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A Mixed-Methods Study of Bambara Farming in Mtwara, Tanzania

by

Basile Boulay

Abstract

Economic research tends to focus on a reduced set of crops, leaving a vast array of crops under-researched. However, these 'marginal crops' have typically been farmed for centuries and are better suited for the local environment in which they are grown than crops prioritized within existing research. As such, they can contribute towards a less intensive and productivist mode of farming and help achieving important sustainable development goals. Our mixed-methods study conducted in Tanzania contributes to advancing knowledge of one such marginal crop, the Bambara nut. On the quantitative side, we surveyed 270 farmers across 32 villages in the Mtwara rural district to gather socio-economic and agricultural data. On the qualitative side, we ran focus groups in four villages to enquire about village norms and constraints surrounding the farming of Bambara. We show that Bambara is often seen as a vital crop for food consumption and food security, as it is easy to grow and has a strong nutritional content. However, despite selling at a high price, its market is not well developed due to lack of availability of improved seeds and unreliable marketing channels. We argue that developing the economic potential of indigenous crops constitutes a path towards greater agricultural sustainability as these crops are suited to local environments, need little chemical inputs, are drought resilient and extremely nutritious. Doing so would constitute a first step towards changing the existing and highly problematic agricultural paradigm and reducing farmers' dependency on input and output markets.

JEL Classification: O13, Q01, Q12, Q18, Q19

Keywords: agriculture, underutilised crops, mixed-methods, sustainability

Centre for Research in Economic Development and International Trade, University of Nottingham

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A Mixed-Methods Study of Bambara Farming in Mtwara, Tanzania

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> *'Strategies adopted to address the ongoing problem of food security, particularly in developing countries, continue to narrow the diversity of the food supply by neglecting indigenous and traditional food systems' (Cloete and Idsardi, 2013:903)*

1 Introduction

In recent years there has been a nascent interest in socio-economic research on underutilised crops. These crops possess attractive features from an economic, agronomic and biological point of view, and their potential is even more important in food insecure areas: 'Many of these traditional crops grown for food, fiber, fodder, oil and as sources of traditional medicine play a major role in the subsistence of local communities and frequently are of special social, cultural and medicinal value. With good adaptation to often marginal lands, they constitute an important part of the local diet of communities providing valuable nutritional components, which are often lacking in staple crops' (Ebert, 2014:323).

The term 'underutilised' is one among the many used to characterise those crops, which are also referred to as 'marginal', 'indigenous', or sometimes even 'orphan'. Each of these terms in fact captures a given dimension of these crops but none is fully satisfying. The label underutilised mainly refers to the idea that those crops do not currently possess the commercial aspect they deserve, and that they have the potential to generate higher income. On the other hand, it is problematic as the term implies they are seldom 'used' (i.e., planted/consumed/sold), which goes against empirical evidence at the local level. The term marginal accurately reflect the fact that these crops do not form part of the set of crops prioritised within current agricultural policies and food security strategies. However, they are not (necessarily) marginal in their effects on livelihoods as the quote from Ebert above suggests. Finally, the term indigenous is appealing because it correctly emphasizes that these crops are locally grown and benefit from local autonomous farming knowledge and are well adapted to local climatic conditions. However, the word can be misleading in the sense that an indigenous can easily be grown in a different area from which it originates. For example, it is believed that the Bambara nut originates from parts of Nigeria and Cameroon, although it is widely grown in other parts of Africa and can be grown in some Asian countries (Azam-Ali *et al.*, 2001).

This study aims at expanding knowledge in the socio-economic literature on one underutilised crop, the Bambara groundnut (henceforth BG). Despite being often considered as a 'poor man's crop', BG is an important leguminous crop grown in many countries across sub-Saharan Africa and frequently competes with other legumes such as pigeon pea. Although the crop is cultivated in several regions, varieties bred have not fully been established yet, and most farmers still rely on landraces (Azam-Ali, 2001; Mkandawire, 2007). However, BG possesses very attractive features, notably its high protein content (higher than groundnut), as well as its ability to grow in relatively arid environments (Hillcoks *et al.* 2012). Yet knowledge of the socio-economic dynamics associated with BG remains very limited. This study reports and analyses results from a mixed methods fieldwork combining quantitative (surveys) and qualitative (focus groups and interviews) data collection in 32 villages in the Mtwara rural district in Southern Tanzania in 2016.

Our research is framed around two lines of enquiry. First, we wish to study whether households growing BG are different from those not growing the crop. To the extent that very little is known about the socio-economic characteristics surrounding marginal crops, an important first step is to determine whether farmers growing BG are similar to those not growing it. For example, are family structure and living conditions of both groups similar or do we observe significant differences across them? Second, once we have established whether any significant differences between growers and non-growers of BG exist, we assess the status of this crop in the study area. More specifically, we want to know whether BG is considered a subsistence crop, a cash crop, or a mixed one with both subsistence and commercial features. This implies comparing perceptions of BG to that of other crops widely grown in the area, such as cassava, cashew or groundnut.

As there is almost no literature on BG in Tanzania, with the exception of some crop science research, even where it is grown very little is known about the importance of the crop in production and consumption. The fieldwork therefore constitutes exploratory analysis to learn about the crop, and Mtwara was chosen as a study area because BG is relatively widely grown.[1] At a national level, BG is a minor crop (in terms of production or consumption) and hardly features in national farm surveys so it was not included in the analysis of Chapters 2 or 3.[2] In designing the fieldwork we aimed to collect data that would permit analysis of BG in the context of issues addressed using the TNPS, so we sought information on market structure and plot sizes. The presence of a formal market structure in villages is an important determinant of the commercialisation of a crop, so we aimed to determine if channels for selling BG are comparable to those available for other crops. We also aimed to explore other constraints inhibiting the production and marketing of BG, such as traditional beliefs or the limited availability of improved seeds.

Section 2 reviews the scarce socio-economic literature on underutilised crops. Section 3 describes in details the

[1] Mtwara and Dodoma are the two regions where the crop is widely grown in Tanzania.

[2] There are only 89 plot/crop observations for BG in the first wave of the TNPS, about 1.56% of the total dataset. Figures are even lower for wave 2 and 3: 54 observations in wave 2 (0.90% of total dataset) and 71 for wave 3 (0.89%).

organisation of the fieldwork and challenges faced. Section 4 presents summary statistics for socio-demographic and agricultural dynamics in the study area. Section 5 analyses the status of BG as a crop and compares it with other crops grown locally and Section 6 analyses the economic and market potential. Section 7 concludes.

2 A Nascent Research Framework on Underutilised Crops

Research on agriculture and food is subject to paradigm shifts that are linked to public debates within economic and political spheres. In the context of food and agriculture, one can refer to the dominant paradigm as the dominant food regime, which encapsulates the dimension of food in a broad sense: from input suppliers to farming practices and from agribusiness to public policy. The current food regime is characterised by the importance of transnational agribusinesses and of international financial institutions ruling trade across countries (McMichael, 2013), the evolution of patenting and property rights in favour of private transnational companies and a research agenda largely influenced by those. This 'corporate' food regime prioritises a particular set of crops in terms of research and general interest (including media attention), notably the 'big four': wheat, rice, maize and soy (Bernstein, 2010). By doing so, it de facto leaves aside a vast array of crops that receive little attention in research. These crops are considered to be 'marginal', 'orphan', 'underutilised' or 'indigenous'. However, they have been farmed for centuries and are typically better suited for the local environment in which they are grown than crops prioritized within the current food regime. In fact, the term 'under-utilised' is slightly misguided because it is easily interpreted as a sign that these crops are barely grown. As argued below, this is far from being the case. While marginal crops tend to be widely grown, the term 'under-utilised' refers to the idea that they could constitute greater sources of income and be more commercialised than they currently are (i.e., that their potential as cash crops is not as developed as it could). The fact that the potential of this crop is not as high as it could be is also linked to few efforts in applied research at exploring this potential: 'It is axiomatic that underutilized crops are also under-researched crops' (Azam-Ali *et al.*, 2001:434)

In this context, it is therefore not surprising that there is only a nascent literature on indigenous crops in socio-economic research. Mabhaudhi *et al.* (2016) explore the mechanisms by which underutilised crops could help countries in southern Africa reach the Sustainable Development Goals (SDGs) in the context of the Post-2015 Development Agenda. They identify four key specificities of these crops. Firstly, they are resilient as they are grown in an environment for which they are suited, which is directly relevant in the context of global climate change. Secondly, they typically contribute to dietary diversity and can improve households' nutrition. Thirdly, they present a large pool of genetic resources that are preserved by farmers' practices and directly contribute to maintaining biodiversity of species. Finally, they can contribute to income generation processes as a stable demand for these crops exists, and hence a stable market. Focusing on BG, William et al. (2016) study the determinants of adoption in Ghana, and how adoption impacts the welfare of growers. Using a monetary definition of welfare, their study finds that BG growers have a higher welfare than non-growers, although the difference is small. The paper stresses the need to assess more closely the contribution of indigenous crops to

household welfare as it is still unclear how the four advantages identified by Mabhaudhi *et al.* translate in practice. Focusing on South Africa, van der Merwe *et al.* (2016) argue that indigenous crops should be considered as part of national food security strategies for they de facto constitute an important part of household diets. This approach towards the food security question received no attention from public authorities, despite the obvious importance of indigenous crops for local livelihoods. In a study of the North-West province of South Africa, Cloete and Idsardi (2013) show that underutilised crops enter the diet of 52% of households.[3]

Not only do marginal crops not receive enough attention in national food strategy plans, they do not receive enough attention food security research either. For example, a heavily cited and influential paper by Godfray et al. (2010) identifies several ways to guarantee food security in the future (such as closing yield gaps, or reducing waste) but nowhere are indigenous crops mentioned as important factors towards achieving food security. In that sense, it can be argued that marginal crops are 'excluded' from the current agricultural paradigm when it comes to identifying viable solutions to guarantee food security.

Hillocks *et al.* (2012) review the utilisation and market potential of BG in Africa, and argue that it is the third most important legume in SSA (after cowpea and groundnut). They survey the many ways BG is prepared/cooked in SSA (fresh, roasted, as a soup etc.), and identify possible promising developments in terms of processing, notably the high potential for BG malting. In terms of market potential, the authors conclude: 'Closer examination of the few examples of commercial exploitation of Bambara, suggests that compared to groundnut and some other legumes, the issue is rather a lack of promotion of Bambara and little investment in the development of functional value chains, than lack of demand' (Hillocks et al., 2002:8). Greenhalgh (2000) also explores the market potential of BG as part of a DFID funded project on the crop. The study stresses the need to generate more knowledge about the crop, for governments or other public bodies do not seem to collect data on BG regularly, unlike for other important legumes. Another important issue that has received little attention in socio-economic research is that of traditional beliefs influencing BG farming and marginal crops more generally. Forsythe *et al.* (2015) for Malawi is the only paper - to the best of our knowledge - which looks into detail at how traditional beliefs affect BG production. Their methodology is based on focus groups in villages and one-to-one interviews with traditional doctors. Their results show that BG production is significantly hindered by those beliefs. However, while it is traditionally understood that BG can only be grown by specific segments of the population, such as older women who lost a child, there is evidence that the taboo is less and less stringent. Their analysis also reveals that taboos could further be weakened if the marketing potential of the crop was to increase.

Despite a nascent interest in underutilised crops in the social sciences, interest in economics remains extremely marginal. The following table reports the number of studies referenced on the Scopus database for journal

[3]Cloete and Idsardi (2013) and van der Merwe (2016) use the label *'indigenous and traditional food crops'* (ITFCs), which they further break into conventional and less conventional ITFCs. The 'less conventional ITFCs' category roughly corresponds to our definition to underutilised crops in this study.

articles in the *economics, econometrics and finance* category between 2000 and 2017 which contain the keyword in either the title, abstract or keyword section.

Table 1: Number of publications referenced in the Scopus Database

Keyword entered in seach	Number of corresponding publications
Maize	710
Rice	1006
Soybean	489
Underutilised crops	1
Bambara groundnut	2

Note: search period: 2000-2017. Accessed 04/06/17

This study is thus contributing to effort at bringing more knowledge on under-utilised crops into the development and agricultural economics literature, and to show that such research attention is justified for several reasons. Their climatic resilience, capacity to grow with very little or no chemical inputs and their nutritional properties could turn these crops into good candidates towards achieving food security.

3 Fieldwork Organisation and Data Collection

3.1 Timeline and location

Fieldwork took place in the Mtwara rural district, one of the districts in the Mtwara region of Tanzania, in the southernmost part of the country. The data collection process started on the 19th of September 2016 and ended on the 3rd of November 2016. Mtwara district is characterised by a warm climate and a rainy season starting around early December and finishing around March. Planting for most annual crops happens during those months, while harvest usually takes place between May and July. Therefore, fieldwork was conducted in a period of the year in which farmers were not busy planting or harvesting annual crops. The Mtwara region is one the poorest regions of the country where agriculture is largely subsistence based. However, it is a large producer of cashew nuts, an export crop grown by a majority of farmers in the area, which is the main source of agricultural income for farmers.

Fieldwork was conducted in partnership with the Naliendele Agricultural Research Institute (henceforth ARI), a public research institute very active in the area. The ARI has several research units, including a socio-economic unit, and focuses on practical research aimed at improving living conditions for farmers in the area by providing improved seeds, agronomic advice etc. ARI teams frequently survey villages in the region for research purposes. A team with two enumerators and a driver was formed to implement the fieldwork.

3.2 Data Collection

This research project included both quantitative and qualitative data collection. We chose to focus on the Mtwara rural district only for two reasons. The first one is a practical reason: with limited budget and time available for fieldwork, focusing on this particular district allowed to keep expenses in check as it did not imply additional expenses in terms of spending nights outside Mtwara and reduced travelling time. The second reason is more methodological. Focusing on one district allowed us to survey each single ward within that district in which BG can be grown (16 in total), and hence get a representative picture of this geographical area.

Collection of quantitative data was based on household and agricultural surveys. In total, 271 surveys were implemented. However, a few surveys needed to be discarded, and 258 surveys constitute our final sample.[4] Our sample possesses the feature of a randomised sample. In each of the 16 wards of the Mtwara rural district where BG can be grown, we contacted the agricultural extension officer (a State employee whose task is to link the villages with administration for any matter regarding agriculture, as well as facilitating research activities, promotion of farming advice etc.). We commissioned the extension officer to select two villages in his/her ward in which both growers of BG and non-growers live. In each village, eight farmers were selected. Given that this research pays particular attention to the farming and socio-economic practices associated with BG, we selected 5 growers and 3 non-growers per village (equivalently, 10 growers and 6 non-growers per ward). One may object that one possible bias is that extension officers may have selected the farmers who typically engage more with extension services than the average. To the extent that this is the case for both growers and non-growers, it should not have a systematic effect on our comparisons between the two groups. Another bias could have arisen if extension officers were implicitly pushing farmers to grow BG over other crops, which could have affected the selection process. However, our experience in the region provides no evidence that extension officers are strongly pushing farmers to grow marginal crops.[5] In fact, it is hard to claim that these officers constitute a homogeneous group, notably in terms of effort and commitment towards their assigned ward. In the next section we present summary statistics showing that households growing the crops are not statistically significantly different from those not growing it in terms of family structure, which lends support to our claim that we have a random sample of the population.

The first day was a pilot study to identify the main challenges in administering surveys, and hence, the data for that day was discarded. An extra day was added at the end to return to the same ward (but to a different village) to compensate for that 'lost' data. Altogether, 33 villages across 16 wards were surveyed (two villages per ward except for the first ward where three villages were surveyed instead of two). Each day, prior to starting the surveys, a common introductory meeting was held in the village office, in the presence of farmers, the survey team, the ward agricultural extension officer, as well as village officials (village head and village chairman).

[4]The 13 surveys that cannot be used did not have to be discarded for systematic reasons. Hence, there is no reason to worry about a possible bias due to their omission in our study (they are unusable because of random reasons, such as a farmer being too old to be able to answer most questions).

[5]It is worth remembering that extension officers are state employees whose main purpose is to link farmers with the administration. In that sense, the role of these officers is *not* to push for any particular agricultural strategy.

(a) Surveying team

(b) Typical interview set-up

Figure 1: Data collection pictures (1/2)

During these meetings, the purpose of the research was explained to the farmers and the opportunity was taken to answer any questions before starting the individual surveys. These usually took place outside the village offices.

To collect qualitative data, we ran a series of focus groups on BG in four villages. Focus groups are usually held before the design of a survey or an interview, and are seen as an efficient way to gather the necessary information to design survey or interview questions (as in marketing studies for example). However, we conducted focus groups with another purpose in mind. While quantitative surveys are useful in capturing the degrees of subsistence, commercialisation etc. in agriculture, they cannot easily capture issues relating to customs and traditions in agriculture as these are difficult to quantify. Focus groups, on the other hand, allow for a discussion with farmers about the issues surrounding the farming of BG, from traditions and village norms to household use of the crop and comparisons with other crops. In that sense, we treat focus groups as a complement to quantitative surveys, rather than as preliminary work that leads to subsequent design of questionnaires. Doing the focus groups after the surveys also allowed us to discuss concerns and issues that farmers had raised in all villages surveyed, and get explanations for some quantitative patterns observed during the first phase of data collection. For example, while BG is very widely grown in this district, it is typically planted on small areas, with correspondingly small harvests. Focus groups allowed us to enquire why, and how could BG be such an important crop in terms of frequency (numbers growing), but a relatively minor crop in terms of output.

The four villages for focus groups were selected to reflect the diversity of environments found in the Mtwara rural district. The first was conducted in Nanguni (Mayanga ward), a village close to infrastructure networks (large tarmac road to city) but relatively far from an urban centre as such. The second took place in Mtama (Lipuidi ward), a village far inland and not accessible via tarmac road with no urban centre close by. The third focus group was organised in Mwindi (Mbawala ward), and represents a location with good infrastructure and connection to a close-by urban centre (Mtwara town). Finally, the fourth session was run in Mnazi (Nalingu

(a) Focus group in Mtama

(b) Mtwara central grain market

Figure 2: Data collection pictures (2/2)

ward), a coastal village where livelihoods depend not only on agriculture, but also largely on fishing, an activity exclusively carried out by men.

For each focus group, we aimed at bringing together a group of six farmers as small group size was privileged. This is in line with the qualitative literature on focus groups which suggests an ideal group size comprised between 6 and 8 persons (see for example Bloor *et al.* (2001)). Each session ran for about an hour and a half.

Further, to capture the commercial aspect of the BG at higher levels along the value chain, we conducted a group interview of three agricultural traders at the central grain and legumes market of Mtwara. Doing so allowed us to capture a dimension of this crop which is largely missing from surveys and focus groups and move to another level along the food chain.

3.3 Challenges in Data Collection

A number of challenges arose during the data collection process. During the quantitative data collection phase, the main challenge was to maintain the balance of five growers and three non-growers. Indeed, there was some confusion in the farmers' selection process regarding who was a grower and who was not. We came to understand later that this was due to a misunderstanding of the meaning of 'last agricultural season'. The last *fully completed* harvest was that of summer 2015 (with planting late 2014 and early 2015), but most farmers had already harvested most of their crops for the 2016 harvest, which led to some confusion. However, in most cases, this issue could be rectified by adding a new farmer to the group to make sure the balance was maintained, or by maintaining the balance at the ward level (if the balance could not be maintained in the first village in a given ward, the group of farmers could be altered in the second village so as to maintain 10 growers and 6 non-growers within that ward). In rare occurrences, the balance could not be maintained. During focus groups, the main challenge was to get everyone to talk, especially women, who participated very little in the Mtama

village. In Mnazi, we faced the challenge that too many people turned up to the meeting. After explaining several times that this meeting was intended for a group of six farmers only, no farmer seemed to be ready to leave the room so we had to conduct the focus group with 11 farmers which was impractical and partially hampered in depth discussion on BG. However, this was the last focus group and by then we were reaching saturation of information. No problem was faced for the group interview of traders at Mtwara central market.

Apart from the general and organisational issues mentioned above, a more practical problem encountered during quantitative data collection relates to issues of measurement of agricultural variables. Since we collected primary data for this project, we are able to comment directly on issues associated to the measurement of key agricultural variables that are often encountered in agricultural datasets, such as physical harvests, physical sales, or selling price (usually per kg). Very often, further complications arise because measurement problems are crop specific, since quantities for one crop can be naturally expressed in many ways which differ across crops. For instance, nut crops (such as groundnut) can be weighed in terms of shelled or unshelled produce, while root/tuber crops (such as cassava) can be measured in their fresh or dry forms. In the part of the questionnaire concerned with agricultural variables, physical quantities needed to be coded in kg. Very often, farmers use alternative measures of quantities, each suited to a particular crop. For example, cassava is typically measured in terms of baskets (*tanga*), while cashew will be measured in terms of large polyester bags (*viroba*). Conversion to kg units is not straightforward for several reasons. The first is that each container filled with produce after harvest is 'more or less' full, which creates variation in weights (as can be inferred from pictures 5 and 6, which show *tanga* and *viroba*). The second is that different varieties of a same crop will give a different weight per unit of produce. Yet the most important reason is the fact that even farmers do not consistently agree on how much a full container of a given crop weighs. Therefore, in the absence of the possibility of weighing the physical harvest of every farmer, agricultural physical variables will all come with a bias, the magnitude of which can hardly be estimated. However, there is no reason to believe the bias is not systematic across villages. More generally, approximations needed to be made for general physical magnitudes as farmers needed to recall how much was harvested, how much stored, and how much sold.[6] Again, while this creates bias in measurement, the same sort of bias is observed across villages, so that errors are systematic across survey locations.

4 Summary Statistics

4.1 Demographics and Farm-related Statistics

In this section we present summary statistics for important socio-economic, demographic and farm-related variables. In order to obtain evidence on whether differences exist between households growing BG and those not growing, and between their farm characteristics, we present results for growers and non-growers separately.

[6]This is indeed an important limitation of agricultural datasets which is now generally acknowledged, as stressed in Gourlay, Kilic and Lobbell (2017) for example.

(a) Kanga measurement units

(b) Viroba measurement units

Figure 3: Example of local measurement units at Mtwara Central Market

Our sample is made of 61.2% of growers and 38.8% of non-growers (this is indeed very close to the target we had set of having 5 growers and 3 non-growers per village, which is equivalent to 62.5% and 37.5% respectively). Table 2 presents summary statistics for demographic data and household structure.

Table 2: Demographic Summary Statistics

	Non-growers				Growers				Diff in means	
	mean	sd	min	max	mean	sd	min	max	P-value	Alter hyp
No of members in household	5.16	1.86	1.00	11.00	5.47	2.69	1.00	28.00	0.27	$\neq 0$
No adults aged 16-65	2.54	1.26	1.00	9.00	2.59	1.43	0.00	14.00	0.77	$\neq 0$
Adults over 65	0.20	0.49	0.00	2.00	0.35	0.65	0.00	3.00	0.07*	$\neq 0$
Children (under 16)	2.46	1.44	0.00	7.00	2.56	1.78	0.00	13.00	0.50	$\neq 0$
Age of head of household	48.37	12.91	22.00	72.00	50.63	13.42	23.00	86.00	0.19	$\neq 0$
Gender of head of household	0.14	0.35	0.00	1.00	0.13	0.33	0.00	1.00	0.66	$\neq 0$
Education level of head of household	1.61	0.51	1.00	3.00	1.64	0.53	1.00	3.00	0.42	$\neq 0$
Observations	99				152					

Note: Full definitions of variables are reported in Table 6 in the Appendix

The penultimate column of the table reports the p-values for t-tests which establish whether the differences in means across the two groups are statistically significant. The last column specifies the alternative hypothesis for which the p-value is reported. The average number of persons normally resident in the household and the number of working-age adults is very close across the two groups. The head of household is slightly older on average for BG growers, but this is not statistically significant. The only variable for which there is a significant difference in means is the number of adults over 65, but it is only significant at the 10% level.[7]

[7]Using a Wilcoxon non-parametric test instead of the standard t-test gives the same results for all summary statistics presented here.

Table 3: Demographic Summary Statistics

	Non-growers				Growers				Diff in means	
	mean	sd	min	max	mean	sd	min	max	P-value	Alter hyp
Had farming training? (0/1)	0.23	-	0.00	1.00	0.28	-	0.00	1.00	0.38	$\neq 0$
Farm size (acres)	3.87	3.11	0.25	19.00	4.68	3.70	0.25	20.00	0.03**	< 0
No. plots	1.90	0.93	1.00	5.00	2.28	1.15	1.00	9.00	0.00***	< 0
Rent land? (0/1)	0.21	-	0.00	1.00	0.20	-	0.00	1.00	0.89	$\neq 0$
Number of plots you own	1.64	1.06	0.00	5.00	2.08	1.22	0.00	9.00	0.00***	< 0
Years spent farming?	21.71	12.66	2.00	50.00	23.73	14.87	2.00	68.00	0.29	$\neq 0$
No. of crops grown on farm	3.11	1.41	1.00	7.00	3.84	1.28	1.00	8.00	0.00***	$\neq 0$
Agricultural revenue (Tshs)	534654	806359	0.00	4720000	641943	907821	0.00	681950	0.31	$\neq 0$
Observations	100				157					

Note: Full definitions of variables are reported in Table 6 in the Appendix

While there are no marked differences in means of demographic variables, this is not the case for farm related variables. Farm size, number of plots farmed and number of plots owned are larger for BG growers and all have a statistically significant difference in means. P-values for the t-test reported in Table 3 for these variables are those for the alternative hypothesis that the difference in mean is less than zero (i.e.: $mean(non-grower) - mean(grower) < 0$), but the difference in means is also statistically significant when testing the null against the hypothesis that the difference in means is different from zero (i.e.: $mean(non-grower) - mean(grower) \neq 0$)). However, farm size tends to be extremely low, at 3.9 acres and 4.7 acres for non-growers and growers respectively (equivalent to 1.2 and 1.6 hectares).[8] The number of plots farmed and owned is also very small on average for both subgroups. Also note that the total number of crops grown on the farm is significantly larger for growers, who grow an average of one more crop compared to non-BG growers. Although the average total agricultural revenue is larger for growers, we do not observe a significant statistical difference in means between growers and non-growers.[9] While revealing some marked differences between growers and non-growers, these statistics show that small scale farming is largely prevalent across the whole sample.

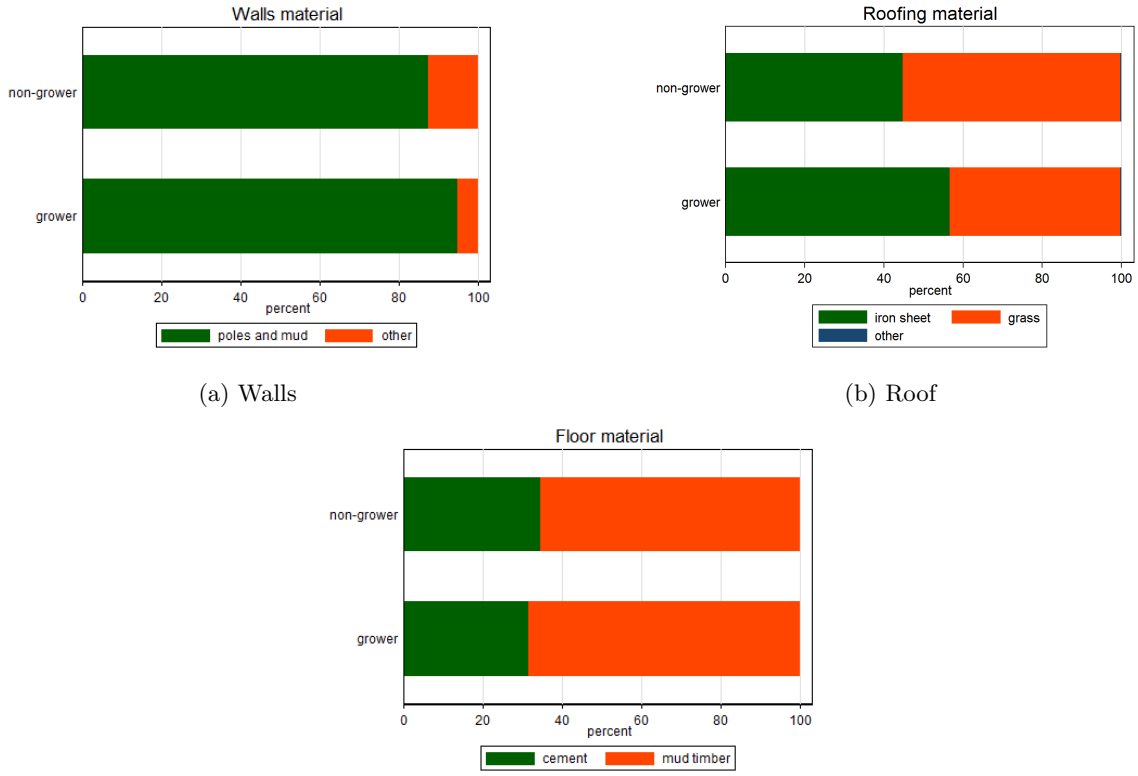
4.2 Housing Conditions and Access to Energy

The previous summary statistics tables show that there are no important differences between growers and non-growers in terms of socio-economic and demographic characteristics, but that growers tend to farm bigger farms (both in terms of area grown and number of plots). We now present summary statistics related to housing and living conditions. Part of our questionnaire was specifically designed to assess whether housing and energy access conditions differ between growers and non-growers.[10]

[8] Farm size in this study is understood (and measured) as the total size of land which was farmed during the 2014/2015 season (i.e., it does not include any land that a household may own but did not farm that year). This distinction also applies for number of plots.

[9] By total agricultural revenue we refer to the revenue derived from direct sales of crops during the 2014/2015 season. Therefore, this include all sales of primary produce but does not include any income derived from the processing or agricultural produce subsequently sold. To calculate this revenue, we evaluated sales using price per unit for each crop, aggregated at the farm level.

[10] This part of the questionnaire largely draws upon questions asked in the 2002 Tanzania population census.



(a) Walls

(b) Roof

(c) Floor

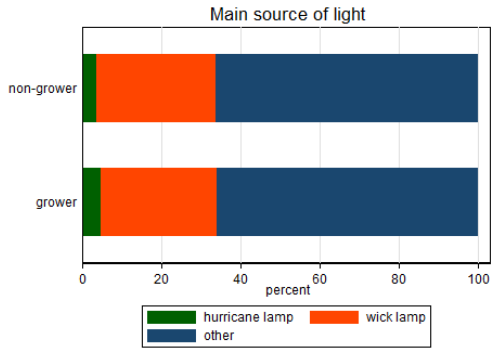
Figure 4: Distribution of Housing Variables

Comparing the distribution of responses to these questions across subgroups is a useful first step in trying to assess whether important differences these two groups. Figure 4 presents distributions of responses regarding housing conditions, while Figure 5 presents those relating to access to energy.

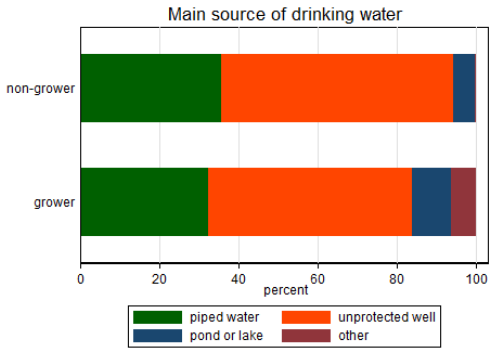
In the case of wall and floor materials used to construct houses, answers reported are largely similar across the two subgroups. There is more variation for materials used for roofing, with a larger proportion of roofs built with iron sheet (more solid than grass) among growers than non-growers.

In terms of energy related variables, Figure 5 reports bar charts for the distribution of answers to questions about the main source of light, cooking energy and drinking water used by households. The distribution for the main source of light is very similar across groups, as are source of cooking energy and drinking water. An overwhelming majority of farmers use firewood to cook, and use either tap water or unprotected wells as a source of water. The fact that a household uses a tap as a main source of water should not be understood as a sign of personal wealth: this refers to village taps where the village has collectively invested in a tap system (usually because a major source of drinking water is located nearby). In some villages, villagers must pay a fee for each bucket of water collected at the tap.

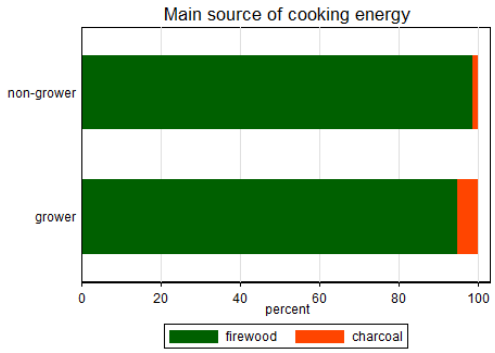
We have shown that there are no significant differences between growers and non-growers in terms of socio-



(a) Main course of light



(b) Main source of drinking water



(c) Main source of cooking energy

Figure 5: Distribution of Energy-related Variables

economic or demographic status. We have also provided evidence that no strong difference exists either in terms of living standards (proxied by housing conditions and access to energy). So far the only difference found is in terms of farm size and crop count. In the next subsection we report opinions about BG to see whether any differences exist between the two groups.

4.3 Farmers' Opinions and Attitude towards BG

To gain a better picture of how BG matters to farmers, we use their direct opinion regarding several statements on BG to infer views and attitudes towards the crop. To the extent we are interested in *how* and *why* the crop matters to farmers, there is clear value in directly asking farmers.

The surveys included a series of eight statements with which farmers had to either agree, disagree or have no opinion. Figure 6 provides the distribution of answers for all eight statements. We focus here on statements for which there are clear differences in the pattern of answers. What is clear from these graphs is that the proportion of 'undecided' answers is much lower among growers than non-growers (for some questions, non-growers considered they did not have sufficient information to agree or disagree). This is the case for the statements on yield, rainfall, nutritional qualities, use of fertiliser, use of labour and availability of markets to sell BG. For the statement on yields, there is large agreement with the question, especially among growers (85%). This shows that despite recurrent problems of pests and diseases affecting the crop (as commented upon in focus groups),

BG is considered a reliable crop in terms of yield.

For the statement 'BG requires little amount of labour', there is no grower reporting an undecided opinion. This statement is quite interesting as it shows there is no consensus among growers as to whether it requires lots of work or not. This may be because some farmers follow recommended agronomic practices (which encourage weeding two to three times a year, ploughing as well as ridging) while others do not. Hence, there is no clear agreement on this statement.[11] There is much more of a consensus regarding whether BG requires little fertiliser: more than 65% of non-growers and 80% of growers agree with this statement. Among growers, only 4% of respondents disagree with it.

Regarding the statement about whether there is a good market for BG, responses are mixed. In the case of growers, 40% of respondents agree, 40% disagree and 20% are undecided. Being a grower and yet undecided about availability of market reflects that BG is often retained for home consumption, or sold outside formal market networks (for instance to a neighbour or friend).

The relatively high levels of agreement with the statements 'BG has high yields', 'BG requires little amount of fertiliser', and 'BG needs little rainfall' all confirm insights from the literature on underutilized crops which insists on the climatic resilience and good production capacity of these crops. In fact, not only does BG require little fertiliser, but it also fixes nitrogen in the soils, thus enhancing yields of other crops such as maize (Ani *et al.*, 2013). Agreement with the statement 'BG is a nutritious crop' is also high, especially among growers, consistent with the fact that BG is extremely rich in protein content.[12] These preliminary results suggest that the advantages of indigenous crops described in the literature are not mere theoretical possibilities, but are consistent with the opinions of farmers themselves. Large rates of agreement among farmers (both across growers and non-growers) regarding the nutritional properties of the crop, but also its tolerance to harsh climatic conditions implies that research on underutilised crops is correctly emphasizing their qualities and potential contribution towards a more sustainable agriculture.

[11] However, there may also be some confusion in the way the statement is asked, because of the negative included in the question, which in some instances made the task of agreeing or disagreeing with the negation slightly hard to understand for farmers.

[12] BG is richer in proteins that groundnut, cowpea and pigeon peas, the other legumes grown in the region. Its protein content varies between 16 and 25% (Azam-Ali *et al.*, 2001).

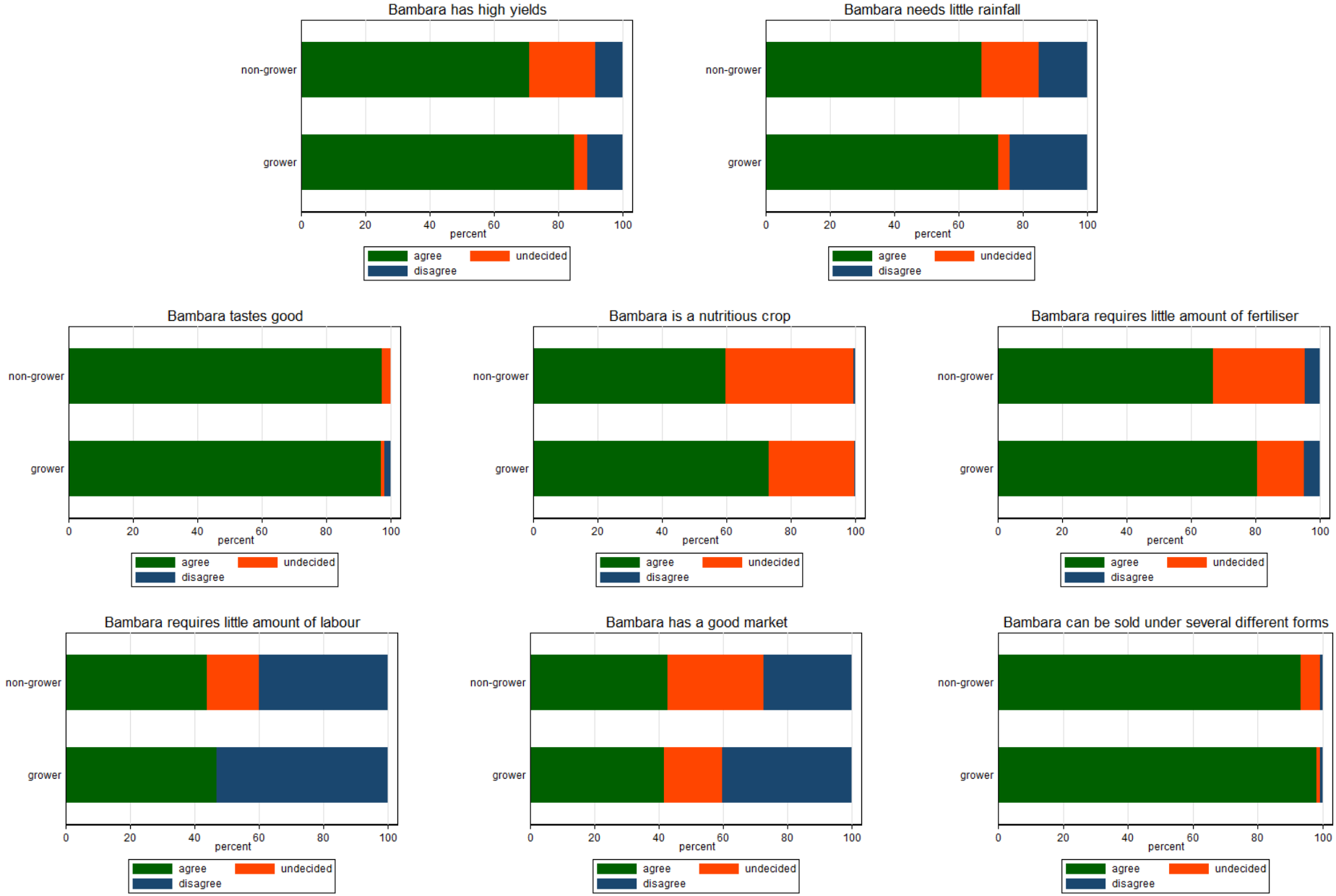


Figure 6: Distributions of Responses to Statements about BG

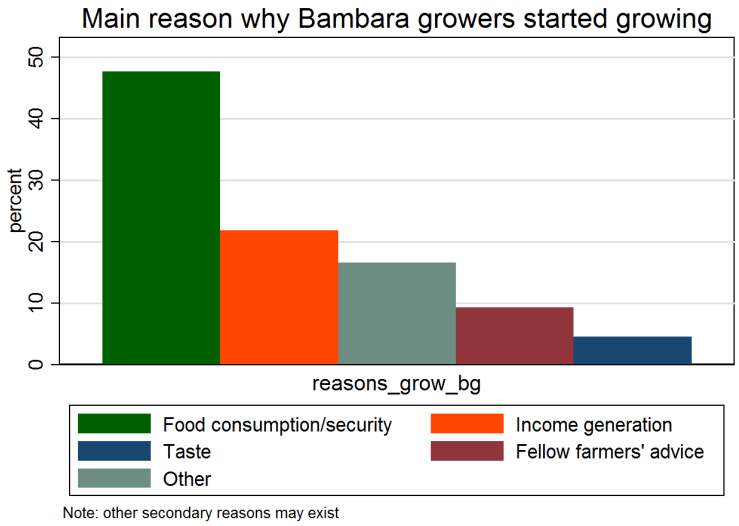


Figure 7: Distribution of the main reasons why farmers started growing BG

Together with the above questions relating to opinions on BG, the surveys asked growers when and why they started growing BG. Figure 7 reports the distribution of the main reason why they started planting BG.[13]

Half of growers gave the main reason as food consumption or food security (79 farmers out of 158 growers). Income generation is the second highest response with 20% of observations, confirming that BG serves both consumption and income purposes, albeit it seems to be more often used for food consumption. Fellow farmers' influence seems to be a driver of moderate importance, for 10% of growers. Focus groups and short interviews with farmers confirm that BG is primarily considered as an important crop in terms of food consumption and security, and that, as a secondary feature, it also serves for income generation purposes.

5 Crop Status of BG and Contribution Towards Food Security

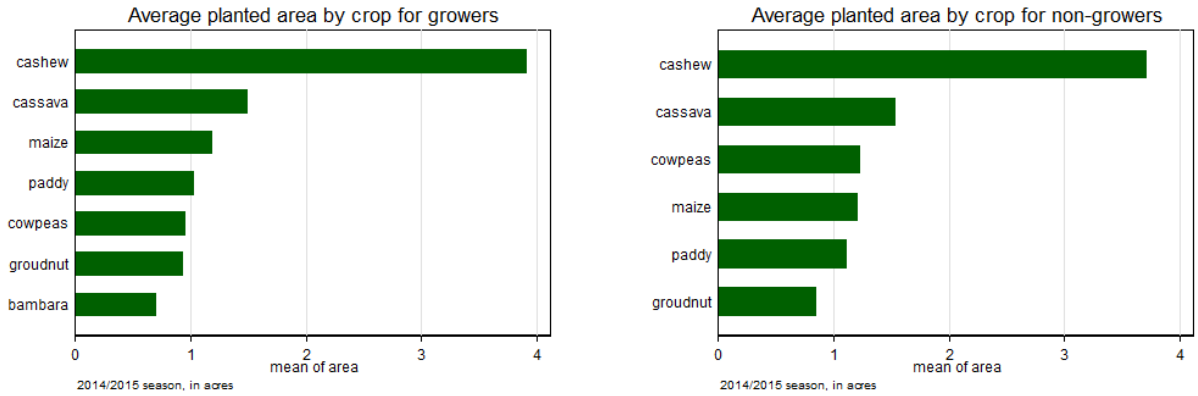
Data collected in the survey provides information about how and why BG's status is so clearly related to the issue of food security.

5.1 Key Agricultural Statistics

The number of crops grown in Mtwara rural district is relatively small: seven crops constitute 8% of observations in our agricultural dataset.[14] These are: BG, cashew, cassava, cowpeas, groundnut, maize and paddy. The quantitative importance of any crop grown can be evaluated in terms of area planted, share of harvest or of sales, as well as yields. Figure 8 report average planted area for the main crops grown in our sample by group.

[13]Therefore, if a farmer said he/she started growing BG for food consumption, while another said he/she started for food consumption and income generation, both answers are reported as belonging to the 'Food consumption' category on the graph because food consumption is either the only or the main reason reported.

[14]However, note that garden crops grown around the house are not included in the analysis if the surface is less than 0.25 acre (the minimum surface we used to qualify as a plot). In practice, farmers often grow some crops around the house that are not listed here, such as potato leaves or amaranth (marginal crops themselves).



(a) Growers

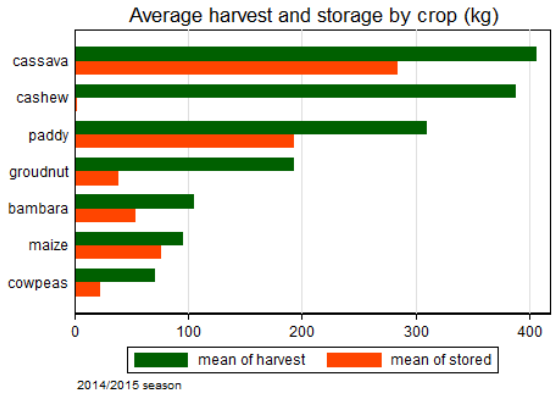
(b) Non-growers

Figure 8: Average planted areas for the main crops

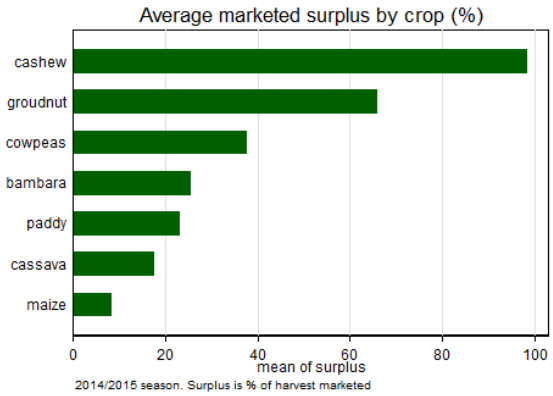
Figure 8 reveals that BG has the smallest average cultivated area among the most important crops, at about 0.7 acres planted. Cashew and cassava have, on the other hand, the highest average planted areas, which can be explained by the fact they are the main source of cash and food respectively. This holds for both growers and non-growers. This is also largely explained by the fact that cashew plots tend to be much larger than any other plots, and that when intercropped, cashew is most often intercropped with cassava. Interestingly, non-growers of BG have an average cultivated area of 1.26 acres for cowpeas, much larger than the average for growers, at 0.96 acres. Although this difference is not statistically significant it may indicate that non-growers tend to rely on other legumes such as cowpea if they do not grow BG. For both growers and non-growers groundnut is cultivated on small areas (less than one acre on average for each subgroup).

While these graphs start bringing a more precise picture of local farming, they are not enough to describe precisely the nature of each crop for two reasons. The first is that area planted and harvest levels are not highly correlated. Some crops, typically legumes, bring a physically small harvest, while cereals or export crops give much higher harvests in terms of physical product. The second is that to understand the nature of each crop, one must look at both physical harvest and sales. Figure 9a reports average physical harvest and stored quantity for each crop. We also present a graph of average marketed surplus (Figure 9b), which is another way to present the information contained in Figure 9a. Marketed surplus is defined as the percentage of physical harvest which is sold. It is thus a measure of commercialisation and helps assess the degree of marketability of a given crop. Intuitively, export crops, or crops clearly identified as cash crops will have a marketing surplus approaching 100% while real subsistence crops will have a very low marketed surplus.

On the one hand, cashew is a cash generating export crop virtually only grown for sales. As a result, almost no part of harvest is stored by farmers (Figure 9a). Alternatively, it has a marketed surplus of almost 100% (Figure 9b). On the other hand, cassava is largely stored and retained by farmers because it is the backbone of



(a) Harvest and storage



(b) Marketed surplus

Figure 9: Average harvest and storage and corresponding marketed surplus

local diets (Figure 9a). Maize also fits the definition of a subsistence crop in the area: heavy storage and small marketed surplus. However, for the other crops in the analysis, the picture is not so clear. Although groundnut is seen as a cash crop, with a large marketed surplus of 66%, one third of the harvest is still, on average, retained for home consumption. For cowpeas, BG and paddy the picture is even more complicated. All these crops have a non-negligible average marketed surplus between 23% and 38%, but are mainly retained for home consumption. Their primary function is thus to satisfy household food requirement and contribute towards food consumption/security, while also serving a secondary purpose in terms of income generation. One could legitimately object that farmers' storage can be used for both consumption *and* future sales, thus undermining our interpretation of Figure 9a. However, clarifications during the quantitative surveying phase as well as anecdotal evidence from the focus groups make us think this is not a major concern. Virtually all produce stored is kept for home consumption. The only exception to this is when farmers store a few kilograms of the crops to be used as seeds for the next planting season. These are usually kept in plastic bottles but represent a negligible proportion of total storage. We assume in the rest of this chapter that storage is used for home consumption only.

This interpretation is consistent with qualitative evidence on BG gathered during focus groups. BG is an important contributor to diets because it helps solve the side dish (*mboga*) problem. Farmers' meals largely rely on *ugali*, (processed cassava or maize flour), for which they often lack side dishes. BG is a useful food because it constitutes a good side dish to *ugali*, and it is a strong source of protein, which complements the heavy carbohydrates content of *ugali*. Further, it can be eaten as *futari*, that is, as a small meal of its own before working in the field. BG is also heavily consumed during the holy month of Ramadhan, because it is a soft food easy to eat and digest. Therefore, evidence from focus groups confirms the idea that BG is an important contributor to diets. Further, there is also evidence that BG is sold to generate cash but this is of secondary importance due to the market not being well developed. As explained in more detail in section 6, trade often happens between farmers in the village, outside formal market structures. The following quote from a farmer in Namgumi village sums up this issue well: 'It's a good crop for food consumption, sometimes a good source of income too, but there is no permanent market for it, which is a problem' (Rachid Abdulrahman).

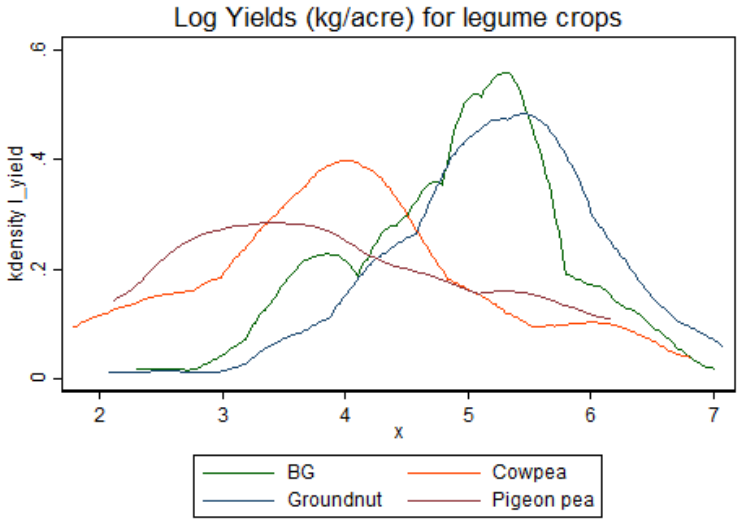


Figure 10: Densities of yields for legume crops

Finally, an important dimension to look at is yields, defined as physical output harvested per acre of land. Since we collected data on both area planted for each crop and harvest, we are able to compute this measure. Figure 10 below shows kernel densities of the log of yields for the major four legumes grown in the area of study: BG, groundnut, cowpea and pigeon pea.

Figure 10 shows that BG and groundnut have higher densities at high levels of yields (above log(5), equivalent to about 148 kg) than cow pea and pigeon pea. It is also in line with the biosciences literature on BG which stresses the high yield potential of the crop compared to other important legumes (Hillocks *et al.*, 2000).

5.2 Factors Affecting Home Consumption of BG

One possible way to get a more detailed picture of how BG matters for food consumption is to run a regression of the percentage of output retained for home consumption (one minus marketed surplus) on farm and demographic covariates for farmers producing BG. However, to the extent we are trying to understand BG's status vis-a-vis other crops, we also look at the determinants of output retention for the pooled sample, for cassava, and for other legumes (these include groundnut, cowpea and pigeon pea). Comparing with the latter is particularly interesting because Bambara and other legumes share common agronomic features but are not considered close from an economic point of view. Because our dependent variable is the retention rate of a crop, it is measured between zero and one. Therefore, we estimate retention rate using fractional response models, which are particularly suited to this type of dependent variable. We also estimate output retention rates via OLS as a robustness check and present the results in the appendix (the OLS output is directly comparable with the marginal effects of fractional response models).

Denoting the retention rate of crop c in household j by $Home_{cj}$, we estimate the following specification:

$$Home_{cj} = \alpha + \beta_1 HH_j + \beta_2 Farm_j + \beta_3 Market_j + \epsilon_{cj} \quad (1)$$

We present in Table 4 marginal effects for fractional response models. Despite the very small size of the geographical area covered in absolute terms, one could argue that results are partially driven by village or ward fixed effects. Indeed, there is an important degree of variability in access to urban centres across wards, as well as clear geographical differences, such as being inland or on the coast, which may impact retention rates of crops. Therefore, we present results for estimations without and with ward fixed-effects for each crop.[15]

[15]We favour ward fixed effects over village fixed effects because they use half the degrees of freedom (16 rather than 32).

Table 4: Estimation of retention rates: marginal effects from fractional response models

	All crops		BG		Cassava		Other legumes	
Dep ratio	0.000	0.000	-0.000	-0.000	0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number HH	0.006	0.009**	0.005	0.008	0.023	0.016	-0.012	-0.001
	(0.004)	(0.004)	(0.008)	(0.008)	(0.015)	(0.010)	(0.010)	(0.011)
Age head	0.000	0.001	0.001	0.001	-0.001	-0.002	-0.003	0.000
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Sex head	0.063	0.007	0.253**	0.201**	0.016	-0.062	0.218*	0.094
	(0.041)	(0.042)	(0.109)	(0.101)	(0.074)	(0.067)	(0.112)	(0.111)
Educ head	0.007	0.004	0.110*	0.072	0.023	0.013	0.056	0.045
	(0.028)	(0.026)	(0.056)	(0.049)	(0.049)	(0.045)	(0.059)	(0.056)
Transport	0.028	-0.026	0.105	0.023	-0.081*	-0.066	0.070	-0.063
	(0.030)	(0.030)	(0.065)	(0.062)	(0.049)	(0.050)	(0.080)	(0.082)
Phone	0.042	0.007	0.084	0.060	-0.066	-0.049	0.043	-0.046
	(0.031)	(0.031)	(0.058)	(0.060)	(0.049)	(0.048)	(0.072)	(0.074)
Family workers	0.012	0.006	0.009	-0.009	-0.027	-0.034	0.139**	0.025
	(0.020)	(0.018)	(0.043)	(0.036)	(0.030)	(0.028)	(0.057)	(0.061)
Hired workers	-0.005	-0.002	0.008	0.016*	-0.016**	-0.023***	-0.006	-0.008
	(0.004)	(0.004)	(0.009)	(0.009)	(0.006)	(0.007)	(0.014)	(0.014)
Farm size	-0.011***	-0.011***	-0.024***	-0.021**	-0.010	-0.016**	-0.018	-0.014
	(0.004)	(0.003)	(0.008)	(0.008)	(0.008)	(0.006)	(0.012)	(0.011)
Rented plot(s)	-0.082**	-0.084**	-0.090	-0.044	-0.087	-0.177***	-0.091	-0.002
	(0.040)	(0.040)	(0.073)	(0.073)	(0.058)	(0.052)	(0.097)	(0.100)
Count	0.006	0.012	-0.048*	-0.037	-0.040**	-0.021	0.034	0.043*
	(0.013)	(0.011)	(0.027)	(0.025)	(0.019)	(0.018)	(0.029)	(0.023)
Cashew grower	-0.196***	-0.222***	0.038	0.014	0.125**	0.115**	0.097	0.066
	(0.033)	(0.030)	(0.072)	(0.067)	(0.059)	(0.051)	(0.088)	(0.083)
Market	-0.015	-0.058	-0.157**	-0.126*	0.014	0.009	0.103	0.053
	(0.030)	(0.038)	(0.063)	(0.075)	(0.048)	(0.053)	(0.072)	(0.110)
N	836	836	143	143	171	171	150	150
Ward fixed effects	no	yes	no	yes	no	yes	no	yes
$Pseudo - R^2$	0.05	0.08	0.12	0.23	0.12	0.26	0.08	0.16

Standard errors in parentheses (clustered at the farm level)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The main result to take from this analysis is that the presence of a market has a negative and significant effect on the proportion of output retained for BG only: the presence of a marketplace in the village decreases the average retention rate of BG by 16 percentage points in the model without fixed effects (and by 13% in the specification with fixed effects). This reflects the commercial environment surrounding BG where many producers wish to market more but are unable to do so due to poor marketing channels. Whenever a formal village market is present, BG trade picks up, decreasing the proportion of output retained. This suggests that village markets are a crucial marketing channel for BG, potentially because alternative marketing channels are not available for that crop, which we discuss in greater length in the next section.

Table 4 also shows that characteristics of the head of household have no significant effect in any model at the 5% level or less, except for BG where a positive and significant effect on the percentage of output consumed of being a female-headed household is observed. Female headed households have, on average, retention rate of BG 25 percentage points higher than their male counterparts (or 20 percentage points in the model with

fixed effects). This could indicate that BG is consumed more in more constrained households (i.e., headed by a widow), or that women tend to give priority to more nutritious crops in households' diets. Although our data on this issue is limited, we have limited evidence in favour or the latter effect. Doing a t-test of difference in means for the statement variable 'BG is a nutritious crop' gives a p-value of 0.027 for the alternative hypothesis $mean(male) - mean(female) > 0$ (where the variable is coded as 1 if the respondent agrees and 2 if he/she disagrees). While 65% of respondents from male-headed households agree that BG is a nutritious crop, the percentage is much higher among female-headed ones, at 82%. Therefore, there is evidence to support the idea that female-headed households tend to value the nutritional properties of the crop more than male-headed households, which partly explains the result in table 4. We can rule out the fact that BG would be a women crop only because households farming BG tend to be those in which the husband has migrated to the city to work. Indeed, female headed household in this context only refers to households headed by a widow.

Interestingly, the number of family workers on the farm has a positive significant effect on the proportion retained for home consumption of other legumes: an extra family worker increases the average retention rate of those crops by 14 percentage points (although this effect is not robust to inclusion of fixed effects). This can be surprising as these are considered cash crops, and hence one would a priori expect a negative effect of extra workers on retention rates. However, given that the dependent variable is the *proportion* of output retained, a higher proportion retained is not inconsistent with a larger *quantity* sold than in farms with less family workers. The proportion of cassava retained is negatively affected by the effect of hiring an extra worker, which is expected as cassava is the most subsistence based crop in the area.[16] However, the magnitude of the effect is small (only a reduction of 2 percentage points in retention rate on average), which is probably due to the fact that cassava forms the backbone of virtually everyone's diet in the villages.

Except for a mild effect of hired labour in the model with fixed-effects, none of the labour variables has any significant effect in the regression for BG. Farm size, on the other hand, has a negative and strongly significant effect on the proportion retained. Again, the effect is small in magnitude: a one-acre increase in farm size is associated with a 2 percentage point decline in BG retention rates, on average. This is indeed a small effect given that average farm size for BG growers is 4.7 acres, and confirms the idea that BG is not a cash crop and is heavily consumed across the distribution in farm size. Being a cashew grower has a negative effect on the proportion of output retained in the pooled model, which is expected given that cashew is virtually entirely sold. Further, cashew typically represents the largest physical harvest so it mechanically brings the dependent variable down. However, it has a positive effect on the proportion of cassava retained: being a cashew grower increases cassava retention rate by 13 percentage points on average. One reason for such effect is that cashew, when intercropped, is most often done so with cassava (49% of observations). Hence cashew growers, while being able to generate cash via cashew trade, can also be food secure in terms of cassava with intercropping.

[16] It could also be the case that hired workers are paid in cassava. Unfortunately, our dataset does not allow us to test for that.

Using OLS estimations instead of fractional response model as a robustness check give very similar effects (see Table 7 in Appendix). For example, while the marginal effect of a village market decreases BG retention rates by 16 percentage points in the benchmark fractional response model, it does so by 14 percentage points in the OLS specification. Similarly, being a female-headed household increases BG retention rate by 25 percentage points in fractional models and 26 percentage points in the OLS model.

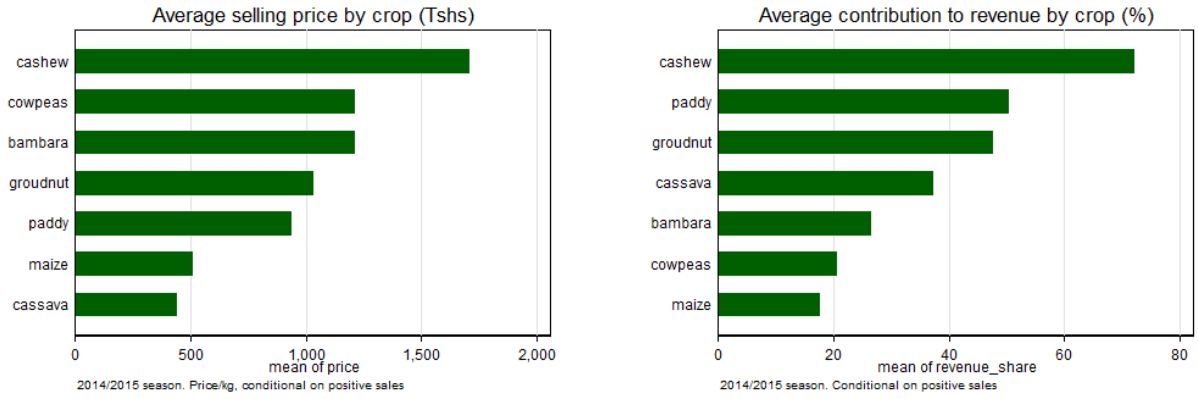
The most important result from this analysis is the strong negative and significant effect of a village marketplace on the proportion of BG output retained. This suggests the existence of mechanisms hindering the marketing of the crop, to which we turn our attention in section 6.

6 Assessing the Economic and Market Potential of BG

In the previous section we provided evidence that BG is an important contributor to diets and thus contributes towards households' food security. However, we have also given preliminary evidence that it has a secondary purpose of income generation, with a marketed surplus of 25%. Indeed, both quantitative (see Figure 7 for example) and qualitative evidence confirm the idea of BG being a secondary source of income. In fact, most farmers showed a great willingness to market more of BG provided they have access to improved seeds and marketing channels. This section thus studies the economic and market potential of BG.

6.1 Key Statistics

A good starting point to assess this potential is to look at the average selling price of BG in Tanzanian shillings (henceforth Tshs) and see how it compares with other crops, as well as the average contribution made by crops to total agricultural revenue. This is shown in Figures 11a and 11b respectively.



(a) Average selling price per kg

(b) Average contribution to agricultural revenue in %

Figure 11: Selling price and crops' contribution to agricultural revenue

Figure 11a reports average selling price per kg of produce conditional on positive sales. Cashew has the highest

selling price at approximately 1711 Tshs/kg, followed by cowpeas (1216 Tshs/kg) and BG (1214 Tshs/kg). The average selling price of groundnut, the closest crop to BG, is lower at 1037 Tshs/kg. Therefore, despite the fact that farmers tend to grow less BG than groundnut and tend to market a smaller surplus, the former has a higher selling price than the latter on average. One possible reason for such high price is a clear shortage of supply before planting season when seeds are not easily available and sell at a high price. In the focus group in the Nangumi village, farmers explained that after harvest (May-June), Bambara sells at around 500 Tshs per kg, but that around January prices can reach 2,500 Tshs as demand before planting time largely exceeds supply. Similarly, the focus group in Mtama, reported that post-harvest price oscillates between 1,000 and 1,500 Tshs per kg while it lies between 2,000 and 2,500 before planting. This is a first indication that improving storage capacity would allow farmers to retain a higher share of the production right after harvest to sell later in the year when farmers need seeds for planting.[17]

Figure 11b shows average contribution to total agricultural revenue conditional on positive sales of any crop. For example, if paddy has a contribution of 50% for a given household, this means that out of all the agricultural revenue obtained from crop sales, half of that amount comes from paddy sales. Cashew is, as expected, the main contributor. Groundnut has the third highest contribution, which confirms that although its average marketed surplus is 66%, it possesses strong cash crop features. The second highest ranked is paddy. Although this may appear counterintuitive given its rather low marketed surplus, this is because it is typically sold in large amounts, which mechanically makes it an important contributor to revenue.[18] Cassava is also a relatively important contributor because, despite having a low selling price, it is also sold in large quantities, with average sales of 418 kg. BG has a more modest contribution to revenues, although a non-negligible one at 27%.

6.2 Regression Analysis of the Determinants of Sales

To understand the economic and market potential of BG we can use regression analysis to study the determinants of market participation. To do so we estimate Probit models, and present average marginal effects in the main text since coefficients cannot be interpreted as such (key goodness of fit measures of the Probit models are reported in the Appendix).

We estimate the following specification:

$$Pr(Seller = 1|x) = \Phi(\eta + \gamma_1 Price_c + \gamma_2 HH_j + \gamma_4 Market_{j)} \quad (2)$$

Where $\Phi(.)$ is the normal distribution function. Including a price variable in market participation analysis supposes that we are imputing price data for non-sellers. To do so, we compute the average selling price of a

[17] Current storage capacity for BG is very low. The crop is usually stored in sealed clay pots which do not contain large volumes, or in plastic buckets/containers.

[18] Average sales of paddy amount to 286 kg, higher than groundnut (203 kg), BG (126 kg) or maize (106 kg), conditional on positive sales

crop at the district level and use this price level for any households not selling the crop. For households selling their output (partly or entirely), we use actual price data from their reported sales. The price data has been rescaled so as to give an average marginal effect on the probability of participating in the market of a 100 Tshs increase in price. The vector of household characteristics includes dependency ratio, age, sex and education level of the head of household, whether the household owns a mean of transport and a phone, whether it is a cashew grower and the number of years spent farming. It also includes variables related to employment: the number of family workers on the farm, the number of hired workers, as well as whether anyone in the household holds a formal job. The latter is included because holding a formal job is typically a strong marker in terms of income and this may influence the decision to participate in agricultural markets. The vector of farm related variables includes farm size, whether any plot is rented and the total number of crops planted. We also include the dummy variable capturing whether a physical market exists in the village. Before interpreting results, let us clarify that by 'market participation', we refer to the process of selling crop output, no matter in which quantity, and more importantly, no matter how and where. Hence, one call sell output (i.e., participate in the market) even though there is no physical market in the village as such.

As for analysis of the drivers of retention rates in the previous section, we estimate for each crop (category of) a specification without ward fixed effects and another with fixed effects. Table 5 presents the marginal effects on the probability of becoming a seller (i.e., of participating in the market).

Table 5: Drivers of market participation: marginal effects from probit models with ward FEs

	All crops		BG		Cassava		Other legumes	
Price	0.028***	0.028***	-0.001	-0.004	-0.002	-0.004	0.000	-0.004
	(0.002)	(0.002)	(0.008)	(0.008)	(0.024)	(0.023)	(0.006)	(0.007)
Dep ratio	-0.000	-0.000	-0.000	-0.000	-0.001	-0.000	0.000	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age head	-0.001	-0.001	-0.001	0.000	-0.005	-0.002	0.004	-0.000
	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
Sex head	-0.073	-0.018	-0.275**	-0.287**	0.029	0.069	-0.221*	-0.065
	(0.050)	(0.047)	(0.121)	(0.126)	(0.099)	(0.097)	(0.131)	(0.140)
Educ head	0.004	-0.003	-0.082	-0.066	0.040	0.075	-0.046	-0.014
	(0.034)	(0.031)	(0.067)	(0.064)	(0.066)	(0.065)	(0.070)	(0.067)
Transport	-0.050	0.003	-0.053	-0.019	0.096	0.050	-0.104	0.045
	(0.037)	(0.038)	(0.073)	(0.078)	(0.071)	(0.075)	(0.096)	(0.110)
Phone	-0.044	0.004	-0.171**	-0.142*	0.015	0.026	-0.020	0.065
	(0.035)	(0.035)	(0.069)	(0.083)	(0.072)	(0.073)	(0.084)	(0.092)
Family workers	0.003	-0.000	0.015	0.020	0.050	0.062	-0.107*	-0.014
	(0.025)	(0.024)	(0.053)	(0.050)	(0.048)	(0.046)	(0.058)	(0.059)
Hired workers	0.009	0.006	-0.019	-0.030**	0.023**	0.029***	0.004	0.006
	(0.006)	(0.005)	(0.012)	(0.013)	(0.011)	(0.010)	(0.014)	(0.016)
Farm size	0.012**	0.012***	0.044***	0.040***	0.011	0.016	0.016	0.012
	(0.005)	(0.004)	(0.012)	(0.012)	(0.013)	(0.012)	(0.013)	(0.013)
Rented plot(s)	0.086*	0.091**	0.159*	0.091	0.043	0.176**	0.044	-0.035
	(0.046)	(0.046)	(0.088)	(0.092)	(0.083)	(0.089)	(0.112)	(0.112)
Count	0.001	-0.005	0.046	0.045	0.037	0.011	-0.050*	-0.089***
	(0.015)	(0.012)	(0.032)	(0.031)	(0.026)	(0.026)	(0.030)	(0.028)
Cashew grower	0.087**	0.121***	-0.132	-0.082	-0.113	-0.100	-0.075	-0.000
	(0.040)	(0.037)	(0.087)	(0.087)	(0.084)	(0.082)	(0.103)	(0.107)
Market	0.043	0.095**	0.256***	0.242**	-0.057	-0.045	-0.087	-0.127
	(0.034)	(0.045)	(0.070)	(0.097)	(0.069)	(0.089)	(0.083)	(0.128)
Years farming	0.002	0.001	0.001	-0.001	0.005	0.006*	-0.000	0.000
	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.005)
Formal job	0.001	0.001	0.011***	0.009***	-0.007***	-0.005***	-0.001	-0.004
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
N	878	878	152	142	184	172	153	147
Ward FE	no	yes	no	yes	no	yes	no	yes
$Pseudo - R^2$	0.13	0.17	0.22	0.29	0.12	0.26	0.09	0.18

Standard errors in parentheses (clustered at the farm level)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Price is only a significant driver of market participation in the pooled model, where a one-hundred Tshs increase in price increases the probability of being a seller by 2.8%. This effect is robust to the inclusion of ward fixed effects, which gives exactly the same marginal effect. For BG, cassava and other legumes, price does not seem to be a driver of becoming a seller.

In terms of household characteristics, female-headed households are less likely to enter the market for BG, where the effect is robust to inclusion of fixed effects: female-headed households have a probability of entering the market for BG about 28 percentage points lower than their male counterparts. Note that this effect mirrors the results from the analysis of the drivers of retention rates, where we showed that female headed-households tend to retain a much higher proportion of BG output. What results from Probit analysis in Table 5 show is that female-headed households are much less likely to sell *any* amount of BG, i.e., they are less likely to sell

altogether. This reflects that subsistence farming is more prevalent among female-headed household than male-headed ones, which is now a commonly held view in development economics: 'Cash cropping is considered a male domain in most parts of sub-Saharan Africa, while women are often responsible for the production of subsistence food crops'(Handschuch and Wollni, 2016:314). Note, however, that our results do not imply that BG is a women's crop, but that female-headed households are less likely to sell the crop (indeed, anecdotal evidence from the fieldwork suggests it is widely grown by both male and female farmers). This contrasts with preliminary evidence from neighbouring Malawi, where BG is largely farmed by women (Forsythe *et al.*, 2015).[19] Given that female-headed households are those headed by a widow, one can conjecture that these households tend to be poorer and rely excessively on subsistence farming. In fact, average total agricultural revenue is significantly lower for female headed household (just below 250,000 Tshs) than for male-headed ones (almost 660,000 Tshs).[20]

The marginal effect of having a phone has a large and significant negative effects on the participation decision for BG, and for BG only, which is quite puzzling and hard to interpret (although the significance of this effects decreases to the 10% level with ward fixed effects).

Farm size has a positive and significant effect on the probability of being a seller in the pooled model. A positive and significant effect is also observed for BG but with larger magnitude: an increase in farm size by one acre increases the probability to sell by 1.2% for the pooled sample and by 4.4% for BG in the model without fixed effects (or 4% with fixed effects), ceteris paribus. However, these effects are extremely small in magnitude, even for BG, and they can hardly be interpreted as a sign that farm size is strongly correlated with commercialisation. The effects are simply too small to claim that larger farms are characterised by a more commercial endeavour given the average farm size in our sample. Farm size has no effect for cassava and the other legumes category. The dummy variable capturing whether anyone in the household has a formal job has a negative effect on participation for cassava, the main subsistence crop, and a positive effect for BG. However, both those effects are extremely small in magnitude, with an effect of about one percent or even less on the probability to sell for both crops.

The most important result is the effect on selling of having a formal market structure in the village. The effect on participation is insignificant in the cassava and legumes models. However, it is strongly positive and significant for BG. In terms of market participation, a change from not having a market to having one increases the probability of selling BG by 26%, ceteris paribus. This effect is highly robust to the inclusion of ward fixed effects where the effect is found to be almost as high at 24%. Therefore, results reveal that the presence of a market is a crucial driver of BG commercialisation. This confirms that unlike other crops, the market for BG is not well-developed and that formal trading structure in the village can enhance its economic potential. This

[19] Although reality is arguably more complicated than a simple dichotomy between cash and subsistence crops. On this issue, see for example the study by Doss (2002) on the limitations of concepts such as 'men's crops' and 'women's crops'.

[20] A t-test in difference in means for the alternative hypothesis that revenue is larger in male headed households than female headed ones gives a p-value of 0.005.

quantitative result is consistent with qualitative evidence gathered during focus groups and interviews which also reveal that the absence of a market is a crucial barrier hindering the production and marketing of the crop. The next subsection reports qualitative results on the economic potential of the crop that complement quantitative results just presented.

6.3 Qualitative Evidence on the Economic and Market Potential of BG

The above econometric analysis shows the dramatic effect on commercialisation of BG of the presence of a market place in the village. To the extent such effect is not observed for other crops, this indicates marketing issues specific to BG. The evidence gathered during focus groups is consistent with results from regression analysis. Indeed, the two major constraints hindering BG marketing are the absence of market and the unavailability of improved seeds. The following quotes from farmers illustrate this:

'Bambara is a good crop, but we do not have a good market for it, and some farmers stop growing because of that' (Salum Hamis from Nangumi)

'Bambara is a good crop, but the main problems with it are the absence of market and the diseases that can arise' (Adam Fwahili from Mwindi)

6.3.1 The Absence of Reliable Markets

Many non-growers do not grow because of absence of market. Without any market structure, trade is very limited and takes place in small volumes.[21] Typically, farmers sell between themselves, and BG is sold to a neighbour, friend, or relative. The absence of well-established marketing channels means that farmers often sell in their fields, straight after harvest, where the nut is sold fresh. Alternatively, they bring the produce home and sell it boiled in small cups. While we have established that BG does contribute to agricultural income, it is now clear that it is only a secondary source of income. In fact, several farmers explained in the focus groups that BG was a source of cash for unexpected expenses, and was more of a short-term source of income than a planned medium or long term one. In that sense, BG cannot compare with cash crops such as groundnut which constitute more established sources of cash, let alone cashew, the main crop from which farmers derive agricultural revenues. The absence of a physical market is particularly stringent for BG because it has very few alternative marketing channels, unlike other crops. For example, cashew is stored after harvest in a safe room and picked up by trucks which brings the harvest to town where auctions take place. Hence, the presence of a village market does not affect sales for this crop. Cassava and maize can also easily be sold to traders who supply restaurants in town in flour to make *ugali*.

There are buyers occasionally coming from town, but their visits are not regular enough to provide the se-

[21] Using all observations (i.e., sellers and non-sellers), average sales of BG amount to 44 kg only, much lower than the main competing legume, groundnut, at 156 kg.

curity needed by farmers to treat BG as a commercial crop. During the focus groups, some farmers mentioned how some trading possibility looked promising but did not materialise. In Mnazi, a village official explained he started growing BG because he heard over the radio that traders from the Comoros Islands were coming to buy large volumes of BG. However, he could not manage to get into contact with them to sell his output. In Mtama, traders from Zanzibar sometimes come to buy BG before Ramadhan but not every year. A farmer from Nangumi explained that BG could not be treated as a priority crop such as groundnuts, cashew or simsim because of absence of reliable market to sell.

Therefore, BG trade is characterised by very low volumes of sales largely taking place within villages. However, it is not unusual for farmers in some villages to bring their output to town, or for traders to come to the villages. Interview with traders at the central town market also reveal that the market for BG is largely undeveloped at higher levels along the supply chain. Customers are also irregular for them; for instance, traders from Pemba sometimes come and buy in very large amounts but the lack of regularity makes it risky for traders to buy too much from farmers after harvest. There is, however, a more regional trade taking place. Traders have been able to sell output to neighbouring Mozambique via intermediary agents as well as with the Lindi region over the past years. There is also some trade with markets in Dar-Es-Salaam. Trade with more northern regions rarely takes place, largely because buyers in the Comoros Islands or in Mombasa (Kenya) tend to buy from traders in Zanzibar, which is much closer geographically.

As a result, a trader explains that BG is not a priority crop among legumes. It has less importance than other traditional pulses such as cow peas. It also fails to compete with pigeon pea, which was traditionally a crop with low price but which has become an important crop due to rising exports to India, which have pushed its local price to about 2,000 Tshs/kg.

However, traders also identified some key attributes of BG that make it a crop with strong economic potential. First, it keeps a very good appearance, even several months after harvest. The nut stays 'clean' up to 12 months after harvest, while competing crops such as cow pea change colour and appearance as early as 3 months after harvest. A second advantage is that it can be eaten on its own or as a side dish, which makes it a popular food.

6.3.2 Improved Seeds and the Issue of Pests and Diseases

Another barrier identified in focus groups is the lack of availability of improved seeds as well as frequent pests and diseases. These two issues are linked, for improved varieties tend to resist better to some diseases as well as drought. The Naliendele Agricultural Research Institute has released several improved varieties in the past years and seeds are sold at a reasonable price. However, farmers in the area still largely rely on traditional seeds and do not frequently take up improved seeds. In terms of diseases, there is a frequent problem of pods wilting and crop destruction at the flowering stage. A disease affecting production which leaves spots on leaves is also

common. Finally, harvest is sometimes destroyed by animals such as goats (which eat the leaves) or baboons. Note, however, that virtually all crops are affected by diseases or animals, so that this is not a specific feature of BG, but more of a structural problem for agriculture in the region.

6.3.3 Traditional beliefs and Taboos

Finally, an important element which is not captured in the quantitative analysis is the issue of taboos and traditional beliefs surrounding the farming of BG. Focus groups reveal that these are nevertheless stringent and hinder the development of BG farming. In Nangumi, farmers explicitly mentioned taboos alongside absence of markets as barriers to BG production. There is a belief that if a woman on her period walks past a plot of BG the production will dry up and produce no harvest. As a result, farmers have to buy a medicine produced by a witch doctor. That medicine costs around 1,000 Tshs and is a liquid in which pods have previously been soaked to immunise them. In that village, this belief also extends to simsin and groundnut. In Mtama, there is also a medicine, called *male*, used by farmers and sold at about 3,000 Tshs. Again, this medicine is not uniquely used for BG. The medicine is prepared by an old woman as an antidote to spells. Farmers believe spells were originally cast against farmers who were seen as too successful by other fellow farmers. In Mwindi however, the taboo is specific to BG. The medicine is called *numbati*, and costs between 500 and 2,500 Tshs depending on the amount bought. In this village, farmers agree that these traditional beliefs are less and less followed by farmers. In Mnazi, there was a strong belief that anyone who plants BG too early would delay the rain which would bring issues for all farmers in the village. As a result, some farmers plant in secret. In some instances, it was discovered they had planted too early and they were forced to uproot pods which were then thrown in a well to counteract the effect on rainfall. One issue with this belief is that it delays the planting of BG to late January or early February, which has a negative effect on yields (the optimal planting time being around early January). This belief was observed in several other wards in the district during surveying (notably Libobe).

7 Conclusions

This study presents the results of a mixed-methods data collection project in the Mtwara rural district in Southern Tanzania. We collected primary data on socio-economic and agricultural variables with a special focus on BG, an indigenous crop widely grown in the region. Economic research on this crop is virtually non-existent and there is a crucial need to understand the dynamics associated with the farming of BG, and that of underutilised crops more generally. Growers of BG in Mtwara, although having similar socio-economic characteristics and living conditions as their non-grower counterparts, tend to have bigger farms, both in terms of number of plots and total area planted. Using quantitative (surveys) and qualitative (focus groups and interviews) data, we study the current status of the crop in the region, and how it compares with other crops widely grown, such as cassava, groundnut or cashew.

Results show that BG is currently primarily treated as a contributor to food consumption. Half of the farmers

growing BG report food consumption as their primary motive for planting the crop. Indeed, marketed surplus is low for this crop, at around 25%, much lower than groundnut, treated as a cash crop by most farmers with a marketed surplus of 66%. Hence, BG is largely retained for home consumption and is only a secondary source of income for most farmers. However, both quantitative and qualitative insights reveal that this is largely due to no reliable marketing channels existing for BG, unlike for other crops. Hence, this study also assesses the economic and marketing potential of BG. Results show that the presence of a physical marketplace in the village has a dramatic effect on commercialisation the crop. Other factors such as farm size or the presence of a household member holding a formal job also impact the commercialisation process. Further qualitative evidence from focus groups confirms those empirical results and also points towards a set of important production constraints alongside poor marketing channels. These include strong traditional beliefs, the lack of improved seeds and frequent pests and diseases affecting harvest. Efforts towards reducing the importance of these barriers are key to increase the marketing potential of this crop.

A caveat of our study is that its results can hardly be generalised as it is based on a small-scale case study. However, to the extent that our main aim is to learn something about the socio-economics of underutilised crops, such case studies are a useful starting point. It is also one of the few existing studies generating primary data on BG. Another caveat is that we are not able to exploit the intra-household gender dynamics of BG. There is evidence that in certain regions of SSA, BG is a women's crop and as such has specific features. Unfortunately, our data is limited in terms of gender based evidence and we cannot say much about this issue, save the fact that female-headed households tend to rely more on BG for food security than their male counterparts, and are more sensitive to its high nutritional content.

By showing both that BG is an important contributor to local diets and that it has economic potential, our results are entirely consistent with the view that underutilised crops deserve more attention in socio-economic research, which should go beyond the 'Big four' (maize, wheat, paddy and soy). Developing research on marginal crops is crucial as these crops, by their suitability to the environment in which they are grown, directly contribute towards less intensive and more sustainable modes of agriculture, while also having the potential to become important source of income. Their climatic resilience and strong nutritional properties (protein content in the case of BG) make them attractive crops to fight malnutrition and fulfil several of the SDGs developed by the United Nations, such as the Zero Hunger, Good Health and Wellbeing, or Climate Action goals.

8 Appendix

8.1 Quantitative Appendix

Table 6: Definition of variables

Variable	Definition
Household variables	
Dependency ratio	Ratio of persons between 0-16 and above 65 to the number of persons of working age (16-65)
No of household members	Number of persons normally resident in the household
Age of head	Age of the head of household
Gender of head	Gender of the head of household (0=male, 1=female)
Education of head	Categorical variable: 1=primary school, 2=secondary school, 3=higher
Formal job	Whether anyone in the household holds a formal job (0=no, 1=yes)
Phone	Whether anyone in the household holds a phone (0=no, 1=yes)
Transport	Whether anyone in the household holds a means of transport: bike and/or motorbike (0=no, 1=yes)
Years farming	Number of years since the household started farming
Cashew grower	Whether the household is a cashew grower (0=no, 1=yes)
Farm variables	
Farm size	Farm size in acres, understood as total area farmed in the 2014/2015 season
Rented plot(s)	Whether the household has rented any plot in the 2014/2015 season
Family workers	Number of family workers who worked on the farm in the 2014/2015 season
Hired workers	Number of hired workers who worked on the farm in the 2014/2015 season
Count	Total number of crops grown on the farm in the 2014/2015 season
Village variables	
Market	Whether there is a physical marketplace in the village (0=no, 1=yes)

Table 7: Estimation of retention rates: OLS models

	All crops		BG		Cassava		Other legumes	
Dep ratio	0.000	0.000	-0.000	-0.000	0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number HH	0.006	0.009**	0.003	0.005	0.023	0.020	-0.011	-0.000
	(0.004)	(0.004)	(0.008)	(0.010)	(0.014)	(0.013)	(0.010)	(0.013)
Age head	0.000	0.001	0.001	0.001	-0.001	-0.002	-0.003	0.000
	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Sex head	0.058	0.006	0.259**	0.190*	0.020	-0.043	0.225*	0.102
	(0.038)	(0.041)	(0.100)	(0.102)	(0.060)	(0.062)	(0.117)	(0.120)
Educ head	0.005	0.005	0.092	0.066	0.016	-0.002	0.060	0.053
	(0.028)	(0.026)	(0.059)	(0.057)	(0.055)	(0.055)	(0.062)	(0.065)
Transport	0.029	-0.024	0.110	0.030	-0.074	-0.049	0.077	-0.058
	(0.030)	(0.030)	(0.071)	(0.069)	(0.047)	(0.054)	(0.085)	(0.096)
Phone	0.042	0.007	0.090	0.056	-0.053	-0.053	0.045	-0.046
	(0.031)	(0.032)	(0.063)	(0.067)	(0.049)	(0.054)	(0.076)	(0.086)
Family workers	0.013	0.006	0.012	-0.011	-0.018	-0.014	0.139**	0.030
	(0.020)	(0.019)	(0.045)	(0.039)	(0.034)	(0.034)	(0.060)	(0.069)
Hired workers	-0.005	-0.003	0.009	0.016	-0.019**	-0.025***	-0.007	-0.010
	(0.004)	(0.004)	(0.010)	(0.011)	(0.009)	(0.008)	(0.015)	(0.017)
Farm size	-0.011***	-0.012***	-0.028**	-0.025**	-0.012	-0.019**	-0.019	-0.015
	(0.004)	(0.004)	(0.011)	(0.013)	(0.010)	(0.009)	(0.012)	(0.013)
Rented plot(s)	-0.083**	-0.086**	-0.095	-0.038	-0.095	-0.197**	-0.094	-0.005
	(0.041)	(0.041)	(0.082)	(0.086)	(0.075)	(0.078)	(0.105)	(0.117)
Count	0.007	0.014	-0.042	-0.032	-0.042*	-0.025	0.034	0.042
	(0.013)	(0.011)	(0.030)	(0.031)	(0.023)	(0.022)	(0.031)	(0.025)
Cashew grower	-0.198***	-0.222***	0.055	0.027	0.137**	0.125**	0.098	0.066
	(0.034)	(0.031)	(0.076)	(0.081)	(0.065)	(0.061)	(0.093)	(0.095)
Market	-0.015	-0.056	-0.142**	-0.109	0.013	0.020	0.104	0.062
	(0.031)	(0.038)	(0.064)	(0.093)	(0.056)	(0.065)	(0.078)	(0.129)
Constant	0.607***	0.739***	0.739***	0.930***	0.996***	1.281***	0.088	0.080
	(0.090)	(0.103)	(0.207)	(0.205)	(0.170)	(0.192)	(0.204)	(0.258)
N	836	836	143	143	171	171	150	150
Ward fixed effects	no	yes	no	yes	no	yes	no	yes
R^2	0.08	0.12	0.18	0.34	0.18	0.34	0.14	0.28

Standard errors in parentheses (clustered at the farm level)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Goodness of fit statistics of probit models

	Pseudo R^2	Sensitivity	Specificity	Correct predictions	LROC
Pooled sample	0.13	60	71	66	0.72
Pooled sample with fixed effects	0.17	69	71	70	0.76
BG	0.21	52	89	76	0.79
BG with fixed effects	0.29	63	86	77	0.84
Cassava	0.12	32	90	72	0.73
Cassava with fixed effects	0.26	50	88	76	0.83
Other legumes	0.09	80	38	63	0.70
other legumes with fixed effects	0.18	80	57	71	0.77

Note: Sensitivity refers to the percentage of correctly specified ones, while specificity refers to the percentage of correctly specified zeros. The LROC statistics refers to the area (between zero and one) comprised under the receiver operating characteristic curve. The higher the area is to one, the greater the fit of the probit model. Note that the sensitivity, specificity and percentage of correct predictions are based on a 0.5 cut-off. Hence, it is logical to find much a much higher specificity than sensitivity for crops such as cassava which are largely retained, while the opposite happens for crops which are very often sold. The cut-off value can be increased or decreased depending on the crop one is looking at, thus affecting the sensitivity, specificity and correct prediction rates.

8.2 Qualitative Appendix

8.2.1 Focus groups 1: Nangumi village (Mayanga ward). Date: 28/10/16

6 farmers participated, 1 woman and 5 men. In addition, the village extension officer (woman) and ward agricultural extension officer (man) also participated. Focus group was conducted in the village office.

Introductory questions (introduce yourself, and tell us about the main issues you face in the village as farmers. Then tell us your general opinion about bambara)

One of the main issue farmers mentioned is the problem of pests and diseases for many crops. For example, simsim is often eaten by insects (also a problem of leaf obstruction), cassava suffers from batobato disease, for Bambara there are insects that cause wilting of pods, or the crop can be destructed during flowering stage. There are also droughts problems that have recently been experienced for maize and Bambara. Regarding Bambara, the village extension officer mentioned the problem of taboos in the village that complicate growing. She is the only person who talked about taboo in these introductory questions, and the fact she is an official may be a reason (all other farmers initially did not mention these, although it's clear they are stringent concerns in this village). The ward extension officer also expressed a general concern for the lack of availability of improved seeds, and the fact that agriculture uses very little fertiliser.

Regarding opinions about Bambara, farmers expressed the following:

'Bambara is a good crop, but we do not have access to improved seed varieties' (Yusufu Musa)

'We are still using local traditional varieties, but Bambara helps us on food consumption and income generation' (Stavao King)

'Bambara is a good crop, but we need to know is we can use fertiliser for it. It helps for food consumption and

income' (Pius Likutwete)

'Farmers get good harvest for Bambara. There is need for formal farming training though. Many farmers also suffer from the taboos' (Salma Mataka, village EO)

'Bambara is a good crop, but we do not have a good market for it, and some farmers stop growing because of that' (Salum Hamis)

'It's a good crop for food consumption, sometimes a good source of income too, but there is no permanent market for it, which is a problem' (Rachid Abdulahman)

'Here we get very little information about Bambara from Naliendele research centre, but we get a lot of information for other crops' (WAEO)

Core questions

Why do you grow or don't grow BG?

Stavao King explains that Bambara is mainly grown for food consumption, but that another reason for growing is that it can be a source of income when needed too. According to Salma Makata, it involves a lot of activities to farm. Salum Hamis only grows for food consumption. He explains that although Bambara is an important crop, it is not a priority crop like other crops such as groundnuts, cashew and simsim. The latter, especially cashew and simsim are full cash crops. He also explains that Bambara is not grown that much because of the absence of market to sell. And taboos are strong. The main taboo is that if a woman on her periods walks past a plot of Bambara, the pods will dry up and there will be no harvest. Therefore, farmers have to buy a special medecine for 1,000 schillings to a witch. The medicine is a liquid in which you soak seeds before planting to immunise them against drying up. He explains that even if they get seminars explaining the farming of Bambara etc., farmers will listen but will still behave according to the taboo. However, the taboo is not exclusive to Bambara in this village, but also applies to groundnuts and simsim, for which farmers also buy the medicine.

In what ways is Bambara an important crop?

For Rukia Musa and Pius Likutwete, Bambara helps for food consumption within the household. Pius explains that you can eat Bambara in the morning and then don't eat to eat until the evening (it fills you a lot). For Yusuf Musa, it is also a source of income whenever there are unexpected problems arising.

It is also a popular food during Ramadhan, when people like to eat soft food (hard food is not good for the stomach during fasting).

How does Bambara compare to other crops (maize, paddy, sweet potatoes, cow pea, pigeon peas, cassava and groundnut) in terms of...

Growing: For Salum Hamis, Bambara is a tedious crop to grow because you have to do earthing up (cover the pods in small mud piles). But for Rashid Abdulahman, it is an easy crop to grow compared to the above. For Rukia Musa, the easiest crops to grow are cowpeas, maize and cassava. Therefore, there seems to be no clear consensus on this matter.

Selling: For Pius Likutwete, Bambara is harder to sell than the above crops, but Stavao King stresses that Bambara and groundnuts have the advantage that they can be sold fresh from the farm during harvesting

season.

Storing: For the WAEO, Rukia Musa and Salma Makata, Bambara is very easy to store (and groundnuts, which is similar), while other crops are harder to store.

Cooking: For Rukia Musa, cassava, sweet potatoes and groundnuts are the easiest to cook. Salma Makata stresses that Bambara and pigeon peas consume a lot of charcoal for cooking, which is a problem.

How do you buy/sell Bambara? (under which forms)

For Stavao King, fresh Bambara is easier to sell (fresh from farm). It can also be boiled and sold in town, which is pretty popular. When selling boiled Bambara, any variety can easily be sold, but when selling dried, there is a strong preference for the creamy variety. In the village people seem to prefer fresh Bambara over boiled. But boiled Bambara can be sold like boiled groundnut.

When is Bambara most available or popular?

Salum Hamis says time of harvesting is between May and June, where it's available without any scarcity. Scarcity arises during sowing season, in January-February, where price for seeds can reach 2,500 or 3,000 schillings per kilogram. Stavao King says price is about 10,000 for a plastic bag of approximately 20 kilograms during harvesting season, which is 500 schillings per kilogram. This is the usual selling price when they sell to town buyers. Sometimes there are also price increases during Ramadhan, as it's a popular food during fasting period.

8.2.2 Focus groups 2: Mtama village (Lipwidi ward). Date: 29/10/16

6 farmers participated, 3 woman and 3 men. In addition, the ward agricultural extension officer (man) also participated. Focus group was conducted under a tree.

Introductory questions (introduce yourself, and tell us about the main issues you face in the village as farmers. Then tell us your general opinion about bambara)

Farmers expressed several concerns regarding farming: problems of wilting of Bambara, for cassava there are problems of pigs eating the plants and the fact that it often dries before harvest. For groundnut, there is an issue of pests and insects, and for cowpeas farmers say they cannot afford chemicals they would like to use for that crop. For Bambara, there is also an insect problem which affects pod formation.

Regarding opinions about Bambara, farmers expressed the following:

'Bambara is a very good crop, because if you plant 1 kg of seeds you can get 50 kg harvest' (Said Ally)

'Bambara production is very good, sometimes if you plant 1 kg you can harvest 2 bags of 100 kg each' (Hadija Mohamed)

The rest of farmers agreed with the above opinion about Bambara being a good crop with good yield. They also said it depends on the weather and it can easily be destructed by insects.

Core questions

Why do you grow or don't grow BG?

Said Ally said that they grow Bambara because it has a good price compared to other legumes, especially during the Ramadhan period. During that period, price is 1,500 per kilogram, while cowpeas sell only for about 700 per kilogram. Before and during Ramadhan, traders from Zanzibar sometimes come to buy Bambara in the villages. Mohamed Chikambo said that Bambara is good for food consumption especially in the morning. Further, it has a good market and it is very easy to sell fresh Bambara.

Ally Hussein that Bambara involves a lot of work and he fails to grow it sometimes for this reason, because you have to do ploughing which requires lots of work and he cannot afford to hire labour for that work. Mohamed Chikambo agrees that ploughing is a problem, and he also explains that Bambara is not an easy crop for intercropping because it needs dense planting and does not leave space for other crops. Regarding taboos, he says there are no taboo in this village, but they used to exist long ago (in a village nearby, they say farmers do not plant Bambara because they fear it will attract lions to the village). However, we found that there are issues of this sort, but they are not considered as taboos by farmers because everyone follows them and it's common practice and knowledge, as explained in the following description. Ally Hussein that farmers use a local medicine called male that stops magic power from disturbing the production of Bambara. But this medicine is also used for many other crops, and is not unique to Bambara. It costs 3,000 schillings. If a farmers cannot pay for it when needed, he can take some from a friend and repay later in crop. Said Ally explains that the medicine is like a paste, prepared with plant extracts and water that the witch doctor has previously used to wash her intimate body parts. Regarding the origins of this practice, Mohamed Chikambo says it started because some people were jealous of others' success in agriculture and wanted to slow their success by putting spell on them. This medicine is thus like an antidote to the spell, and this is how is all started. It can only be prepared by local female leaders (it must be made by a woman who no longer has her periods).

In what ways is Bambara an important crop?

For Asha Mohamed, it is both a source of income and food, neither of which has a bigger weight (fifty fifty). For Hadija Mohamed, it is also the case, with equal importance of selling and eating. But Mohamed Chikambo adds that selling is often prioritised because it is easy to sell as seeds. Said Ally says you can sell as grain for 1,200 per kilogram, but seeds often sell at around 2,000 per kilogram (or even more). This man says that he had been to Dar Es Salaam last year and saw Bambara being sold for 2,800 per kg as grain, and there were many customers. He would like to go there and sell there before Ramadhan at a higher price than here, maybe he could also take with him some of his fellow farmers' harvests to sell.

How does Bambara compare to other crops (maize, paddy, sweet potatoes, cow pea, pigeon peas, cassava and groundnut) in terms of...

Growing: For one woman, groundnut, cassava and cowpeas are the easiest to grow on that list, they are easier than Bambara which requires lots of ploughing. For another woman, maize, pigeon pea and cowpeas are the easiest, while Bambara requires too much work.

Selling: For Ally Hussein, Bambara is very easy to sell, no matter whether it's sold fresh or dry. Said Ally

emphasizes that selling fresh Bambara is easy.

Storing: For Said Ally, maize is the easiest to store because you can leave the leaves on it, and dry it outside your house on a wooden structure (hanging on it). Stealing is not a problem (and apparently the threat of a spell is part of the reason). For Hadija Mohamed, cassava is the easiest to store because you can simply smoke it in the kitchen (*dari*).

Cooking: For Hadija Mohamed, sweet potatoes are very easy to cook, they just need to be boiled. For Asha Mohamed, pigeon peas is the easiest. Ally Hussein says the easy crops to grow in our list are: sweet potatoes, cassava, maize and groundnut. So there is no agreement as to which crop is the easiest to cook, but there is clear agreement it's not Bambara.

How do you buy/sell Bambara? (under which forms)

Zaituni Chombo says she sells fresh Bambara for 7,000 per plastic bag, but sometimes she also sells dry. She adds that when selling fresh, any variety can be sold, while for selling dry there is a clear preference for the cream colour ones.

When is Bambara most available or popular?

Mohamed Chikambo says that the period of high availability if June-August, where price lies between 1,000 and 1,500 per kilogram. Scarcity period is during January-February where it reaches between 2,000 and 2,500 per kilogram when farmers need seeds for planting. Bambara is also very popular during Ramadhan when it's eaten with *tambi* (sort of noodles), *andazi* (doughnuts) and chapatis.

8.2.3 Focus groups 3: Mwindi village (Mbawala ward). Date: 30/10/16

6 farmers participated, 3 woman and 3 men. In addition, 2 village officials participated (one man and one woman). Focus group was conducted in the village office.

Introductory questions (introduce yourself, and tell us about the main issues you face in the village as farmers. Then tell us your general opinion about bambara)

Regarding problems faced by villagers, Musa Hamis said there is an issue of diseases on cassava which they do not know how to control (don't know what chemicals to use). For cashew there was a problem of availability: fertilisers arrived late which caused problems. Cassava does not have a big market. Zainab Mpiku also says getting inputs is a problem, and fertilisers don't come on time. For cashew there is a disease, there is also a problem of insects for Bambara, and the market for cassava is too small. Ester Mrope says there are rats and diseases on fields, although they started prepared farm early. For cassava, they have the batobato desease, and for Bambara the major issue is that it has no market. Cashew has the problem of disease mentioned by previous farmers, and paddy often gets eaten by birds.

Regarding opinions about Bambara, farmers expressed the following:

'Bambara is a good crop, it is good for health, and it helps for food consumption and also as a source of income'

(Rukia Sallum)

'Bambara is a good crop, but the main problems with it are the absence of market and the diseases that can arise' (Adam Fwahili)

'Bambara is a good crop; but the problem is it has no market' (Hassan Ally)

Core questions

Why do you grow or don't grow BG?

Zainab Mpiku says it is a good source of food consumption and it serves to satisfy needs. It is good food as futari. Halima Munga (village official) says it's good for food and income but market is the main issue. She says they are asking the government to provide a reliable price as for cashew. It is a crop with a good and sweet taste. For Rukia Salum, it can be sold to buy other crops like paddy, and also to cover medical bills for children.

Regarding non-growers, Musa Hamis says he does not grow because there's no market, even if growing Bambara is very easy. Hassan Ally insists on the same problem.

Regarding taboos or traditions, Musa Hamis says traditions are not very stringent anymore, but they used to be more important. Hassan Ally says there used to be the belief that if you planted Bambara too early, lions would come to your house. Zainab Mpiku explains that the taboos about witchcraft and women on their periods causing pods to dry still exist though, and you can use a medicine called numbati to prevent those issues. Ester Mrope says it's produced by old people, and it is sold between 500 and 2,500 schillings depending on the amount bought. However, it is specific to Bambara (unlike in village for previous focus group). But not all farmers follow this tradition and grow it without the medicine. A farmer insists that what matters is rainfall, and not numbati.

In what ways is Bambara an important crop?

Adam Fwahili says it's important for food consumption, especially as futari, and mboga (side dish). Rukia Salum says you can have it in the morning and work on your farm all day after that, and she says it's also very good for Ramadhan. Hassan Ally says they'd like a reliable price (following government intervention). Ester Mrope says it's good food and there is no need to go to the market if you have Bambara.

How does Bambara compare to other crops (maize, paddy, sweet potatoes, cow pea, pigeon peas, cassava and groundnut) in terms of...

Growing: For Musa Hamis Bambara is very easy to grow because you don't need to do weeding more than three times per year. For Zainab Mpiku, Bambara is also easy to grow for the same reason, and because you don't need to use fertiliser. For Hamis Sadiki (village official), Bambara is easy to grow, but it needs ploughing, weeding and earthing up. With 1 kilogram of seeds he says you can harvest about 50 kilograms.

Selling: For Ester Mrope, the easiest to sell are cowpeas and groundnut because of the high demand existing for these crops (for fresh product). For Zainab Mpiku, Bambara and cassava are easy to sell but market is quite

small. Bambara can also be sold pretty easily when fresh. Hassan Ally says the easiest crop to sell is groundnut. Musa Hamis says Bambara, groundnut, pigeon peas and sweet potatoes are the easiest to sell in our list, but that as soon as you want to sell big amounts, things get complicated due to absence of markets.

Storing: For Rukia Salum, Bambara and groundnuts are very easy to store in clay pots, and you don't need to shell before selling. Adam Fwahili agrees with this.

Cooking: For Ester Mrope, groundnut, pigeon peas and cowpeas are the easiest to cook. Bambara takes a long time to cook, and requires lots of charcoal.

How do you buy/sell Bambara? (under which forms)

Zainab Mpiku says fresh Bambara is more popular during harvesting season. After that, dried Bambara is the main form under which you can consume it. During harvesting, you can sell a plastic bag (20 litres bag) of fresh Bambara for about 5,000 schillings. Outside harvesting periods, Bambara sells for about 2,000 per kilogram (dry). Regarding varieties, people want the white Bambara to eat fresh and for selling dried. The red variety is only retained for home consumption (not sold). She says you can sell dried Bambara for about 1,5000 per kilogram in the villages (at the shop). It sells higher in town (about 2,000) but there is a search cost in terms of finding market and buyers. Hamis Musa insists that price varies with demand. For Hassan Ally, dried Bambara are more marketable. People sell fresh Bambara to satisfy short term immediate needs, while dried Bambara is sold with a more medium/long term commercial logic.

When is Bambara most available or popular?

Musa Hamis says May-September is the period of high availability, while the period of scarcity stars in December. Price during high availability ranges between 1,000 and 1,5000 schillings per kilogram when selling, while it ranges between 2,000 and 2,500 in December, when many farmers want to buy seeds for planting. Adam Fwahili says that the price also increases to about 2,000 per kilogram during Ramadhan when it's a very popular food.

At the end of the meeting, Musa Hamis asks for feedback and tell us we should get back to them to tell them about the importance of our discussion.

8.2.4 Focus groups 4: Mnazi village (Nalingu ward). Date: 02/11/16

Many more farmers than we had asked for participated today. At some point we had 11 villagers participating, which was clearly too much but we could not reduce numbers. After explaining several times that we just needed 6 and no one being willing to leave, we started. Some people came and went away during the meeting etc. so it was not the best setup. 3 farmers were non-growers. Focus group was conducted in village office. This village is on the beach, so fishing is very important for people here.

Introductory questions (introduce yourself, and tell us about the main issues you face in the village as farmers. Then tell us your general opinion about bambara)

Ally Said says a big problem is goats, because they eat the leaves of many crops, and destroy an impor-

tant part of harvest. Masudi Musa says Bambara is affected by diseases, especially one which leaves spots on the leaves. Mohamed Said said that in addition to goat, there are also issues with baboons and monkeys which eat crops. For cashew, Said Abdallah says there is a disease during flowering stage which affects harvest. But he also mentions diseases for groundnut and Bambara: spots on leaves, plant wilting, as well as the goat/baboon problem already mentioned. He also complains that cassava harvests are very small here.

Regarding opinions about Bambara, farmers expressed the following:
'Bambara suffers from diseases' (Ashura Hashimu)
'We grow Bambara here, but we have low yields and we get pests and diseases' (Adija Abdallah)
'Bambara tastes good' (Rashid Mohamed)
'Although we have the problem of goats and monkeys and diseases, Bambara is still a good crop to grow' (Ally Said)
'Last year I planted 1,5 acres of Bambara but only harvested 10 kg because of diseases, especially leaf spots' (VO)

Core questions

Why do you grow or don't grow BG?

Sharifa Abdallah started growing Bambara because her parents were growing it. For Ashura Hashimu it is a source of food and income. In terms of food, it's eaten both on its own (futari) and as a side dish (mboga). The village official says he started growing it because he heard in a radio program that traders from the Comoros islands had come to town to buy big amounts of Bambara due to a very high demand in their country at that time. He thought he would try to sell his harvest, and his friends', but he was not successful.

Regarding why non-growers are not planting Bambara, Rashid Mohamed says it is not worth it due to the baboon problem: if almost everything gets eaten up, then you face a big loss. Mohamed Saidi has the same opinion. Ally Said says it is the goats issue that prevents him from growing. Said Abdallah says they need support in terms of chemicals usage, although the main problem is baboons, because they eat/destroy the plant during pod formation.

Regarding taboos or traditional beliefs, the village official says the belief that if you plant too early will delay rainfall still persists. This is why they only plant in February (doing so before would cause drought). Said Abdallah says that in this village, people believe that if farmers plant Bambara too early, they will only see thunderstorm but the rain will fail to come.

In what ways is Bambara an important crop?

This question was omitted due to lack of time and complications because of the high number of farmers.

How does Bambara compare to other crops (maize, paddy, sweet potatoes, cow pea, pigeon peas, cassava and groundnut) in terms of...

Growing: For Ashura Hasimu, the easiest crops to grow are: groundnut, cassava and Bambara because you

only need to weed a couple of times, which is not the case with other crops. For Mohamed Saidi, these are also the easiest crops to grown because they are drought resistant. The village official says that pigeon pea is also very popular to grow here (on small areas, mostly around houses).

Selling: For Adija Abdallah, groundnut is the easiest to sell because it's sold fresh. For Mohamed Saidi, Bambara is the easiest because you can sell dried.

Storing: For Masudi Musa, Bambara and groundnuts are very easy to store unshelled. Fatuma Yusufu (arrived late in meeting) agrees with this.

Cooking: For Fatuma Yusufu, cassava is the easiest to cook as it does not require a long cooking time. The village official says sweet potatoes are also very easy to cook, and several villagers agree while he says that.

How do you buy/sell Bambara? (under which forms)

Fatuma Yusufu says fresh Bambara is the preferred form, but Said Abdallah says dried Bambara is also popular. The village official says fresh Bambara can either be sold on the plots or at home, for a price of between 5,000 and 7,000 schillings for a plastic bag of 20 litres. Dried Bambara sells at higher price, between 1,300 (farmers' price) and 1,500 (shop price) schillings per kilogram. Boiled Bambara is also sold, for about 200 schillings per cup. He says that fresh Bambara is sold to satisfy immediate needs (as opposed to dried Bambara).

When is Bambara most available or popular?

Masudi Musa says the scarcity period is December-January, where price can reach up to 2,500 schillings per kg when farmers want seeds. During harvest time, when Bambara is abundant, it sells are around 1,000 to 1,200 per kg. During Ramadhan, the price usually goes up as it is a popular food at that time of the year. In the past years there have been boats coming to buy Bambara from Zanzibar for Ramadhan. However, because it roughly coincided with harvest time in the past 2 years, there was no major effect on price due to abundance of the crop. Fatuma Yusufu says it's a good and soft food during Ramadhan.

8.2.5 Traders' interview: Mtwara Central Market. Date: 03/11/16

The three traders interviewed are:

-Shahibu Ngombo : aged 53, with primary level of education, from Lindi region

-Mhamed Naheka: aged 54, with primary level of education, from Mtwara region

-Ramadhani Mtumba: aged 48, with secondary level of education, from Mtwara region

All of them are traders, but in addition, Ramadhani is also the chairman of the traders' association. We had planned for an interview with one trader only, but another one asked us at the last minute if he could join. Further, we were joined by the chairman since the interview took place in the traders' office. So this is the report of a semi-structured group interview.

Why and when did you become an agricultural trader?

Shahibu started working in business in 1974, he was selling fruits in Mtwara market. He started being an

agricultural trader as such in 1982, because at that time, being in this business paid more than other forms of employment. In 1994 they formed the traders' association and he was secretary.

Mhamed started selling fruits in 1985. He also worked as a labourer which was not enough to live, and was influenced by other traders who were already established. This is how he became a trader himself in 1994/1995. He started working with Shahibu who influenced his decision to become a trader.

Ramadhani started in 1986 by selling fish in his village, right after he completed primary school. But in 1989 he arrived in Mtwara where he stayed at his uncle's place and he became a trader due to other traders' influence. Between 2004 and 2006 he went back to school to follow secondary education; he was doing trading business in the morning, and went to school in the afternoon.

What crops do you sell here?

Basically all of them sell cereals and leguminous crops. What they are selling exactly at one point in time depends on seasonal availability and customers' demand. Among crops sold are: groundnut, paddy, Bambara, green gams, maize, cowpeas, sorghum, millet etc.

What are the positive and negative aspects of selling Bambara from a trader's perspective?

Ramadhani said that a positive aspect is that it is easy to sell to many small restaurants around who cook Bambara. A negative aspect is that there used to be traders coming to town from Pemba/Zanzibar to buy large amounts of Bambara but they do not come as regularly anymore, because the price of Bambara has increased in Mtwara region. He says that in that sense, the market is not reliable. A corollary problem is that sometimes they buy big amounts of Bambara when they think traders from Pemba will come, but if they don't, they end up with huge amounts to store. Further, if they cannot sell readily to Pemba traders, they need to use chemicals to store the crop so it doesn't go bad after a few months.

Mhamed said that in the past years, yields of Bambara have been low in the villages around, especially in Nambare village in Tandahimba district where they used to get large supply. Now they rely more in villages in Newala district. This means that the price is now higher than it used to be. A good point is that Bambara is a good crop for food consumption and is popular because it can be eaten on its own or as a side dish.

Shahibu said that a good aspect of trading Bambara is that it keeps a very good appearance, after months after harvest. The nut stays nice even 12 months after harvesting, while it is much shorter for cowpeas (about 3 months before it changes colour and appearance). But on the bad side, yields have been too low recently, partially due to eroded soil fertility, so that farmers are switching to other crops (some of them cash crops like

simsim).

In which months is there high demand/supply of Bambara? When do you buy? In what amount? At what price?

Shahibu said that supply is abundant in June and July, when the price ranges between 700 and 800 schillings per kg for wholesale price (large amounts), and 900 to 1000 for retail price (small amounts). Between November and May, when availability goes down, wholesale price increases to between 1,200 and 1,400 per kg, and retail price between 1,800 and 2,000.

Regarding buying, there are often trucks coming from the villages to sell Bambara to traders at the market. He explains that he does 'his research'. This means that he tells the first truck coming 'Yes- I will buy from you in a few days but I don't have the money now'. In fact, he waits for other trucks to come in the days after and checks their price, and he then selects the seller with the most advantageous price. The quantities they buy are very big: each trader can buy up to 20 tons of Bambara (and 20 of groundnut, 30 of cowpeas etc.). However, the amount bought varies according the capital that each trader has. Mhamed agreed with this last point.

Tell us about Bambara collection. Who is collecting the crop? And where do you buy it from?

Shahibu said that during high availability season, right after harvest, there is no need to go to the villages, because farmers are coming to town by themselves to sell Bambara (or trucks come, as explained above). But from September onwards, traders need to send agents to the villages to get Bambara.

Mhamed said he used to go himself to the villages and collect the crop, but now he is too old for that. He also explained that woman traders get more quantity than men because they do not incur the same costs than men (because in a household, a man is supposed to cover expenditures for the family, so that the wife does not have to pay for the bus fare to go collect Bambara to a village etc.).

Do you have any links with markets outside Mtwara, like in Dar Es Salaam, Zanzibar or nearby countries such as Comoros Islands?

Ramadhani said that in terms of foreign markets, they often sell to traders in Mozambique, who send money to an agent here, who then dispatches the crop (i.e., traders from Mozambique don't physically come here). There is no trade from other countries, because such trade goes via Zanzibar, which is much closer to Comoros Islands and big coastal cities such as Mombasa in Kenya, so the only foreign trade here is with Mozambique, which is very close from Mtwara. There is also national trade with other regions like Lindi, which is quite close. Here

too, trade usually operates via an agent who receives the money and makes sure that crop is dispatched. They also have customers in Dar Es Salaam.

In terms of trading, how does Bambara compare with other important crops like groundnut, cowpeas and pigeon peas?

Shahibu explained that Bambara is a 'secondary' crop, that it is less important than cowpeas. Cowpeas usually have a higher selling price. For example, cowpeas sells for 1,300 to 1,400 schillings per kg now, as oppose to 1,200 to 1,300 for Bambara.

Mhamed said that pigeon peas also became a very important crop because of a very high export demand to India, which pushes its price. It used to be a crop with a very low price but things have changed after trade with India started, the price is now about 2,000 per kg.

How and where do you store your crops?

Mhamed explained there are different storage places. One is inside the market, the other is outside. In the latter they store crops on which chemicals have just been applied, because of the strong smell it gives for some time. Once sprayed with chemicals, Bambara needs to be put away and not consumed for some months before I can be sold. It is then stored in big jute bags.

Are you aware of any processing of Bambara in the region?

They all agreed that there is no processing in the region. They do not know of any factory that would process Bambara into flour for instance. Everything seems to be used for home/restaurant consumption, and not for processing.

After the interview, we went back into the market place to take pictures of crops stored in jute bags, piled up right in the middle of the market place. So there is no separate storage facility, rather all crops are stored in the same place they are sold.