers are. In other words, the level of opportunity cost reflects such factors as distance to market, access to social amenities, and population density. What is not captured by the horizontal axis is the agro-ecological condition, which is, together with the current technologies, reflected by the shapes and positions of the curves for the given set of crops. For instance, with a more favorable ecology, the maize curve would appear above those of sorghum and pearl millet. In Marara, however, the benefit-cost ratio for maize stays below that of sorghum and pearl millet, and barely takes the value of two when the opportunity cost is close to zero. This means that maize is a very marginal crop under this production environment in terms of profitability. The graph clearly suggests that the more marginalized the farmers are, the more advantageous sorghum and pearl millet become over maize.

4.6. Adoption of Improved Varieties

Table 17 presents the farmers' self-reported adoption rates for different varieties of sorghum and pearl millet by variety and by gender of household head. The combined adoption rate for improved varieties, as perceived by farmers, was 83 percent for sorghum and 61 for pearl millet. In particular, the improved sorghum variety Macia registered a 78 percent adoption rate. Other than Macia, farmers mainly preferred local varieties.

Although the adoption rates of improved varieties seem high, we observed some issues to be noted. First, a quarter of the farmers depend on recycled seeds (Table 19), which leads to seed impurity and degraded performance in general. Second, farmers' varietal identification may not be accurate. The local word for Macia is "Kagipi", but this seems to refer to any short-statured variety. In fact, the word is also used to mean a short-statured variety of pearl millet. Third, for pearl millet, 46 percent of the farmers were unsure of the name of the improved seeds adopted. Such seeds might well be local varieties with some favorable traits.

Taking it at face value, there is a certain degree of gender gap in adoption rates of improved varieties. For both sorghum and pearl millet, male respondents exhibit higher adoption rates, which may be because it is usually men who travel to the market to sell livestock and then also buy improved seeds. Another factor may be a gender gap in social networks and access to information as to recycled improved seed in the community.

Table 17: Self-reported Adoption Rates for Improved Sorghum and Pearl Millet in Marara, 2013/2014.

Crop	Variety	Adoption Rates (%)		
		Male Headed	Female Headed	Aggregate
Sorghum	Macia	80.2	66.7	77.5
	Local Variety	14.6	29.2	17.5
	Pilira 1	1.0	0.0	0.8
	Pilira 2	1.0	0.0	0.8
	Chokwe	1.0	0.0	0.8
	Mussequesse	0.0	4.2	0.8
	Other or Unidentified Improved Varieties	2.1	0.0	1.7
Pearl Millet	Local Variety	35.3	64.3	39.4
	Kuphanjala-1	11.8	7.1	11.1
	Changara	4.7	0.0	4.1
	Other or Unidentified Improved Varieties	48.2	28.6	45.5

Source: Survey data

Table 18 summarizes the reasons for adoption, non-adoption, and dis-adoption of improved varieties. For both sorghum and pearl millet, the majority of the adopters claim that high yields are the reason for using improved varieties. The second major reported reason for adoption is that the variety is considered the best adapted for the area. On the other hand, many non-adopters perceive improved seeds as more susceptible to pests and diseases. In addition, a considerable proportion of non-adopters attribute non-adoption to unavailability of improved seeds. For sorghum, lack of resources to buy seeds is also a major reason for non-adoption of improved varieties. Although a minority, some farmers once adopted improved varieties but later dis-adopted. These farmers mention reasons similar to those given by non-adopters.

Table 18: Reasons for Adoption, Non-adoption, and Dis-adoption of Improved Seeds

Behavior	Reason	% of farmers	
		Sorghum	Pearl Millet
Adoption (sorghum N=92 pearl millet N=95)	High Yield	42	32
	Familiarity to Growers	34	32
	No Other Variety Available	22	19
	Recommended by Others	1	2
	Other Reasons	1	1
Non-adoption (sorghum N=21 pearl millet N=14)	Susceptible to Diseases/Pests	48	57
	Lack of Cash or Credit to Buy Seed	29	7
	Cannot Find Seed	14	36
	Low Yield	10	0
Dis-adoption (sorghum N=12 pearl millet N=7)	Cannot Find Seed	25	43
	Lack of Cash or Credit to Buy Seed	25	14
	Susceptible to Disease or Pests	25	29
	Poor Taste	0	14
	Other Reasons	25	0

Source: Survey Data

Table 19 presents the sources of improved seeds of sorghum and pearl millet. Nearly one fourth of the growers purchased seeds from some type of market, while another quarter used their own seeds recycled from the previous season. The most prominent market in the locality is the livestock market in Marara Catchembe where seeds are also available. Since seeds provided by other farmers and family members are also likely to be recycled seeds, in total, more than a half of the growers seem to use recycled seeds of improved varieties, for both sorghum and pearl millet. Therefore, improved varieties may suffer high levels of seed impurity.[8]

[8] According to Smale et al. (2009), in SSA, 90 percent of smallholders rely on informal channels to access seeds, e.g., on-farm seed recycling, exchange with peer farmers, and unregulated sales.

Table 19: Sources of Improved Seeds of Sorghum and Pearl Millet in Marara

Category	Seed Source	% of Growers			
		Sorghum		Pearl Millet	
Market Transaction	Local Trader or Agro-Dealers	15.7	26.9	15.4	25.3
	Local Seed Producers	8.3		8.8	
	Farmers Cooperatives	2.8		1.1	
Donated	Provided Free by Other Farmers*	18.5	48.1	20.9	44.0
	Inherited From Family*	11.1		9.9	
	Provided Free by Other Gov't Agency	7.4		6.6	
	Provided Free by NGOs/Researchers	3.7		4.4	
	Researchers	5.6		2.2	
	Extension Demonstration Plots	1.9		0.0	
Retained	Own Recycled Seeds	21.3		25.3	
Other		3.7		5.5	

Source: Survey Data * Presumably recycled seeds

Access to extension services is important for obtaining broad-based knowledge, technologies, and market information. Although the study could not assess the quality of information provided by extension officers, the frequency of exposure to extension services may indicate farmers' access to modern technologies and market support. Compared with other areas in southern Africa, extension services themed on crop farming and livestock husbandry are extremely limited in Marara (Homann-KeeTui et al., 2013). Table 20 presents the frequency of visits by extension services per farmer. Farmers received an average of 2.5 visits per year for some kind of agricultural topic, of which 1 visit was made by the government extension officer. When it comes to sorghum or pearl millet, however, the government extension officer visits only once in 10 years, on average. There seems to be more extension support on maize and groundnut, even though they are not the most common crops. The government extension office is understaffed compared to the geographical scale and extensive nature of agriculture in Marara. There are only one extension officer in charge of crop farming and another for livestock farming.

Table 20: Frequency of Visits by Extension Services in per Farmer per Year in Marara, 2013/2014 season

		Agent								
		Government extension service	Farmer cooperatives or groups/IP	Seed traders/Agro-dealers	Animal health or feed suppliers	Output traders (crops)	Output traders (livestock)	NGOs	Private, national, and international research	Total
Subject	Maize related	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4
	Sorghum related	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.4
	Groundnut related	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
	Other	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.3
	Goats related	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	Soil and Water Management	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2
	Product Quality	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	Pearl Millet related	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Other Livestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Inputs (Markets, Use, and Prices)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	General Management Practice	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Other Crops	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cattle related	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bird Control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Specific Technologies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Product Market and Prices	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Financial Management	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	1.0	0.2	0.2	0.0	0.3	0.1	0.6	0.1	2.5

Source: Survey Data

4.7. Crop Utilization

Table 21 shows that most of the sorghum and pearl millet harvest is consumed at the household level, whereas less than 10 percent is sold, confirming that crop production is primarily for subsistence. By contrast, one third of maize production is sold. Aside from consumption and selling, the only notable usage is retention as seeds for the next season, which accounts for around five percent of the harvest. This contributes to the common practice of using recycled seeds.

Table 21: Use of Harvest of Maize, Sorghum, and Pearl Millet in Marara

Crop		Quantity Harvested	Quantity Consumed	Quantity Sold	Quantity Barter -traded	Quantity Released for Free	Quantity Retained as Seed
Maize	Mean (kg)	428.0	269.2	143.0	1.0	3.5	11.3
	%	100	62.9	33.4	0.2	0.8	2.6
Sorghum	Mean (kg)	404.0	337.8	35.4	4.6	5.2	21.0
	%	100	83.6	8.8	1.1	1.3	5.2
Pearl Millet	Mean (kg)	459.0	400.5	27.7	4.0	4.6	22.2
	%	100	87.3	6.0	0.9	1.0	4.8

Source: Survey Data

The scoping study conducted in 2013 revealed that in the Northern Plateau, the most popular way of consuming sorghum was to eat it like rice, resulting in a preference for flint (hard) grain typically found in local varieties, compared to the softer, sweeter grain of Macia.[9] However, in Central Region including Tete, farmers reported that sorghum is mostly consumed as porridge in the same way that maize is consumed in Malawi and elsewhere in Eastern and Southern Africa. This suggests that in Mozambique there is a need to address different consumer preferences depending on the target region. In general, consumers in the study area preferred maize porridge to porridge made from sorghum and pearl millet. Thus, relatively resource rich farmers buy and/or produce maize.

Some women farmers, though not a majority, process sorghum into beer on a small scale for sale within the community. The small difference in the consumption rate between sorghum (8.8 percent) and pearl millet (6.0 percent) may be accounted for by this use of sorghum for beer. This usage also has a potential for women to earn income through market transactions. In Tanzania, Macia is used to make lager by EABL (East African Breweries Limited), in which sorghum substitutes barley up to 30 percent, is transforming livelihoods of sorghum growers in the region. Promotion of this avenue for sorghum sales may be an option for future interventions with smallholders in Marara. In the long run, developing sorghum varieties with good malting qualities can lead to demand from the industry for lager beer production.

Table 22 summarizes food security related indicators. On average, households are not self-sufficient in the staple food in the studied area, i.e., hard porridge made from sorghum or pearl millet, and suffer food insecurity for more than two months in an average year.

[9] In the Northern Plateau, sorghum grain is de-hulled by pounding in a mortar with a pestle, by which the grains do not break and remain separate when cooked in water. Farmers in the Northern Plateau are reported to dislike Macia because of its sweet taste.

Table 22: Food Security Indicators in Marara, 2013/2014

Indicator	Mean	St.Dev
Food Shortage Months in an Average Year	2.28	1.40
Frequency of Food Shortage in the Last 5 Years	1.73	1.03
Frequency of Food Aid Receipt in the Last 5 Years	0.14	0.92
Months Sorghum Nshima (hard porridge) is Consumed	7.38	4.42
Months Pearl Millet Nshima (hard porridge) is Consumed	6.40	4.56

Source: Survey Data

Table 23 presents the percentage of households with enough food in each month in an average year. The status of food security changes with the crop season. The leanest month is January when two thirds of households run short of food and that is when it becomes important to sell livestock to buy food. Then, as harvest comes, the proportion of food secure households sharply rises. Between April and September, most households are food secure.

Table 23: Percentage of Households Food Secure in Each Month, Marara

Month	% Farmers Food Secure
January	36
February	53
March	82
April	99
May	100
June	99
July	98
August	96
September	96
October	87
November	84
December	73
Average	84

Source: Survey Data

4.8. Crop-Livestock System

Given the important role of livestock in the study area, the status of ownership of cattle and goat and its purposes were stated by farmers (Table 24). The average number of animals owned per household was 3.7 for cattle and 6.9 for goats. Some farmers kept a large number of animals, suggested by the maximum numbers in the table. Cattle and goats were held by 35 percent and 59 percent of the households, respectively. Two thirds of the households possessed at least one of either animal.. The most frequently reported reasons for keeping livestock were meat consumption and cash income generation. Again, in lean months, farmers sell livestock in the local market, obtain cash, and buy food for survival.

Table 24: Livestock Holding and Purposes in Marara, 2014

		Cattle	Goat	Either
Number of Animals per Household	Mean	3.7	6.9	
	St Dev	8.5	11.1	
	Max	64	77	
Holders (% of Households)		35	59	65
Why hold livestock?* (% of Owners)	Meat Consumption	86	94	
	Cash Income	82	94	
	Social Reasons	44	60	
	Milk Consumption	42	29	
	Draft Power	52	1	
	Manure	14	6	
	Status	2	1	
	Other	14	5	

Source: Survey Data
*Each owner chose up to 3 reasons

Although two thirds of smallholders in Marara engage in livestock husbandry and livestock is the main source of cash income, our survey has found that nearly 80 percent of the crop residues are simply left in the field (Table 26). In other words, only a limited proportion is utilized for grazing and fodder purposes. Furthermore, we have noted that crop residues are not purposively incorporated into ridges during land preparation, as is practiced in Malawi. In addition, livestock dung is not adequately utilized for manure purposes either (Table 27). In fact, during the crop season, 78 percent of the dung is left unused, while only 19 percent is utilized as manure. These observations suggest the lack of integration of crop-livestock system in this area and a huge potential for improvement for that matter, which is in line with the finding by Homan-KeeTui et al. (2013).

Table 26: Use of Crop Residues by Growers

Use	%		
	Maize	Sorghum	Pearl Millet
Left for Mulching	78.3	79.1	74.8
Grazed by Animals	16.6	12.5	13.2
Used for Feed	1.9	2.2	2.9
Used for Fuel	1.0	1.7	2.6
Sold	0.2	0.6	1.3
Other Use	2.0	3.9	5.3
Total	100.0	100.0	100.0

Source: Survey Data

Table 27: Use of Livestock Dung by Farmers*

Use	%	
	Dry Season	Wet Season
Not Used	64.8	77.6
Used for Manure	30.1	18.8
Sold	2.2	1.9
Used for Other Purpose	2.0	0.8
Used for Fuel	0.9	0.9
Total	100.0	100.0

*Arithmetic mean over livestock holders (N=91)
Survey Data

4.9. Production Function

Using the input and output variables for the three crops, production functions were estimated through village fixed effect regressions (Table 28). Allocated land size is controlled for, having some positive effects on production. For sorghum, seed density has a positive and significant effect. This result may be worth looking into when designing agronomic intervention programs. Interestingly, labor, being the dominant input in this region, does not have a significant effect on production. This suggests that labor supply is abundant, causing the marginal product of labor to come down to almost zero. The effect of manure is positive for maize, but its negative effect on pearl millet production is difficult to interpret. Among the control variables on household characteristics, gender of household head has some effect on sorghum and pearl millet production, but not on maize. This may be attributed to the gender gap in adoption of improved varieties shown in Table 17.

Table 28: Estimated Production Function, Village Fixed Effect

Variable	------Maize------		----Sorghum----		---Pearl Millet---	
	Coeff.	P-Value	Coeff.	P-Value	Coeff.	P-Value
Age of HH Head (years)	12.7	0.404	1.93	0.607	6.80	0.155
Education of HH Head (years)	39.5	0.668	10.3	0.615	60.6	0.022
HH Size (head count)	-4.26	0.964	9.75	0.612	10.15	0.678
Gender of HH Head (1=male)	72.8	0.932	369.7	0.092	329.2	0.154
Marital Status (1=married)	144.9	0.866	-268.2	0.204	-323.8	0.128
Land Allocated to Each Crop (ha)	279.4	0.117	50.6	0.151	264.9	0.000
Fertilizer Quantity (kg/ha)	na	na	7.13	0.391	3.98	0.747
Manure Quantity (kg/ha)	102.9	0.000	-14.04	0.340	-36.4	0.000
Amount of Seed (kg/ha)	0.68	0.377	2.72	0.023	-0.12	0.978
Labor Input (person days/ha)	0.12	0.909	-0.13	0.782	0.18	0.776
Intercept	-1204.3	0.451	46.2	0.882	-591.8	0.129
	N=55, F(13,41)=6.08, P=0.000, R^2=0.65		N=107, F(15,1)=1.08, P=0.390, R^2=0.16		N=104, F(16,87)=2.63, P=0.002, R^2=0.32	

Source: Survey Data;
Dependent Variable: Production (kg);
Village Fixed Effect with Robust Standard Errors.

4.10. Adoption Function

Table 29 presents the results of a probit regression to examine the determinants of adoption of improved varieties for sorghum and pearl millet. The effect of distance to market is not significant, which may be attributed to the habit of recycling seeds and not sourcing from markets. As expected, male-headed households are more likely to adopt improved seeds. However, households with polygamy are less likely to adopt improved seeds, which may be because women in such households may have larger influence in agricultural decision-making.[10] The effect of cultivated area for each crop, which may be a proxy for level of wealth, is not statistically significant though the sign is positive. This can be because of the abundance of land in the study area.. For sorghum, years of experience with sorghum farming does not seem to help adopt improved seeds. Engagement in off-farm activities has a negative effect possibly because they are more profitable and attractive than sorghum farming, limiting the exposure to information on sorghum.

[10] A similar implication of polygamy is pointed out by Orr et al. (2014).

Table 29: Probit Regression Result for Determinants of Improved Seed Adoption for Sorghum and Pearl Millet in Marara

Variable	----------Sorghum----------			---------Pearl Millet---------		
	Coeff.	Marginal Effect	P-Value	Coeff.	Marginal Effect	P-Value
Age of HH Head (years)	0.000	0.000	0.703	0.020	0.000	0.221
Education of HH (years)	0.000	0.000	0.942	0.160	0.060	0.026
HH Size (head count)	-0.040	0.000	0.599	0.070	0.020	0.240
Gender of HH Head (1=male)	1.820	0.550	0.032	0.960	0.370	0.098
Marital Status (1=married)	-0.820	-0.100	0.323	-0.410	-0.140	0.457
Number of Living Spouses	-0.530	-0.090	0.098	-0.410	-0.150	0.101
Access to Extension Service (1=yes)	0.110	0.020	0.916	na	na	na
Experience in Farming this Crop (years)	-0.030	-0.010	0.099	-0.010	0.000	0.348
Land Allocated to Each Crop (ha)	0.110	0.020	0.392	0.060	0.020	0.560
Distance to Market (minutes)	0.003	0.000	0.179	0.000	0.000	0.457
Food Security (months per year)	-0.080	-0.010	0.595	-0.020	-0.010	0.815
Engagement in Off-farm Activities (1=yes)	-0.950	-0.150	0.049	-0.340	-0.120	0.320
	N = 96, LR chi^2 (17) = 24.35, Prob > chi^2 = 0.110, Pseudo R^2 = 0.263			N = 86, LR chi^2 (17) = 20.39, Prob > chi2 = 0.203, Pseudo R^2 = 0.178		

Source: Survey Data;
Dependent Variable: Improved Seed Adoption (1=yes)

4.11. Commercialization Function

Table 30 presents the results of a probit regression to examine the determinants of commercialization of maize, sorghum, and pearl millet. Production scale, as represented by allocated area size, seems to positively affect market participation to some extent, in particular for sorghum. For all the three crops, engagement in off-farm activities leads to greater likelihood of selling the harvest to markets, suggesting that participation in non-agricultural work may be a sign of business orientation of the household head. The coefficients in the maize equation are largely insignificant because (1) maize growers almost always sell part of their harvest, i.e., there is not much variation in the dependent variable, and (2) the sample size is limited. For sorghum and pearl millet, more older farmers tend to sell part of their harvest compared to younger farmers. As expected, the shorter the distance to markets, the more likely are farmers to sell their crops. Food insecurity seems to be associated with the tendency to sell pearl millet, which may be because farmers tend to produce more pearl millet in order to reduce the risk of household food insecurity.

Table 30: Probit Regression for Determinants of Commercialization of Maize, Sorghum, and Pearl Millet in Marara

Variable	----------Maize----------			----------Sorghum----------			---------Pearl Millet---------		
	Coeff.	Marginal Effect	P-Value	Coeff.	Marginal Effect	P-Value	Coeff.	Marginal Effect	P-Value
Age of HH Head (years)	0.00	0.00	0.724	0.03	0.00	0.067	0.03	0.00	0.104
Education of HH Head (years)	0.09	0.02	0.481	0.16	0.03	0.065	0.09	0.00	0.290
Marital Status of HH Head (1=married)	0.92	0.16	0.769	0.08	0.01	0.941	-0.52	-0.06	0.477
Gender of HH Head (1=male)	0.06	0.01	0.984	0.68	0.09	0.571	0.85	0.05	0.356
HH Size (head count)	0.02	0.00	0.824	0.01	0.00	0.797	0.02	0.00	0.766
Experience in Farming this Crop (years)	0.00	0.00	0.926	-0.01	0.00	0.349	-0.03	0.00	0.143
Distance to Market (minutes)	0.00	0.00	0.176	0.00	0.00	0.027	-0.01	0.00	0.013
Number of Lean Months	0.09	0.02	0.567	0.27	0.05	0.112	0.41	0.04	0.046
Engagement in Off-farm Activities (1=yes)	1.59	0.35	0.017	1.30	0.22	0.002	1.40	0.13	0.008
Land Allocation to Each Crop (ha)	0.18	0.04	0.143	0.21	0.04	0.038	0.12	0.01	0.288
	N = 53, LR chi^2 (14) = 15.55, Prob > chi^2 = 0.341, Pseudo R^2 = 0.239			N = 93, LR chi^2 (16) = 33.12, Prob > chi^2 = 0.0071, Pseudo R^2 = 0.295			N = 86, LR chi^2 (15) = 34.96, Prob > chi^2 = 0.002, Pseudo R^2 = 0.357		

Source: Survey Data
Dependent Variable: Commercialization Dummy (1=yes)

4.12. Sources of Income

Since engagement in off-farm activities contributes to the tendency to sell sorghum and pearl millet (Table 30), Table 31 shows the proportion of households earning off-farm income through different sources. Apart from receiving remittances, the most common sources were selling drinks, petty trading, selling firewood or charcoal, and wage labor on other farms. Overall, 82 percent of the households were involved in at least one income generating activity off farm.

Table 31: Sources of Off-farm Income in Marara

Source	% of Households Engaged
Remittances	21
Selling Drinks	16
Petty Trading	15
Selling Firewood or Charcoal	13
Wage Labor on Other Farms	9
Natural Medicine	7
Selling Snacks	7
Regular Employment	6
Provision of Transport	2
Gold Mining	1
Construction Business	1
Art or Craftwork	1
Any of the above	82

Source: Survey Data

Table 32 shows household cash income from different sources. Sales of livestock account for 43 percent of income, while crops account for 26 percent, reflecting the subsistence oriented crop farming system in the study area. Cattle are by far the largest contributor to income (34 percent), followed by goats (eight percent), while pigs and chickens together account only for 1 percent. Farmers in this area indeed show high offtake rates for livestock and thus participate actively in livestock markets where crops are also traded. Income from livestock sales is used mostly to buy food when crop harvest fails and during lean months, i.e., in the end, for subsistence. Those markets are, however, largely informal and thus do not adequately encourage market oriented production. The combination of Tables 31 and 32 implies that one out of five farmers receive remittances, but its average contribution to income is limited to three percent and that although selling drinks and petty trading are equally common, petty trading generates higher income.

Table 32: Cash Income per Farmer (All Farmers), by Source, Marara, 2013/2014

Category	Income Source	Mean Income (MT)	% Share	
Crops	Maize	678	7.4	26
	Sorghum	440	4.8	
	Pearl Millet	302	3.3	
	Other Crops*	916	10.0	
Livestock	Cattle	3075	33.6	43
	Goats	703	7.7	
	Pigs	68	0.7	
	Chickens	52	0.6	
Off-farm Activities	Petty Trading	658	7.2	32
	Regular Employment	391	4.3	
	Selling Firewood or Charcoal	382	4.2	
	Selling Drinks	374	4.1	
	Receiving Remittance	307	3.4	
	Natural Medicine	139	1.5	
	Selling Snacks	110	1.2	
	Labor on Other Farms	97	1.1	
	Construction	66	0.7	
	Gold Mining	14	0.2	
	Provision of Transport	10	0.1	
	Art or Craftwork	7	0.1	
	“Other”	369	4.0	
Total		9158	100	

Source: Survey Data
*Groundnut, cowpea, coffee, and vegetables

How about the income distribution? The average household income by quartile was MT 284, MT 1480, MT 5180, and MT 30161 in ascending order, suggesting a high level of income inequality in the study area. Further, Figure 5 presents the Lorenz Curve for the sample households, indicating a considerable gap in distribution from the uniform distribution. In fact, the Gini coefficient calculated from the survey data is 70, which is much higher than the nation-level Gini coefficient of 46.[11] The mean income of MT 9158 is lower than both the international poverty line (IPL) of MT 14,600 and the national poverty line (NPL) of MT 11,680. The poverty headcount ratio with respect to the IPL and NPL is 80 and 77, respectively, which are higher than the nation-level equivalents of 60 and 55.[12] These statistics imply that the inhabitants of these villages are characterized by a large extent of both poverty and inequality.

[11] The nation-level Gini coefficient was last measured in 2008 by the World Bank.

[12] The nation-level poverty headcount ratio with respect to the IPL and NPL was measured in 2008 and 2009, respectively, by the World Bank.

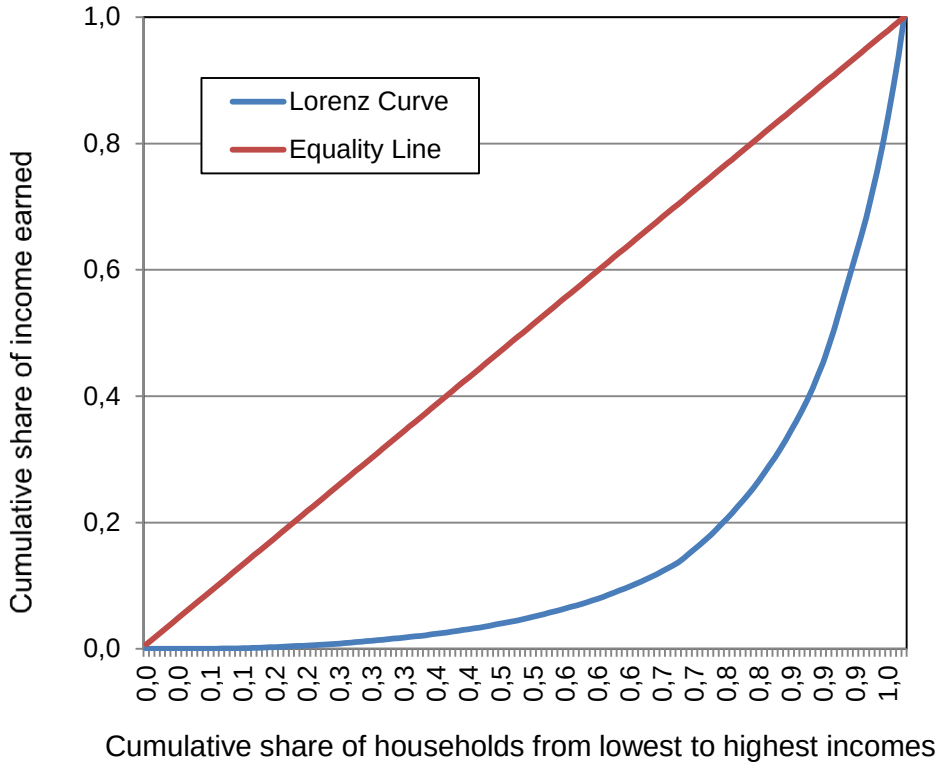


Figure 5: Lorenz Curve for Sample Households in Marara, 2013/2014

Nonetheless, we have noted that barter economy is prominent in the study area, in which in-kind and labor are often used as a medium of transactions in place of cash. Hence, the description of cash income alone may not be sufficient to capture the comprehensive structure of economic activities within the community. Moreover, farmers' general tendency to understate income opportunities means that the actual income level in the community could be higher than what was reported by farmers.

Information on farmers' asset holding was also collected (Table 33). The most prominent asset item was an animal-drawn scotch cart, followed by motorbike and music players. However, 37 percent of the households owned none of these asset items, and consequently the mean asset holding by quartile was MT 0, MT 574, MT 3392, and MT 27444 in ascending order, showing a significantly uneven distribution of asset. The Gini coefficient for value of asset was 0.76, which is even higher than the same coefficient for income.

Table 33: Value of Asset Holding per Household based on Estimates, Marara, September 2014

Item	Value per HH (all HHs) (MT)
Scotch Cart	3092
Motorbike	735
Radio, Cassette, or CD Player	701
Ploughing Oxen	617
Horse/mule Cart	583
Bicycle	490
Ox-plough	423
Mobile Phones	357
Grain Mill	162
Solar Panels	118
Sewing Machine	109
Refrigerator	108
Private Borehole	106
Generator	74
Television	59
Wheel Barrow	51
Private Water Well	42
Water Pump	42
Ploughing Donkey	35
Tractor	35
Satellite Disk	21

Source: Survey Data

5. Concluding Remarks

5.1. Research findings

Smallholders in the study area are largely resource-poor and rely predominantly on sorghum and pearl millet production, as well as livestock husbandry, for subsistence purposes because of the harsh production environments not suitable for maize production. The dominance of sorghum and pearl millet is also consistent with the benefit-cost analysis, which reveals that sorghum and pearl millet are more profitable than maize in this environment, and that the more marginalized the environment is, the more advantageous sorghum and pearl millet are over maize. The major constraints to production of sorghum and pearl millet are seed quality, low inputs, yield losses from birds, and lack of integration with livestock rearing. The widespread use of recycled seed must be a critical reason for poor yields. High rates of recycling are attributable to the inadequate extension services in the study area, as well as the long distance to markets. A gender gap in adoption rates for improved varieties was observed. Additionally, the estimated production function suggests that there may be some potential to increase sorghum yields by increasing the seed rate, but

limited scope for increasing yields by additional labor. Although farmers accept bird damage as inevitable, the magnitude of loss from bird attacks suggests the need for new technology to address this issue. Crop farming and livestock husbandry are not well integrated. Most of the crop residues and animal dung are left unutilized.

Unlike Nampula, where sorghum is consumed like a rice dish, in the Central Region sorghum and pearl millet are normally consumed in the form of hard porridge, for which consumers carry the grain to a community mill for processing into flour. Maize porridge is actually preferred in terms of taste, though only wealthier consumers can enjoy it.

Finally, only a limited share of sorghum and pearl millet production is sold. Engagement in off-farm activities and distance to markets are significant factors affecting market participation. Aside from selling foodgrains, the only notable avenue for crop marketing is processing sorghum into beer at household level, which is mainly performed by women.

5.2. Recommended R&D Activities

Based on the results of the baseline survey, it is recommended that the national extension service in the study area address the following issues:

- Seed Quality: To reduce seed recycling, efforts are required to link input-dealers with smallholders, while addressing the credit constraint. Given the gender gap in adoption of improved varieties, women need to receive more information on improved varieties. One option may be community-level seed multiplication, which will make improved seeds more accessible for women who are less mobile than men.
- Seed Rate: On-farm research is needed to determine the optimal seed rate for sorghum, which seems to be one reason for low sorghum yields in the study area.
- Bird Control: Training is needed to raise awareness of the significance of bird damage, and to introduce methods of control (e.g., bird net, pesticide, head protection with coverings of grass or cloth, etc.) that are not too costly in terms of resources but are more effective than the primitive measures farmers currently use.
- Crop-Livestock Integration: Given the importance of livestock as a cash income source, training programs should emphasize the need to fully harness the system of crop and livestock farming, so that the utilization of crop residues and animal dung, among other things, will benefit the entire agro-pastoral system. Dual purpose sorghum could play an important role, considering the feed shortages for livestock.
- Marketing: As distance to markets is found to significantly affect the participation in commercialization, infrastructure, e.g., road and transport, is required to facilitate farmers' access to markets. Besides, value addition activities would empower

smallholders through increased marketing opportunities. Extension programs could tap into the potential of expanding sorghum and pearl millet beer production at household level, which would also empower women farmers. Some farmers hold lots of livestock and land, who could help establish a channel for smallholders to feed their outputs in. Nutritional advantages of sorghum and pearl millet should also be more proactively promoted, especially in areas with chronic malnutrition. Another possible marketing channel may be to sell pearl millet to the chicken industry, e.g. in Manica Province.

In addition to reinforce agricultural extension, public support should also cover research on adaptation of seeds to local environments.[13] Crop improvement on sorghum and millets should give greater emphasis to sorghum in light of the volume produced in Mozambique (Table 3). The national breeding programs need to consider:

- Besides adaptation of improved varieties to drought, location-specific adaptation to suit the local dietary habit should not be neglected: specifically, a soft grain suitable for porridge meals consumed in Central Region, and a flint grain preferred in Northern Region.
- To improve the integration of agro-pastoral system, relevant traits for dual purpose crops as human food and livestock feed should be enhanced.
- Consumer taste preferences favor maize over sorghum, so efforts to match sorghum with consumer tastes will mean that resource-poor farmers will receive greater consumer satisfaction, while better-off farmers will shift some resources from maize to sorghum farming. However, the nutritional benefits of sorghum should not be sacrificed.
- Developing sorghum varieties with good malting qualities can promote sorghum beer production at household level, and at the same time, could help trigger demand from the industry for lager beer production in the long run.

[13] Salami et al. (2010) and Bryceson (2002) also point out that in most parts of SSA, the main cause for the declining productivity of smallholder farming is the shrinking public support on both (1) seed adaptation to local environments and (2) extension services to farmers.

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Appendix

Sorghum and Pearl Millet Production, Utilization, and Profitability by Smallholder Farmers in Marara District, Tete Province, Mozambique; CRP Dryland Cereals 2014

SECTION 1: Introduction

Respondent's Name			
Date of Interview		Name of District	
Time of Interview	:	Name of Locality	
Interviewer's Name		Name of Village	
Cell Contact		Supervisor's Name	
Quality Check 1	(Good, Poor)	Quality Check 2	(Good, Poor)

* If the rating of Quality Check is poor, the enumerator must re-interview.
** Any final form MUST be rated GOOD to pass through.

SECTION 2: Demographic Information of the Sample Household

Household denotes all the people living in the same compound, eating from the same "pot" and working to sustain the family members. Household head is the one who is currently generating the income the household depends very much on and/or who makes the most important decisions in the household			
1. Name of head of household			
2. Marital status of head of household (Marriage Code)		Marriage Code: 1=Single 2=Married, 3=Divorced 4 = Widowed	
3. How many living spouses does he/she have?			
4. How many years of experience does he/she have in ….?		5. How many months of a year does the HH head stay together with the HH members in the same house? [ ]	
(a) crop farming			
(b) sorghum farming			
(c) p.millet farming			
(d) livestock keeping			

6. List max 5 adult members of household

ID	First name	Relationship with HH Head (see Code)	Gender 1=Male 2=Female	Age (years)	Years of education	Involved in agricultural activities? 1=Yes 0=No	Engaged in off-farm activities in the last 12 months? 1= Yes 0=No
1		1					
2							
3							
4							
5							

Relationship Code:	1 = Household Head Self 2 = Spouse (allow polygamy) 3 = Child 4 = Parent 5 = Grandparent 6 = Grandchildren 7 Sibling 8 = Other

7. Fill in the Numbers	Male	Female
Number of total adults		
Number of total non-adults		

SECTION 3: Access to Market (Market means the location where you buy or sell commodities using money)

	Market	Travel Time (minutes)	How often do you (or a family member) go there? 1= weekly, 2 = monthly, 3 = seasonal (dry), 4= seasonal (rainy), 5 = none or very rare
1.	The village market from your residence		
2.	The nearest main market		
3.	The nearest source of seed		
4.	The nearest source of fertilizer		
5.	The nearest source of herbicides/pesticides		
6.	The nearest farmer cooperative		
7.	The nearest extension/veterinary office		
8.	The nearest livestock market		

SECTION 4: Asset Holding

4.1: Land Holding and Use in the 2013/14 Cropping Season		
1.	Number of farm plots owned by the HH	
2.	Size of farm land owned by HH including fallow	acre or ha
3.	Area actually cultivated	acre or ha
4.	Does the HH rent in farm land?	Yes No **[if No, skip to Q 5]**
4-1	Size of the land rented-in	acre or ha
4-2	Cost of rent-in for one season	MT or other ( )
5.	Did the HH rent out farm land?	Yes No **[if No, skip to Section 4.2]**
5-1	Size of the land rented-out	
5-2	Revenue from rent-out for one season	MT or other ( )

4.2. Asset Inventory

	Asset	How many units does the HH own?	Estimated value if sold all units [MT]
1	Animal scotch cart		
2	Bicycle		
3	Cars		
4	Generator		
5	Horse/mule cart		
6	Mobile Phones		
7	Motorbike		
8	Grain mill		
9	Ox-plough		
10	Ploughing oxen		
11	Ploughing donkey		
12	Private water well		
13	Private borehole		
14	Radio, cassette or CD player		
15	Refrigerator		
16	Sewing machine		
17	Television		
18	Tractor		
19	Water pump		

20	Wheel barrow		
21	Peanut butter machine		
22	Solar panels		
23	Satellite disk		

SECTION 5. Crop Farming in 2013-2014. Focus on maize, sorghum, and pearl millet

5.1. Crop Management:

		Maize		Sorghum		Pearl Millet	
Choose the largest one plot for each crop and answer questions about it.							
Area planted (ha)							
Cropping pattern; partner crop		;		;		;	
Seed Type		R - O - H		R - O - H		R - O - H	
Who manages? (Manager Code)	Production						
	Sales						
Seed input [kg]	Retained						
	Purchased						
	Shared						
Date of sowing [dd/mm]							
Animal manure [scotch carts]							
Human manure [scotch carts]							
Fertilizer [kg]							
Fertilizer expenses [MT]							
Herbicide expenses [MT]							
Pesticide expenses [MT]							
Date of harvest [dd/mm]							
Quantity harvested [kg]							
Estimated loss by bird attack [kg]							
Labor Input [person days] (1 day = 8 hours)		family & shared	hired	family & shared	hired	family & shared	hired
	Land Preparation – Male						
	Land Preparation – Female						
	Planting – Male						
	Planting – Female						
	Weed Control – Male						
	Weed Control – Female						
	Bird Control – Male						
	Bird Control – Female						
	Harvesting – Male						
	Harvesting – Female						
	Threshing – Male						

		Female						
	Wage paid for hired labor [MT/day]							
Cropping Pattern: 1=Monocropped, 2=Intercropped, 3=Mixedcropped								
Manager Code: 1=Only Husband 2=Only Wife 3=Husband Leads 4= Wife Leads 5= Other member								
Crop Code: 1=Maize 2=Sorghum 3=Groundnut 4=Tobacco 5=Pearl Millet 6=Finger Millet 7=Cowpea 8=Pigeonpea 9=Irish potato 10=Sweet potato 11=Tomato 12=Cotton 13=Bambaranut 14=Other cereal crops 15=Other garden crops 21=Feed crop 1_____ 22=Feed crop2_____ 23=Feed crop 3_____ 24=Other feed crops								
Seed Type Code: R = Retained, O = OPV, H = Hybrid								

5.2. Use of Harvest:	Maize	Sorghum	Pearl Millet
Answer about the same plot as in Section 5.1			
Quantity harvested* ; Unit	;	;	;
Quantity consumed ; Unit	;	;	;
Quantity sold ; Unit	;	;	;
Earnings from sales (MT)			
Quantity barter traded ; Unit	;	;	;
Quantity released for free ; Unit	;	;	;
Quantity retained as seed ; Unit	;	;	;
To whom was it sold? (Buyer Code)			
Which expenses did it cover? (Expense Code)			
Who decides about selling? (Decider Code)			

Crop Code:	1=Maize 2=Sorghum 3=Groundnut 4=Tobacco 5=Pearl Millet 6=Finger Millet 7=Cowpea 8=Pigeonpea 9=Irish potato 10=Sweet potato 11=Tomato 12=Cotton 13=Bambaranut 14=Other cereal crops 15=Other garden crops 21=Feed crop 1_____ 22=Feed crop2_____ 23=Feed crop 3_____ 24=Other feed crops
Buyer Code:	1= Other farmer, 2= Trader/Middlemen , 3= Private company, 4= Others
Expense Code:	1=food, 2=school fees, 3= human health, 4= housing, 5= transport, 6=crop inputs, 7= livestock inputs, 8=purchase of livestock, 9=others (specify)_____
Decider Code:	1=Only Husband 2=Only Wife 3=Husband Leads 4= Wife Leads 5= Other member

* needs to correspond to Section 5.1

5.3 Crop Residue Collection and Use. How did the HH use the residues of the three crops?

		Maize	Sorghum	Pearl Millet
1	Left for mulching/fertilizer	%	%	%
2	Grazed by animals	%	%	%
3	Used for feed	%	%	%
4	Used for fuel	%	%	%
5	Sold	%	%	%
6	Other use ( )	%	%	%
7	Total	100%	100%	100%
Crop	1=Maize 2=Sorghum 3=Groundnut 4=Tobacco 5=Pearl Millet 6=Finger Millet 7=Cowpea			

Code:	8=Pigeonpea 9=Irish potato 10=Sweet potato 11=Tomato 12=Cotton 13=Bambaranut 14=Other cereal crops 15=Other garden crops 21=Feed crop 1_____ 22=Feed crop2_____ 23=Feed crop 3_____ 24=Other feed crops

5.4 Use of Transport for Crops during the past 12 months

			Transport Cost (MT)		
			Maize	Sorghum	Pearl Millet
1	Mode of transport (Mode Code)	Taking to home			
2		Taking to grinder			
3		To output market			
4		Else ( )			
5	Transport Cost (MT)	Taking to home			
6		Taking to grinder			
7		To output market			
8		Else ( )			
Crop Code:	See 5.3				
Mode Code:	1=walk & carry, 2=wheel barrow, 3=bicycle, 4=scotch cart, 5=own car, 6=borrowed car, 7=lorry, 8=bus, 9=other ( )				

5.5 Production Risk and Crop Choice

	Ask about the past 5 years.	years
1	Over the past 5 years, how many years did HH have sufficient rain throughout the season?	
2	Over the past 5 years, how many years did HH have insufficient rain throughout the season?	
3	Over the past 5 years, in how many years did HH have sufficient rain early in the season and insufficient rain later in the season?	
4	Over the past 5 years, in how many years did HH have insufficient rain early in the season and sufficient rain later in the season?	

Ask about the next crop season (2014/2015).				
	If there is sufficient rain in throughout 2014/2015 season …	Maize	Sorghum	Pearl Millet
5	What proportion of land will be allocated to each crop? (%)			
6	How much yield is expected? (50 kg bags per acre)			
	If there is insufficient rain in throughout 2014/2015 season …	Maize	Sorghum	Pearl Millet
8	What proportion of land will be allocated to each crop? (%)			
9	How much yield is expected? (50 kg bags per acre)			
	If, in 2014/2015 season, there is sufficient rain early in the season and insufficient rain later in the season …	Maize	Sorghum	Pearl Millet
11	What proportion of land will be allocated to each crop? (%)			
12	How much yield is expected? (50 kg bags per acre)			
	If, in 2014/2015 season, there is insufficient rain early in the season and sufficient rain later in the season …	Maize	Sorghum	Pearl Millet
14	What proportion of land will be allocated to each crop? (%)			
15	How much yield is expected? (50 kg bags per acre)			

5.6 Buyers' Preference

1. What are the three most important characteristics (or traits) your crop buyers look at? Answer about maize, sorghum, and pearl millet.

	Maize	Sorghum	Pearl Millet
First factor			
Second factor			
Third factor			
Attribute Codes:	1=Crop variety 2= Weight (measured) 3= Weight (estimated) 4= Condition of product 5= Free of disease/pests 6= Time of delivery 7= Place of delivery 8= Quality of the crop 9=grade of the crop 10= freshness 11=low price 12=volume in sales lot 13= specified use of inputs 14=diversified products 15=delayed payment allowed 16=other (specify)		

2. What are the three most important factors that determine the price of your crops in the market? Answer about maize, sorghum, and pearl millet.

	Maize	Sorghum	Pearl Millet
First factor			
Second factor			
Third factor			
Pricing factor Code:	1=Weight 2= Condition of crop 3=Variety of crop 4= transport cost 5= channel used 6= Demand level 7= size of order 8= competitor prices 9= quality 10=other (specify)		

SECTION 6. In-depth Look into Sorghum and Peal Millet

6.1. Seed Systems

6.1.1. Do you know of any improved sorghum varieties? 1=Yes 2=No If yes, fill in the table below.

	Varieties (Variety Code)	Main source of information (Info. Source Code)	Ever planted? 1=Yes 0=No	Why? (Reason Code Yes/ Reason Code No)	If yes, year first planted	First Seed			Planted in 2013/14 season? 1=Yes 0=No	If Yes,		If No,	
						Main source (Seed Source Code)	Volume (kg)	Means of acquiring first seed (Means Code)		Did you plant it continuously 1=Yes 0=No	If no, why not? (Reason Code No)	Will you plant it in future? 1=Yes 0=No	If no, why not? (Reason Code No)
Sorghum													
P. Millet													

Sorghum Variety Code:	1=Pilira 1 2=Pilira 2 3=Macia 4=Chokwe 5=Matica-1 Manica 6=Matica-2 Manica 7=Mussequesse Manica 8=Mucuvea Nampula 9=Otela Nampula 10=Tocole Nampula 11=Mapupulo 12=Sima 13=Other improved ( ) 14=Local Variety
P.Millet Variety Code:	1=Changara 2= Kuphajala -1 3=Kuphanjala -2 4=Other improved ( ) 5=Local Variety
Info. Source	1=Government extension 2=Farmer Cooperative/Union 3=NGO 4=On-farm trials, demos,

Code:	field days 5= Seed/grain stockist 6=Neighbor farmer 7=Radio/newspaper/TV 8=Other, specify ( )
Reason Code Yes:	1 No other variety available 2 Best adapted variety 3 High yields 4 …… (fill name) recommended it to me. 5 Other, specify ( )
Reason Code No:	1=Cannot find seed 2=Lack of cash/credit to buy seed 3=Susceptible to diseases/pests 4=Poor taste 5=Low yielding variety 6=Low output prices 7=No market 8=Requires high skills 9=Seeds are expensive 10=Susceptible to drought 11=Other, specify ( )
Seed Source Code:	1=Researchers (e.g. during participatory variety selection) 2=Extension demonstration plots 3=Bought from farmer cooperatives 4=Bought from local seed producers 5=Bought from local trader or agro-dealers 6=Provided free by other farmers (relative, friend, etc) 7=Provided free by NGOs /Researchers 8=Provided free by other govt agency 9=Inherited from family 10=Recycled/Retained 11=Other, specify ( )
Means Code:	1 Gift/free 2 Borrowed 3 Bought with cash 4 Payment in kind 5 Exchange with other seed 6 Other, specify ( )

* Replacement with fresh seed from seed producers or distributors

6.1.2. Quantity of sorghum and pearl millet seed (local and improved) used in last season 2013/2014

		Variety planted (Variety Code)	Total quantity of seed (kg)	**Major sources**					
				Source 1		**Source 2**		**Source 3**	
				Source Code	Quantity (kg)	Source Code	Quantity (kg)	Source Code	Quantity (kg)
1	Sorghum								
2									
3									
4									
5	Pearl Millet								
6									
7									
8									

Variety Code:	**See 6.1.1**
Seed Source Code:	**See 6.1.1**

6.1.3. Rank the traits of maize, sorghum, and pearl millet based on your preference

Traits	Rank (1-10)		
	Maize	Sorghum	Pearl Millet
Grain yield			
Drought tolerance			
Pest & disease resistance			
Early maturity			
Grain color			
Grain size			
Price			
Taste			
Fodder traits			
Other ( )			

6.1.4. Score the **sorghum** varieties you have ever grown. (0-10)

Traits	**Preferred local variety** Name ( )	**Improved varieties** (Variety Code)			
		Code 1 ( )	Code 2 ( )	Code 3 ( )	Other ( )
Grain yield					

Drought tolerance					
Pest & disease resistance					
Early maturity					
Grain color					
Grain size					
Grain being flint					
Price					
Taste					
Fodder quality					
Fodder quantity (height)					
Other ( )					
Sorghum Variety Code	**See 6.1.1**				

6.1.5. Score the **pearl millet** varieties you have ever grown. (0-10)

Traits	**Preferred local variety** Name ( )	**Improved varieties** (Variety Code)			
		Code 1 ( )	Code 2 ( )	Code 3 ( )	Other ( )
Grain yield					
Drought tolerance					
Pest & disease resistance					
Early maturity					
Grain color					
Grain size					
Grain being flint					
Price					
Taste					
Fodder quality					
Fodder quantity (height)					
Other ( )					
P.Millet Variety Code	**See 6.1.1**				

6.1.6. Seed Management

		Sorghum	Pearl Millet
1	Can you distinguish between local and improved varieties? **1**=Yes; **0**=No		
2	Maximum price you would pay for certified sorghum seed desirable traits (MT/kg)		
3	How many kg of certified seed would you buy every time you replace old seed? (kg)		
4	If you save seed, when do you select the seed? **1**=Before harvest; **2**=During harvest; **3**=After harvest		
5	How do you store your saved seed? **1**=Treated with ash; **2**=Treated with pesticide; **3**=Untreated		
6	Where do you store your seed? **1**=Own store; **2**=Community store; **3**=Other (Specify)		
7	Do you often run out of your own seed? **1**=Yes**; 0**=No		
8	If yes, how often do you run out of seed? **1**=every year; **2**=once in 2 years; **3**=once in 3-5 years		
9	If yes, what is your alterative seed source? (source code)		
10	Have you ever been trained in seed production? **1**=Yes; **0**=No		
11	If yes, who provided the training? **1**= Research institute; **2**=Seed company; **3**= NGOs; **4**=Other ( )		

Source Code:	1= Buy from other farmers with surplus seed saved from previous harvest 2= Buy from other farmers who are engaged in seed production 3= Buy from local trader or agro-dealers 4= Buy from open market 5= Get free from other farmers (relative, friend, etc.) 6= Get free from NGOs 7= Other (Specify)

6.1.7. Seed Production Business

	Sorghum	Pearl Millet
Are you involved in seed production and distribution as a business? **1**=Yes; **0**=No		
If yes, provide the following information		
• Years of seed production		
• Annual seed quantity produced (kg)		
• Annual seed sales (kg)		
• Selling price? (MT/kg)		
• Seed price relative to grain price 1=150% or more 2=120-150% 3=100-120% 4=same; 5=80-100%; 6=80% or less		
• Buyers **1**= Farmers; **2**= Agro-dealers/traders; **3**= Seed company; **4**=Other (Specify)		
• Distance to the point of sale (minutes)		
• Rank the following possible seed production constraints: (1-8)		
- Lack of basic or foundation seed		
- Low seed multiplication ratios		
- Start-up capital (credit)		
- Technical knowledge		
- Storage and processing (cleaning, grading, and packaging)		
- Transport (infrastructure)		
- Market demand		
- Other ( )		

6.2. Processing and Consumption

6.2.1 Processing	Sorghum	Pearl Millet
What do you produce this crop for ? **1**=Cash; **2**=Food; **3**=Cash and food; **4**=livestock feed; **5**=for all		
If you eat this crop, in what form do you eat it? **1**=fresh grain; **2**= ncima (processed flour); **3**= malted flour in beverages; **4**=Not eaten		
If you eat processed flour, what is the major source? **1**=Own production processed in the household **2**=Own production processed at a local hammer mill in the community **3**= Purchased grain processed in the household **4**= Purchased grain processed at a local hammer mill in the community **5**=Purchased processed product from the market **6**=Other (Specify) **7**=Not eaten		
If you process into flour in the household, how many hours does it take you per meal for all members? (hours) If not, write "NA"		
Are you aware of any food processing farmer groups in this area?		

1=Yes; **0**=No		
If Yes, does the group process sorghum and p.millet? **1**=Yes; **0**=No		
What is the grain-to-flour conversion ratio? (0 < "conversion ratio" < 1)		

6.2.2. Have you ever sold processed sorghum or pearl millet product? **1**=Yes; **0**=No
If yes, fill in this table for the last 12 months

	Crop	Form	Quantity Sold (kg)	Revenue (MT)	Buyer (Buyer Code)	Relation to Buyer (Relation Code)
1	Sorghum	Grain				
2		Flour				
3		Other ( )				
4	Pearl Millet	Grain				
5		Flour				
6		Other ( )				
Buyer Code:	1=Private company 2= Consumer or other farmer 3=Rural assembler/middlemen/traders 4=Urban Traders 5=Other ( )					
Relation Code:	1=Family or relative 2=Friend 3=Customer 4=Other ( )					

6.2.3. What is the frequency of consumption of sorghum and pearl millet products in the household?

	Crop	Form	Months per year	Days per week	Quantity consumed (kg/day/HH)
1	Sorghum	Fresh grain			
2		Ncima (processed flour)			
3		Malted grain			
4		Other ( )			
5	Pearl Millet	Fresh grain			
6		Ncima (processed flour)			
7		Malted grain			
8		Other ( )			

6.2.4 Estimate the quantity of fodder from sorghum and pearl millet used in the past 12 months

		Dry Season		**Rainy Season**	
		Cattle	**Goats**	**Cattle**	**Goats**
		(Unit;)	(Unit;)	(Unit;)	(Unit;)
Sorghum fodder	Dry fodder				
	Green fodder				
P.Millet fodder	Dry fodder				
	Green fodder				

SECTION 7. Livestock Management

	7.1. Livestock	**Cattle**	**Goats**
1	Number of female animals the HH rears		
2	Number of male animals the HH rears		
3	Who decides about production? (Decider Code)		
4	Who decides about the sale of the animals (Decider Code)?		
5	Who decides about the sale of milk product (Decider Code)?		
6	3 Main reasons for keeping livestock (Reason Code)?	[ ][ ][ ]	[ ][ ][ ]
Decider Code	1=Only Husband 2=Only Wife 3=Husband Leads 4= Wife Leads 5= Other member		
Reason Code	1= Meat consumption, 2= Milk consumption, 3= Manure, 4= Draft power, 5= Cash income, 6= Status, 7= Social reasons, 8= Other (specify)		

7.2. Dung Utilization Patterns

	Out of the total livestock dung collected in the 2013/2014 season, what % was …	During Dry Season	During Rainy Season
1.	Used for manure/fertilizer	%	%
2.	Used for fuel	%	%
3.	Sold	%	%
4.	Used for other purpose_____	%	%
5.	Not used	%	%
	Total produced	100%	100%

7.3. Income from Selling Livestock in the past 12 months

	Animal	Number of animals sold	Total earnings (MT)	Timing (up to two) (Month Code)		Main buyer (Buyer Code)	Main place of sales (Place Code)	Expenses covered (Expense Code)
1	Cattle							
2	Goats							
3	Other 1 ( )							
4	Other 2 ( )							
5	Other 3 ( )							

Month Code	1=Jan, 2= Feb, 3= Mar, 4= Apr, 5= May, 6= Jun, 7=Jul, 8= Aug, 9= Sep, 10= Oct, 11=Nov, 12= Dec
Buyer Code	1= Large private farm, 2= Government farm, 3= Other smallholder, 4= Butcher/abattoir, 5= Individual trader/broker, 6= Consumer, 7= NGO, 8=Other (specify) _____
Place Code	1= Farm gate, 2=Parallel to the auction, 3=Local collection point, 4=Regional auction, 5=Regional town, 6=Other (specify)
Expense Code	1=food, 2=school fees, 3= human health, 4= housing, 5= transport, 6=crop inputs, 7= livestock inputs, 8=purchase of livestock, 9=others (specify)_____

7.4. Income from other Livestock Outputs in the last 12 months

	Item	Timing of sales (Month Code)	Volume; Unit	Price/unit (MT)	Expenses Covered (Expense Code)
1	Milk		;		
2	Manure		;		
3	Draft Power		;		
4	Other 1 ( )		;		
5	Other 2 ( )		;		

Month Code	1=Jan, 2= Feb, 3= Mar, 4= Apr, 5= May, 6= Jun, 7=Jul, 8= Aug, 9= Sep, 10= Oct, 11=Nov, 12= Dec
Expense Code	1=food, 2=school fees, 3= human health, 4= housing, 5= transport, 6=crop inputs, 7= livestock inputs, 8=purchase of livestock, 9=others (specify)_____

SECTION8. Access to Agricultural Extension Services

	Who	How many times did you interact/discuss with …?	How many field days/training did you attend, organized by	What were the topics? (Topic Code)	How relevant was the information/training? (Relevance Code)

			…?			
1.	Government extension service					
2.	Farmer cooperatives or groups/IP					
3.	Neighbor farmers					
4.	Seed traders/Agro-dealers					
5.	Animal health/feed suppliers					
6.	Output traders (crops)					
7.	Output traders (livestock)					
8.	NGOs					
9.	Private, national, and international research					

Topic Code:	1= Maize related 2= Sorghum related 3=Bird Control 4=P. Millet related 5=Groundnut related 6=Other crops 7=Cattle related 8=Goats related 9=Other livestock 10=Input markets, use, and prices 11=Specific technologies 12=General management practices 13=Product markets and prices 14=Product quality 15= Financial management 16=Soil and water management 17= others (specify)_____
Relevance Code:	1= Relevant 2= Not relevant

8.2. Membership: Are you a member of any agricultural producer group/association/innovation platform? (1=Yes 0= No) [_____]

SECTION 9. Rural Credit

1	Are there times the HH faces critical shortage of funds for agricultural activities?	1 =Yes 0 = No (SKIP to Q 3)
2	In which months do you face critical fund shortages? List months. (Month Code)	
3	Did you receive any cash and/or input credit in the past 12 months for farming inputs or HH consumption?	1 =Yes 0 = No (SKIP to **Section 10**)

	In the last 12 months, did you receive ....?		Source (Source Code)	Quantity; Unit	Did you get it in time? 1=Yes 0=No 3=NA	Are you able to repay in time? 1 = Yes 0 = No 3 = NA	Do you plan to borrow this again? 1=Yes 0=No 3=NA
4	Cash Loan			; MT			
5	In-kind Loan	Food		;			
6		Seed		;			
7		Fertilizer		;			
8		Herbicide/pesticide		;			
9		Farm implements		;			
10		Plowing animals		;			
11		Irrigation		;			

Month Code: 1=Jan, 2= Feb, 3= Mar, 4= Apr, 5= May, 6= Jun, 7=Jul, 8= Aug, 9= Sep, 10= Oct, 11=Nov, 12= Dec

Source Code: 1=Bank 2=Local money lender 3=Neighbor farmers 4 =NGO 5=Government 6 =Relatives 7=ROSCA 8=Other

9.2. Investment Priorities: if you were given MT 1500 for , for what purposes would you spend it? Max 3 options: [___][___][___]
1=food, 2=school fees, 3= human health, 4= housing, 5= transport, 6=crop inputs, 7= livestock inputs, 8=purchase of livestock, 9=others (specify)_____

SECTION 10: Household Economics

10.1. Household Income in the last 12 months

	Activity	Income (MT) in the last 12 months		
1.	Income from crop production **NOT listed in SECTION 6**	Amount ( ) Crops ( )		
		Husband	Wife	Other
2.	Selling of firewood/charcoal			
	Selling of food			
	Selling of drinks			
	Provision of transport			
	Natural medicine			
	Art/craft			
	Petty Trading			
	Wage labor on other farms			
	Regular employment			
	Remittance			
	Other(Specify)			

10.2. Household Expenditure in the last 12 months

	Item	Expenditure (MT)	Who decides? (Decider Code)
1	Inputs for crop production **NOT listed in SECTION 5**		
2	Inputs for livestock production		
3	Hiring agricultural labour		
4	Other expenses for agriculture ( )		
5	Buying food		
6	Paying for education		
7	Health related		
8	Social events/leisure		
9	Personal transport		
10	Housing		
11	Other non agricultural expenses ( )		
Decider Code:	1=Only Husband 2=Only Wife 3=Husband Leads 4= Wife Leads 5= Other member		

10.3. Food Insecurity

1.	In an average year, for how many months does the HH face food shortage?	Number of months _____
2.	In the last 5 years, how many times has this food shortage occurred? (0-5)	Number of years _____
3.	Which are the months in which the HH runs short of food? List months (Month Code)	
4.	What is the main cause of food shortage in the HH household? (Cause Code)	
5.	Has the HH received food aid in any form over the past five years?	1=Yes 0 = No **(If NO, skip 6)**
6.	How many times have you received food aid over the past five years?	Frequency_____
7.	Have you sold any livestock to overcome your food shortage over the last 12 months?	1=Yes 0 = No **(If NO, skip 8)**
8.	Which animals did you sell? (Animal Code)	
Month Code: 1=Jan, 2= Feb, 3= Mar, 4= Apr, 5= May, 6= Jun, 7=Jul, 8= Aug, 9= Sep, 10= Oct, 11=Nov, 12= Dec		
Cause Code: 1=Drought 2=Poor harvest 3=Lost job 4=Death in the family 5=Unreliable income 6=Inflation 7=Theft 8 =family size 9=Other		
Animal Code: 1=Cattle 2=Dairy Cattle 3=Beef Cattle 4=Female goat 5=Male goat 6=Sheep 7=Equines 8=Poultry 9=Others		

Muito Obrigado!!