Capturing views of men, women and youth on agricultural biodiversity resources consumed in Barotseland, Zambia

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CAPTURING VIEWS OF MEN, WOMEN AND YOUTH ON AGRICULTURAL BIODIVERSITY RESOURCES CONSUMED IN BAROTSELAND, ZAMBIA

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EXECUTIVE SUMMARY

This paper presents data and findings from focus group discussions in study communities selected by the CGIAR Research Program on Aquatic Agricultural Systems (AAS) in the Western Province of Zambia. The discussions focused on cultivated crops and vegetables collected from open fields and consumed as food. The population in each of the communities studied was disaggregated into three peer categories: men older than 35 years, women older than 35 years, and men and women aged 35 years or less. Participatory tools for agricultural biodiversity (agrobiodiversity) assessment were used to capture community perspectives on plant species and varietal diversity; factors influencing the availability and use of plants for food; unique, common and rare crop species cultivated in a community, identified through a four-cell analysis methodology; and core problems, root causes, effects and necessary actions to tackle them, using problem tree or situation analysis methods.

Food security, income, hedging against food crop losses and diversifying food sources for diet diversity were major drivers of crop diversification strategies pursued by men, women and youth in the AAS focal communities studied. Low productivity was identified as a core problem that affected food security. To address low productivity concerns, it is recommended that future participatory action research test how best to facilitate farmers' access to quality seeds or planting materials for preferred crop varieties, along with soil fertility improvement.

Based on responses from the initial focus group discussions, as well as those from the follow-up cross-group discussions, the study outlines farmers' trait preferences for rice, maize and cassava. The data collected provide guidance to crop improvement programs that target Barotse communities dependent on aquatic agricultural systems. In addition, these preferences have didactic value for research in areas with seasonal flooding experiences similar to the communities studied in this research.

The 25 cultivated crops and their varieties that were identified by men, women and youth in the study communities provide the opportunity for exploring how to optimize crop diversification on different land types to meet household goals: food security, hedging against crop failure, and diversified diets. In almost all communities studied, *Amaranthus* spp. (amaranth), *Cleome gynandra* (cat's whiskers), *Chorchorus* spp. (bush okra) and *Hibiscus sabdariffa* (roselle or sorrel) were the vegetables most frequently collected from the local agroecology for consumption. In view of their known high and diverse nutrient contents, we recommend that these local leafy vegetables be considered for inclusion in participatory action research on learning plots for crop diversification.

Once farmers understand the value of cultivating these local vegetables and grow them, it is recommended that market research address potential bottlenecks to widespread adoption, focusing on value chains from seed supply to prolonging shelf life and marketing. For other lesser-known locally collected vegetables, research is recommended to identify them (using both common and botanical names) and assess their bio-active nutrient contents. Research is also recommended to explore the presence and types of anti-nutrient factors in the vegetables and whether or not local indigenous treatment in traditional food preparation eliminates or attenuates the potential harmful effects of the identified anti-nutrient factors.

An important limitation of this study was that due to the breadth of issues covered it was not possible to explore responses further. As a result, some responses that portrayed differences across peer groups could not be explored in depth. Future studies may, therefore, want to consider reducing the number of issues to be covered and thus allow for more in-depth exploration. Also, the youth group could be split into males and females to bring out gender-related differences among young people.

BACKGROUND

The Zambezi River floodplain in Western Zambia is an example of an inland aquatic agricultural system where seasonal flooding impacts the agricultural activities and livelihoods of the riverine population. Aquatic agricultural systems are generally highly productive. However, productivity is often constrained by a lack of inputs, poor access to markets, unpredictable seasonal flooding and a lack of innovation (WorldFish 2011). In Western Zambia, the key stakeholders actively practicing agriculture or managing resources used for agriculture in the Borotse[1] floodplain are the Barotse Royal Establishment, the Provincial Ministry of Agriculture and Livestock, farmers and fishers, and nongovernmental organizations. Representatives of these stakeholder groups identified major agricultural development challenges that impact the livelihoods of the population. The development challenges identified in the Barotse communities practicing agriculture in the Zambezi River floodplain include social and gender issues, low agricultural productivity, weak market linkages, unpredictable flooding, seasonal migration, and a lack of well-adapted seed systems and agronomic practices. Some factors that contribute to low productivity include mostly poor, sandy soils; a lack of inputs for soil amendments; weak access to adapted quality seeds; livestock diseases; crop pests and diseases; unpredictable flooding; seasonal migration; and a lack of well-adapted non-seed technologies and agronomic practices (Baidu-Forson et al. 2014).

An important concern expressed by the Barotse stakeholders is the loss of agricultural biodiversity (agrobiodiversity) resources that could be harnessed to improve people's livelihoods. In response to the stakeholders' concerns, the CGIAR Research Program on Aquatic Agricultural Systems (AAS) prioritized an assessment of agrobiodiversity resources in the floodplain to inform research-in-development[2] activities at hub and community levels, particularly with respect to productivity, crop diversification and nutrition. A three-step survey approach (expert or key informant surveys, focus group discussion, and individual household surveys) was used to assess the status, dynamics and drivers affecting agrobiodiversity resources. We covered cultivated lands, crop species and varieties, native vegetation used as sources of gathered food, livestock, fish, edible fungus, etc., found in the Borotse[3] floodplain. This working paper reports data collected and findings synthesized from focus group discussions conducted in the Barotse AAS focal communities. The focus groups were comprised of peer groups disaggregated as follows: adult males and adult females in households, and a mixed group of young men and women who play a different social role as youth in their communities.

The overall objective of the focus group discussion was to understand the views of people in the focal communities on the diversity of plant food resources. It was designed to provide a framework for participatory discussions within the defined peer categories. The disaggregated focus group discussion design facilitated group interactions and created a better understanding of the views, needs and desires of different segments in the Barotse AAS focal communities. The findings from the focus group discussions indicate entry points and pathways for research-in-development initiatives that could effectively harness agrobiodiversity resources for improving the agricultural system and livelihoods of people in conformity with their visions.[4] This working paper is limited to plant species and diversity in varieties and cultivars[5] found in crops and plants collected from open fields or uncultivated lands for use as food by people in the focal communities.

The focus group discussions were guided by four key questions:

- What are the crop species and wild plants collected by people in the AAS focal communities for use as food?
- What are the motivations for crop diversification?
- What are the key opportunities for harnessing plant species, varieties and cultivars for improving productivity and nutrition?
- What social and/or gender distinctions are evident in terms of knowledge of, access to and use of available plant diversity, and how do these differences shape the ways in which AAS develops research-in-development activities?

METHODS

The focus group discussions were conducted in 10 AAS focal communities[6] from July to August 2013. The four districts in which villages were selected for the study in Western Province are shown in Figure 1. Details of the geographical coordinates and elevations of the villages are presented in Table 1. In each of the AAS focal communities studied, the resident population was disaggregated into three social groups: older men (>35 years), older women (>35 years), and youth (both men and women ≤35 years). About 10–15 people from each of these three categories (men, women and youth) constituted the focus groups in each community.

Participatory tools outlined by Boef and Thijssen (2007) were employed during discussions of key issues, namely species and variety or breed diversity; current status and trends that underpin their availability and use; methods for identifying unique, common and rare crop species cultivated in a community (we used a four-cell analysis methodology); and core problems, their root causes, their effects and necessary actions to tackle them through problem tree analyses (or their inverse, referred to as objective tree analyses). Problem tree analysis or situation analysis is a key tool used by major international and bilateral donor agencies (Aune 2000; AusAID 2003). Some of the advantages of the problem tree approach include the following (ODI 2009):

- problems broken down into well-defined issues, which allow clearer focus on objectives and how to resolve them;
- greater understanding of each problem and its causes, to facilitate identification of specific actions to be undertaken by whom at each stage;
- shared sense of understanding, purpose and action, particularly where collective community effort is needed to resolve causes of identified problems.

In our study, the application of the problem tree approach allowed us to do an analysis of differences in responses from the gender and social categories. This helped in identifying appropriate actions and solutions to help meet the needs of people who make up the different categories.

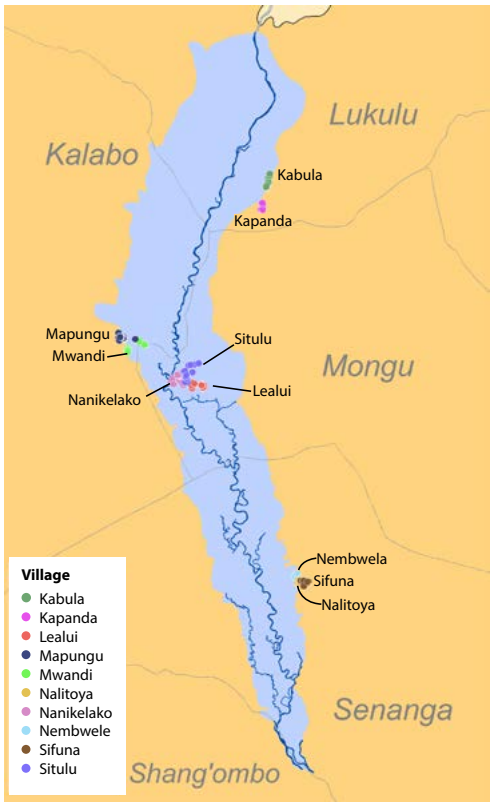

Figure 1. Map showing the AAS focal communities studied in Kalabo, Lukulu, Mongu, and Senanga districts in Zambia.

In the "four-cell analysis" method, the cells defined for the assessments were Cell 1, many households cultivating large land areas (many + large); Cell 2, many households cultivating small land areas (many + small); Cell 3, few households cultivating large land areas (few + large); and Cell 4, few households cultivating small land areas (few + small). Based on the unit of land commonly understood in Barotse communities, we used the local measure *lima* (equivalent to 0.25 hectares [ha]) as an indicative measure of relatively large and small land areas. A "large" land area by local standards in the AAS focal communities was greater than or equal to 1 *lima*, and a "small" land area was less than 0.5 *lima* (or 0.125 ha). For clarity in differences in the assignment of crops to the cells, we focused on the two extreme cells, namely Cells 1 and 4.

The group discussions also focused on the following commonly expressed priority issues: crop diversification objectives and preferences; indigenous or local crop species and varieties lost or at risk of loss; varieties and cultivars lacking adaptation to prevailing cropping conditions in the Borotse floodplain; land types and crops cultivated in them; and a cropping calendar and the dates of commencement and end of flooding in each community.

A second round of visits was conducted in July 2014. During these visits, joint meetings were held with people from all the three social categories for the purposes of sharing summary findings; seeking verification, confirmation and additional data; and providing avenues for learning across the social groups.

	Latitudinal coordinates	Longitudinal coordinates	Elevation (meters)
Kalabo District: *Nu`nyama silalo* Mapungu	15 degrees 5′ 0″ S	22 degrees 46′ 984″ E	1,026
Mwandi Lower	15 degrees 6′ 362″ S	22 degrees 51′ 187″ E	1,023
Mwandi Upper	15 degrees 7′ 400″ S	22 degrees 48′ 128 " E	1,025
Lukulu District: *Mulundwe silalo* Kabula	14 degrees 37′ 185″ S	23 degrees 13′ 3″ E	1,040
Kapanda	14 degrees 42′ 274″ S	23 degrees 12′ 33″ E	1,035
Mongu District: *Siwito silalo* Lealui	15 degrees 13′ 468″ S	23 degrees 1′ 175″ E	1,018
Situlu	15 degrees 11′ 982″ S	22 degrees 58′ 408″E	1,012
Nanikelako	15 degrees 11′ 761″ S	22 degrees 57′ 232″ E	1,023
Senanga District: *Liangati silalo* Nembwele	15 degrees 47′ 588″ S	23 degrees 17′ 835″ E	1,009
Sifuna	15 degrees 48′ 53″ S	23 degrees 18′ 18″ E	1,021
Nalitoya	15 degrees 47′ 963″ S	23 degrees 18′ 435″ E	1,026

Table 1. Global Positioning System (GPS) description of locations of study villages. (The GPS coordinates and elevations were primary data for the location of the home of the head of each village or community, collected by WorldFish staff based at the AAS hub in Western Province, Zambia.)

Crop species cultivated in AAS focal communities

About 25 different crops and their varieties or cultivars were listed by the focus groups in the AAS focal communities (Appendix 1). A few sorghum and millet varieties mentioned by study participants were listed as rarely seen or having disappeared. In addition, about 18 plants were collected from the open fields or uncultivated lands for consumption (Appendix 2). We found that maize, rice, cassava and sweet potato were the four major staples cultivated in the study communities. For the four major staple crops, focus group participants mentioned about 30 cultivars of maize, 11 cultivars of rice, 20 cultivars of cassava plus another cultivar of cassava (*Mandelena*) that is no longer found in the communities, and 44 cultivars of sweet potato.

The number and types of crops and the cultivars planted differed depending on predominant land types, soil moisture conditions and flooding experiences. Some differences were sometimes discernible across disaggregated group categories (men, women and youth). In many communities, the youth groups listed many more species and varieties or cultivars (Appendix 1). This might reflect the willingness or propensity of younger people to experiment more on their plots than people of older age.

Problem tree analysis data for cassava (Appendix 3) and cereals (Appendix 4) showed that low yields, resulting in low production, often contributed to hunger, poverty and malnutrition in the AAS focal communities. In addition, older women (in comparison to older men) experienced additional constraints, such as access to only limited land areas for cultivation and lack of access to tilling equipment and animal draft power (plows and oxen). In the case of the latter constraint, study participants suggested that addressing cattle diseases would help avoid cattle deaths and provide the draft power to cultivate increased land sizes. In addition, healthy cattle could enhance availability of manure for improved soil fertility and increasing productivity on sandy soils that lack organic matter.

Frost and flood damage to existing cassava cultivars are significant problems in the AAS focal communities. Early-maturing cassava cultivars enhance capacity to escape frost damage and effects of unpredictable floods. Frost damage is mitigated through storing cassava cuttings during frost-prone months either under shade or by covering them with branches.

Productivity on maize fields was affected by floods, a lack of adapted or early-maturing varieties or cultivars, erratic rains, and infertile soils. Due to a lack of access to adapted seeds, most farmers across all the defined peer categories recycle maize seed from their previous harvest or purchase seed from the market for use as planting material. However, farmers in the communities studied were aware of yield declines experienced as a result of the planting of recycled maize seed. They noted that this was particularly the case with hybrids and less so with open-pollinated varieties. Farmers who are better off and/or are members of cooperatives access maize seeds from the Farmer Input Support Programme,[7] while the resource-poor who are not members of the cooperatives only use recycled seed from previous harvests.

Diversification of crops on cultivated lands

On all land types, people in the studied AAS focal communities planted a diversity of crops, which were used to achieve specific goals. Data analyses revealed location and gender differences in the underlying rationale for the pursuit of crop diversification in the study villages. Food security, defined by Barotse households as having enough food (often referring to the staples) throughout the year, was cited as one of the main reasons for crop diversification, particularly by older men and youth (Table 2). This is attributable to gender roles of husbands or young adult males as providers of household food security. Only a

few female groups cited food security as the reason for pursuing crop diversification. This possibly reflects the views of widows who depend on their cultivated plots for food to feed their families.

Hedging against crop failure was also cited as a very important reason for crop diversification. Hedging was practiced by all the focus groups but particularly by the youth. It was explained that hedging against risk of crop failure involved a mix of more productive but less hardy crops or varieties and crops or varieties that were less productive yet more tolerant to drought or floods. Older men and youth cited increasing income sources as an important reason for pursuing crop diversification. It is noteworthy that older men never mentioned increasing diet diversity as a reason for crop diversification (Table 2). On the other hand, diversifying diets was important to women and youth (which included young women). These observations on diet diversity probably arise because securing adequate nutrition is gendered and most likely shaped by norms and power relations. Women tend to be responsible for ensuring household members eat a diversity of foods, while men tend to be more concerned about acquiring cash, producing cash crops, purchasing larger items for the home, etc.

		Kalabo District			Lukulu District		Mongu District			Senanga District		
		Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Increase income	**M**	1	1	1	-	-	1	1	-	1	1	1
	W	-	-	-	-	-	-	-	-	-	-	-
	Y	1	-	-	1	-	1	1	1	1	1	1
Food security	**M**	1	1	1	1	1	1	1	1	1	1	1
	W	-	1	1	-	-	-	-	1	-	-	1
	Y	1	1	-	1	1	1	1	-	-	1	1
Enrich soil fertility	**M**	-	-	-	-	-	1	1	-	-	-	-
	W	1	-	1	1	-	1	1	-	1	-	-
	Y	-	-	-	-	-	1	-	-	-	-	-
Hedge crop failure	**M**	-	-	-	-	-	-	-	1	-	-	-
	W	1	-	1	1	-	-	-	1	1	1	1
	Y	1	1	-	1	1	1	1	1	1	-	-
Limited land	**M**	-	-	-	-	-	1	-	-	-	-	-
	W	-	-	-	1	1	1	1	1	-	-	-
	Y	-	-	-	-	-	-	-	-	-	-	-
Pest and disease control	**M**	-	-	-	-	-	-	-	-	-	-	-
	W	-	-	-	1	-	1	-	-	1	-	-
	Y	-	-	-	-	-	-	-	-	-	-	-
Increase diet variety	**M**	-	-	-	-	-	-	-	-	-	-	-
	W	-	-	-	-	1	-	-	-	-	-	1
	Y	-	-	-	-	-	-	-	1	1	1	-
Reduce labor	**M**	-	-		-	-	-	-	-	-	-	-
	W	-	-	1	-	-	-	-	-	-	-	-
	Y	-	-	-	-	-	-	-	-	-	-	-

Notes: M = men older than 35 years; W = women older than 35 years (married and widowed women heading households); Y = youth (women and men 35 years or younger); 1 = cited by group as reason for crop diversification; - = not cited as reason for crop diversification.

Table 2. Crop diversification reasons cited by men, women and youth in AAS focal communities in Western Province, Zambia.

Other less frequently cited reasons for the pursuit of crop diversification included the desire to enrich soil fertility and limited land. The gender and location distinctions have implications for targeting specific species and cultivars or varieties to address the different motivations for crop diversification. On the basis of these findings, it is recommended that participatory action research to test and optimize the cropping options for diversification on available land resources should pay attention to gender and location differences as well as the predominant diversification goals and strategies.

Characteristics of land types in the Borotse floodplain, crops planted and the cropping cycle

The major land types found in the AAS focal communities and their characteristics are presented in Appendix 5. Men, women and youth cultivate crops on different land types based on their knowledge of water requirements, how well the crops matched soil moisture conditions, and the onset, severity and end of flooding. More crops were grown on relatively moist soils (e.g. *mazulu*), and fewer crops were grown on the drier, poor land types (e.g. sandy *mushitu*). Land types closer to homesteads (e.g. *matongo* or even *lizulu* when close to the homestead) had many different crops planted on them, including new crops, varieties or cultivars being tried out by the farmers.

Four-cell analyses of crops

Four-cell analyses of all crops

Residents of the AAS focal communities explained that crops planted on large areas were staples with high market value capable of providing income as well as food. Maize was the crop predominantly planted on large areas by many households (Appendix 6). Rice and cassava were not planted on large areas of land by many study participants in any of the communities studied. In some communities, easy access to planting materials (seeds or cuttings for cassava) was an important factor that affected the size of plots cultivated. It was noted, however, that cassava was the crop well adapted to the sandy soils in the floodplain and uplands. It required low external inputs, provided a long harvest period due to the storability of the roots in the field, and had many food uses.

In specific communities (e.g. Lealui), vegetables were uncommonly planted to large areas. These are communities accessible to the major district markets in Mongu. Women were predominantly the ones who planted the vegetables. Expensive seed, short shelf life, and the need for irrigation and chemicals for the control of pests and diseases were cited as important reasons why few residents of the AAS focal communities planted vegetables on small land areas. Low market demand (due to poor market access and low prices) and low productivity were also mentioned as important decision factors for low vegetable production. For other crops, pilot testing, difficulty in accessing seeds, limited suitable land (not affected by floods), lack of knowledge, and pest and disease risk constituted reasons why they were planted on small areas. More importantly, some crop characteristics (for example, vulnerability of sorghum and millet grains to bird damage, late maturity of local cowpea, and pops[8] in groundnut) led to the planting of some crops in small areas.

Four-cell analyses of maize

Four-cell analyses of maize varieties and cultivars showed that seeds recycled from previous crop production (including grains of MM 441, which is a hybrid) were predominantly grown by many households on large areas. The recycled seeds were either purchased on the open market or collected from each farmer's own previous production, irrespective of whether they were hybrids or open-pollinated varieties. Men, who sometimes purchased hybrid maize seed, were concerned about the high cost of seed. Table 3 shows that inexpensive seed and easy access to maize seed are desired by at least one peer category in almost every one of the communities studied. This finding reveals the two key motivations for the recycling of maize seed. Indeed, many farmers prefer to select, conserve and use their own selected seeds year after year. The recycling of maize seed works well for open-pollinated varieties that produce lower but stable yields and not so well for hybrids. Farmers indicated that yields from recycled hybrids were low. Farmers also noted the

occurrence of yellow-striped leaves (possibly due to maize streak virus attack) on maize plants from recycled hybrid seed.

Although McGuire and Sperling (2011) recognized seed as a vital input, they posited that farmers' production and food security are likely to be affected by a myriad of factors other than "small fluctuations in seed availability," and hence poor seed access may not cause a household to fall into hunger. This assertion is not supported by the experiences and views expressed by maize farmers in the AAS focal communities studied. Here, resource-poor farmers responded to weak access to seed by recycling planting materials from their previous harvest in order to avert hunger, since they did not have the means to purchase seeds. Findings from other studies in Tanzania indicate that the poorest households are the most seed insecure, since they generally fail to produce enough crops to keep seed throughout the year and only access seed through the exchange of labor for seed (Lazaro and Bisanda 2005).

In the AAS focal communities, the critical factors that motivated annual purchases of maize seed included good income (to facilitate availability of extra cash for seed purchases), inexpensive seed and easy access to seed. In view of the poor transport network to many of the AAS focal communities (due to lack of roads, sandy soils and dispersed small communities), seed suppliers from outside the communities face high transport costs to deliver seeds to the farm gate. We recommend market research to examine the feasibility of alternative models for less costly seed deliveries to communities that have poor transport access to town markets (including community seed production linked to community genebanks and development and training of local agro-dealers).

Table 4 also shows that in many of the study communities, at least one peer group desired early-maturing cultivars. Due to the early-maturing trait of MM 441, it fits well with the unpredictable onset of flooding in the Borotse floodplain. With the exception of four communities, early maturity was cited by at least one peer group in each community as the reason why many people planted particular cultivars in large areas. Women and youth from five communities cited low yield as the reason why few people planted some cultivars in small areas. This may be linked to the intrinsic low yield traits of the cultivars. Nalitoya and Nembwele are the only communities where youth cited limited access to land as the reason why cultivars were planted in small areas. Table 4 shows that expensive seed and late maturity were cited by at least one peer group in almost all the communities as the reasons why few people planted maize cultivars in small areas. Expensive seed and difficulty in accessing seed were cited as important factors constraining widespread use of modern maize cultivars (e.g. MM 603, Pool 16).

	Kalabo District			Lukulu District		Mongu District			Senanga District		
Why maize cultivars were planted on large areas by many farmers	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Cheap seed	Y	M	Y	--	WY	MWY	MWY	MWY	W	W	W
Easy seed access	Y	M	--	Y	--	M	MWY	Y	Y	Y	Y
Early maturity	MW	--	MW	W	--	MW	--	MWY	--	Y	Y
Drought tolerance	--	--	--	--	--	Y	--	--	--	--	--
Adapted to BFS	Y	--	--	--	Y	Y	--	--	--	--	--
High yield	MW	--	--	WY	--	--	--	--	--	WY	WY
Stays above floods	--	W	--	--	--	--	--	--	--	--	--
Good grain quality	--	--	--	--	--	--	--	--	--	Y	Y

Notes: M = men older than 35 years; W = women older than 35 years (married and widowed women heading households); Y = youth (men and women 35 years or younger); -- = not cited by any group. BFS stands for Borotse floodplain system.

Table 3. Reasons cited in AAS focal villages as to why many people grow maize cultivars on large areas.

It was explained that late maturity was the reason why a modern maize cultivar, MM 603, was planted in small areas. Similarly, due to the long-maturity characteristics of local maize varieties such as *Kandalendale*, *Munali* and *Simikata*, they were viewed as no longer adapted to the unpredictable flooding experienced in the Borotse floodplain. Some maize cultivars were deemed not adapted to lower-lying areas in the floodplain (in Mwandi Lower, Lealui, Situlu and Nanikelako). An interesting observation was the preference by women in Mwandi Lower for maize plants based on plant height. It was explained that because of its plant height of 1.5 meters at maturity, MM 441 was preferred to Pool 16, which was more prone to submergence in flooded areas.

Based on the findings, factors that stimulate many people to cultivate maize in large areas include cheap seed, easy access to seed and early maturity. On the other hand, lack of seed, expensive seed and late maturity are reasons why few people grow certain maize cultivars in small areas. An additional consideration in promoting maize cultivars is adequate plant height to avoid waterlogging on *litapa* and *mazulu* land types. On the other hand, on drier *mushitu* land types, where rain-fed maize is cultivated on mostly sandy soils, drought tolerance is a key desired trait.

During the second visit to each of the communities, joint meetings were held with all social groups in each village. The second visits were used to share findings from the first agrobiodiversity survey and seek confirmation about the specific characteristics of maize cultivars desired for the different land types. We learned that maize was planted on five different land types, ranging from flood-prone *litapa* to drought-prone *mushitu* and including *mazulu*, *matongo* and *mabala*. Early maturity was mentioned in almost all AAS focal communities as a desired maize cultivar trait on all the land types on which maize was cultivated (Table 5). It was explained that early-maturing cultivars, which have short crop cycles, were protected from the effects of flooding and the early cessation of rains. Long stalks were desired for flood-prone *litapa* where the maize cobs needed to stay above flood levels. Additionally, flood tolerance was desired for *mazulu* in areas prone to flooding. Drought tolerance was mentioned as desirable for cultivars grown on *mazulu* and the drier *mushitu*.

We sought confirmation of the minimum set of traits desired for all maize cultivars. Drought and flood tolerance characteristics were desired in all the AAS focal communities (Table 6). Taste was mentioned as a desired maize cultivar characteristic in Lealui (the highly populated traditional headquarters of the Lozi-speaking people with proximity and easy access to large markets and a consumer base in the provincial capital of Mongu). This desire reflected the sale of roasted maize on the cob. People in the AAS focal communities in Kalabo and Mongu districts (except Nanikelako village) cited long stalks as one of the desired minimum maize cultivar traits.

	Kalabo District			Lukulu District		Mongu District			Senanga District		
Why maize cultivars were planted on small areas by few farmers	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Expensive seed	Y	MW	MY	M	W	M	M	M	WY	Y	--
Hard to access seed	WY	--	--	--	Y	M	W	--	--	WY	Y
Late maturity	MW	--	--	MWY	W	MWY	W	--	W	WY	W
Unadapted to BFS/ plant too short	--	W	--	--	--	W	M	WY	--	--	--
Low market demand	--	--	W	--	--	--	W	--	--	Y	Y
Low yield	--	--	--	WY	W	--	--	W	--	W	W
Snack food	--	--	--	--	--	--	Y	--	--	--	--
Limited land	--	--	--	--	--	--	--	--	--	Y	Y

Notes: M = men older than 35 years; W = women older than 35 years (married and widowed women heading households); Y = youth (men and women 35 years or younger); -- = not cited by any group. BFS stands for Borotse floodplain system.

Table 4. Reasons cited in AAS focal communities as to why few people grow maize cultivars on small areas.

Breeders have long reduced plant height during crop improvements to increase grain yields. It is noteworthy that high yields were not explicitly mentioned as one of the desired minimum traits.

The lesson learned from the assessment of maize cultivar trait preferences is that the promotion of seeds needs to target cultivars with specific traits to fit the different land types cultivated and the times of year when crops are planted. Apart from the trait preference assessments conducted through the focus group discussions, maize crop improvement research could gain greater understanding of farmer choice decisions through exploring the relationship between farmers' knowledge of maize varieties and their selection under conditions of technological change (Bellon 1991). Trait preferences could also be ascertained through plant trait preference modeling, involving conjoint analysis (Baidu-Forson et al. 1997) and/or practically through learning plots and participatory action research.

Four-cell analyses of rice

Supa rice is the most preferred rice cultivar. It is particularly suited to land types that have adequate water in the soil, but less suited to soils that do not receive or contain good amounts of water. It is tolerant of flooding.

Farmers in the AAS focal communities explained that they purchased Supa rice grains for use as seed from the open market, and not from agro-dealers. Farmers also recycled Supa rice seeds selected from their own previous harvests.

	Kalabo District			Lukulu District		Mongu District			Senanga District		
	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Early maturing	---	---	---	Mt, Mu, Mz, M	Mt, Mu, Mz, L	---	---	---	---	Mt, Mu, Mz, M	Mt, Mu, Mz, L
Drought tolerant	Mz	L, Mz	Mz	Mu	Mu	Mz	Mz, L	Mz	---	Mu	Mu
Flood tolerant	---	L	L	Mz	Mz, L	Mz	Mz, L	L	---	Mz	Mz, L
Long stalks	L	L	---	---	---	L	L	---	---	---	---
Tasty roasted corn on cob	L	---	---	---	---	L	---	---	---	---	---

Notes: --- not mentioned; L = *litapa*, Mz = *mazulu*, Mt = *matongo*, M = *mabala* and Mu = *mushitu* land types in the Borotse floodplain system.

Table 5. Preferred maize characteristics for different cultivated land types.

	Kalabo District			Lukulu District		Mongu District			Senanga District		
	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Drought tolerant	•	•	•	•	---	•	•	•	•	---	---
High yielding	---	---	---	•	•	---	---	---	---	•	•
Early maturing	---	---	---	•	•	---	---	---	•	•	•
Flood tolerant	•	•	•	•	---	•	•	•	•	---	---
Long stalks	•	•	•	---	---	•	•	---	---	---	---
Taste	---	---	---	---	---	•	---	---	---	---	---

Notes: --- = not mentioned.

Table 6. Characteristics desired in all cultivars of maize.

Supa rice was grown in large areas by many study participants because of its high market value, potential for income, good taste, good aroma, wholeness of grain when milled, adaptation to flooded areas, and easy seed access mainly from purchases in the open market or recycled harvested grains. Table 7 reveals that in many of the communities studied, high market value, taste and good aroma were very important reasons why rice cultivars are grown in large areas by many people. Appendix 6 shows that several other rice cultivars, notably Xiangzhou 5 (also known as Zhou 5 or *Zawa*), *Kajacket*, Angola, Blue bonnet, Malawi *faya* and Burma, were typically grown in small land areas.

Farmers in the study communities explained that they planted rice cultivars other than Supa rice because the other cultivars had lower water demands than Supa and because women prepared the local food *buhobe* from them. They further explained that the rice cultivars desired for *buhobe* were Blue bonnet, Angola, Xiangzhou 5, Burma, Nerica and ITTA. Table 8 shows that low market price and demand, as well as difficulty in accessing seed, are predominant reasons why few people planted some rice cultivars in small areas. Some of the other factors cited as reasons why people planted some rice cultivars in small areas include lack of adaptation to growing conditions in the Borotse floodplain, susceptibility to bird damage, no aroma and poor taste. Some new rice cultivars, such as Nerica and black rice, were grown in small plots, mainly by men and youth because they were experimenting with cultivars to assess the desirability of morphological and organoleptic qualities.

During second visits to the AAS focal communities, we explicitly sought confirmation about the specific characteristics of rice cultivars desired for the different land types. We learned that rice was cultivated on four different land types: *litapa, matunda, matongo* and *mabala*. Early maturation is a desired trait for cultivation on all four land types (Table 9). Locational differences are observed in the desire for other specific rice cultivar characteristics, such as high yield, unpalatability of stalks to fish, low water demand and salinity tolerance. For example, high yield and long stalks were mentioned as desired rice cultivar characteristics only in the AAS focal villages in Senanga District. Good aroma and good taste were the predominantly desired characteristics across the AAS focal communities (Table 10). In larger communities with proximity or easy access to large consumer markets in the provincial capital of Mongu, long grain after milling was a desired characteristic. Only in Kabula (Lukulu District) was an early-maturing trait not mentioned as a desired rice cultivar characteristic.

The overall lesson learned is that rice cultivar trait preferences differ across locations, land types and levels of moisture availability. Based on past research findings, Joshi et al. (2007) note that when explicit measures are taken to account for the needs of clients (farmers and consumers) through the participation of

	Kalabo District			Lukulu District		Mongu District			Senanga District		
Why rice cultivars were planted on large areas by many farmers	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
High market value	MW	--	MWY	MWY	MWY	MY	MW	MWY	WY	W	--
Income	Y	--	--	--	--	W	Y	Y	--	--	--
Adapted to BFS	--	--	--	--	--	Y	M	MW	--	Y	--
Tasty	MW	--	--	Y	MY	--	MW	Y	WY	W	W
Good aroma	M	--	--	MW	Y	--	MW	Y	Y	--	WY
Staple	--	--	M	--	--	--	--	M	--	--	--
Easy seed access	Y	--	--	Y	MY	--	--	--	--	--	Y
Whole grain	--	--	W	--	--	--	--	--	--	--	Y
Big grain	--	--	--	Y	M	--	--	--	--	--	--
Good food quality	--	--	--	--	--	--	--	--	W	--	--

Notes: M = men older than 35 years; W = women older than 35 years (married and widowed women heading households); Y = youth (men and women 35 years or younger); -- = not cited by any group. BFS stands for Borotse floodplain system.

Table 7. Reasons cited in AAS focal villages as to why many people grow rice cultivars on large areas.

	Kalabo District			Lukulu District		Mongu District			Senanga District		
Why rice cultivars were planted on small areas by few farmers	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Low market demand and price	MWY	--	MWY	MWY	MY	MY	WY	WY	W	WY	Y
No aroma	Y	--	--	--	--	M	--	--	--	--	Y
Poor taste	--	--	--	--	--	--	--	--	--	--	Y
Hard to access seeds	MY	--	W	MWY	MY	--	--	--	Y	WY	WY
Gets flooded, not adapted to BFS	--	--	--	--	--	MW	MW	--	--	--	--
New variety	--	--	--	Y	--	--	Y	M	MY	--	--
Staple	W	--	--	--	--	--	--	Y	--	--	--
Grains break	--	--	Y	--	--	--	--	--	--	--	--
Bird scaring labor demands	M	--	--	--	--	--	--	--	--	--	--

Notes: M = men older than 35 years; W = women older than 35 years (married and widowed women heading households); Y = youth (men and women 35 years or younger); -- = not cited by any group. BFS stands for Borotse floodplain system.

Table 8. Reasons cited in AAS focal villages as to why few people grow rice cultivars on small areas.

	Kalabo District			Lukulu District		Mongu District			Senanga District		
	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Early maturing	L, Md, Mt	N/A	L, Md, Mt	N/A	---	L, Md, Mt	N/A	L, Md, Mt	L, M	L, M	L, M
High yielding	---	N/A	---	N/A	---	---	N/A	---	L, M	L, M	L, M
Salinity tolerant	---	N/A	---	N/A	L	---	N/A	---	---	---	---
Low water demand	---	N/A	---	N/A	M	---	N/A	---	---	---	---
Long stalks to compete with floods	L, Md, Mt	N/A	L, Md, Mt	N/A	---	L, Md, Mt	N/A	L, Md, Mt	---	---	---
Stalks unpalatable to fish	L, Md, Mt	N/A	---	N/A	---	L, Md, Mt	N/A	L, Md, Mt	---	---	---
No lodging	L, Md, Mt	N/A	---	N/A	---	L, Md, Mt	N/A	L, Md, Mt	---	---	---

Notes: N/A = crop not grown; --- not mentioned; M = *mabala*, Md = *matunda*, Mt = *matongo* and L = *litapa* land types in the Borotse floodplain system.

Table 9. Preferred characteristics of rice for different land types.

	Kalabo District			Lukulu District		Mongu District			Senanga District		
	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Good aroma	•	N/A	•	N/A	•	•	N/A	•	•	•	•
Early maturing	---	N/A	---	N/A	•	---	N/A	---	---	---	---
High yielding	---	N/A	---	N/A	•	---	N/A	---	---	---	---
Good taste	•	N/A	•	N/A	---	•	N/A	•	•	•	•
Good *buhobe*	---	N/A	---	N/A	---	---	N/A	---	•	---	---
Long grain after milling	•	N/A	---	N/A	---	•	N/A	---	---	---	---
No lodging	---	N/A	•	N/A	---	---	N/A	•	---	---	---
Long stalk	•	N/A	---	N/A	---	•	N/A	---	---	---	---

Notes: N/A = crop not grown; --- = not mentioned; *buhobe* is the local thick paste prepared from flour (called *nshima* elsewhere in Zambia and Malawi).

Table 10. Minimum characteristics desired in all cultivars of rice.

farmers in specifying the design of desirable varieties and their testing with the target clients in the target environments, the results are effective client-oriented breeding. In addition, we recommend that participatory action research focus on value chain studies that experiment with alternative means of facilitating access to quality seeds, so that a lack of easy access to cheap seed does not constitute a constraint to the large-scale adoption of rice cultivars.

Four-cell analyses of cassava

Four-cell analyses for cassava cultivars showed that in communities studied in Mongu District, cassava was not grown in large areas by many households. In Nanikelako village, located in the floodplain, cassava does not do well. The importance of cassava cultivation was influenced by locational differences in landforms, as well as soils and land suitability for higher-valued crops such as maize and rice. Also, cassava is relatively important to the non-Lozi immigrant population, including Angolans and Congolese, who typically grow and eat a lot of cassava. This finding is similar to what is reported from a study by Murao (1995).

In the study communities where cassava is grown, the predominant cassava cultivar grown on large areas by many households is *Nalumino* (Appendix 5). Table 11 shows that in all but three communities, cassava was grown in large areas by many people as the staple food. Easy access to planting materials (cuttings) and adaptation of *Nalumino* to growing conditions in the floodplain and upland are important reasons why it was cultivated in large areas by many people. In at least one community in each district studied, youth and women were motivated by the high market value to plant *Nalumino* in large areas. Some of the other reasons why people planted cassava cultivars in large areas included good-quality flour for preparation of local food (*buhobe*), resistance to drought, resistance to mealybug attacks and early maturing. An interesting trait of *Nalumino,* mentioned by women, is the bitter taste, which prevents its theft in the fields for raw consumption. Appendix 5 lists at least 17 other varieties or cultivars of cassava (*Kapumba*, *Nakamoya*, *Kapulanga*, *Mutembo*, *Litale*, *Butiki*, *Busele*, *Mbambi*, *Kakota*, Portuguese, *Bangweulu*, *Chila*, *Tumbangezhi*, *Rabbecca*, *Lingoma*, *Nyengo* and *Makamwengo*) grown on small land areas by only a few households.

	Kalabo District			Lukulu District		Mongu District			Senanga District		
Why cassava cultivars were planted on large areas by many farmers	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Easy access to planting materials	MWY	--	MW	Y	MY	--	--	--	Y	Y	Y
High yielding	MWY	WY	MW	W	--	--	--	--	--	W	WY
Adapted to BFS	MY	--	M	--	--	--	Y	MY	Y	Y	Y
Good flour quality	--	--	--	--	--	--	Y	W	--	--	--
Staple	--	WY	WY	M	WY	--	--	MY	Y	Y	Y
Early maturity	--	--	--	--	--	--	--	W	--	--	--
High market value	--	--	Y	--	Y	--	--	W	--	--	Y
Drought resistant	--	--	--	W	--	--	--	Y	W	--	W
Bitter taste, which deters theft on farms	Y	--	--	--	--	--	--	--	W	W	--
Pest (mealybug) resistance	--	WY	--	--	--	--	--	--	W	W	--
Income	--	--	--	--	--	--	--	--	--	--	Y
Tuber stores well	--	--	--	Y	--	--	--	--	--	--	--

Notes: M = men older than 35 years; W = women older than 35 years (married and widowed women heading households); Y = youth (men and women 35 years or younger); -- = not cited by any group. BFS stands for Borotse floodplain system.

Table 11. Reasons cited in AAS focal villages as to why many people plant cassava cultivars on large areas.

Table 12 shows that in all the AAS focal communities studied, the lack of planting material was an important reason why cassava cultivars were planted in small areas. Based on data in both Appendix 5 and Table 12, other factors motivating the cultivation of these cassava varieties in small land areas included poor flour quality, poor tuber storage quality, low yields (notably *Kapumba* variety), pest and disease attacks (particularly susceptibility to mealybug), and limited suitable land. Some cultivars (for example, *Nakamoya*) were planted in small areas by only a few households because they were seen as mainly snack foods. In villages in Senanga District, the good taste of the *Nakamoya* variety was mentioned by women and youth as increasing its vulnerability to theft in the field. On the contrary, women mentioned that *Butiki* was grown in small land areas because of its bitter taste. Further studies are recommended to understand the differences in bitterness between *Nalumino* and *Butiki* in relation to how their bitterness characteristics differentially influenced their relative acceptability to farmers. Good tuber quality in storage was mentioned as a desirable trait in at least one study village. The desirable traits and defects (e.g. susceptibility to frost damage in the field) of *Nalumino* mentioned by the focus groups provide a useful guide to cassava breeding. Traits that cassava crop improvement programs could consider include early maturity (ready in 6 months if possible) and high yields (particularly on *matongo* and *matunda* land types), good quality flour for *buhobe* and resistance to mealybug.

The cassava mealybug, *Phenacoccus manihoti* Matile-Ferrero (Hemiptera: Pseudococcidae), was mentioned as being of particular concern by some farmers in the study communities. It is one of the most severe pests of cassava (Bellotti et al. 1999). Natural enemies, discovered in South America in the late 1970s, were identified, multiplied and released in more than 100 locations in Africa with positive results (Neuenschwander 2001; Nweke 2009). Therefore, a biological remedy for handling cassava mealybug exists. It needs to be implemented by the extension services of the Provincial Ministry of Agriculture and Livestock for the benefit of cassava producers in the cassava-growing areas in Western Province of Zambia, where mealybug attacks occur. Apart from desired cassava traits, it is evident that easy access to cuttings would affect widespread

	Kalabo District			Lukulu District		Mongu District			Senanga District		
Why cassava cultivars were planted on small areas by few farmers	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Lack of planting materials	MWY	WY	WY	MY	WY	WY	Y	MW	MWY	WY	WY
Pest (mealybug) attack	--	--	W	--	--	W	--	--	--	W	--
Not adapted to BFS	M	--	M	--	--	W	--	Y	--	--	--
Snack food	--	--	Y	Y	--	--	Y	M	Y	Y	--
Low market demand and price	--	--	--	--	--	M	--	--	--	--	--
Poor flour quality	--	--	--	--	--	--	Y	--	--	--	--
Poor tuber storage	--	--	--	--	--	--	--	Y	--	--	--
Theft due to taste	--	--	--	--	--	--	--	--	MW	--	--
Require lots of moisture	Y	--	--	--	--	--	--	--	Y	--	--
New cultivar	--	--	--	--	WY	--	--	--	--	--	--
Bitterness	--	W	--	--	--	--	--	--	--	--	--
Labor constraint	--	--	--	--	--	Y	--	--	--	--	--

Notes: M = men older than 35 years; W = women older than 35 years (married and widowed women heading households); Y = youth (men and women 35 years or younger); -- = not cited by any group. BFS stands for Borotse floodplain system.

Table 12. Reasons cited in AAS focal villages as to why few people grow cassava cultivars on small areas.

adoption of new cassava cultivars. In view of the bulkiness of cassava cuttings, research is needed on how best to facilitate continuous ready access to cassava planting materials, particularly within communities having enclave characteristics due to a lack of roads that link communities with market centers or sources of planting materials, along with high transport costs.

During second visits to the AAS focal communities, we sought confirmation about the characteristics of cassava cultivars desired for different land types. We learned that cassava cultivars were cultivated on *matongo*, *mushitu*, *matunda* and *sishanjo* (only in Sifuna and Nalitoya villages in Senanga District) land types. High yield was the desired cassava trait on all the four land types (Table 13). Early maturity (crop cycles of 6 months) and high yield were desired cassava traits in all the AAS focal communities (Table 14). Other desired cassava traits mentioned were quite location specific. For example, drought and frost tolerance were mainly the desired traits in the AAS focal communities in Senanga District.

Factors motivating cropping strategies

Resilient agricultural systems are vital in sub-Saharan Africa, where many communities depend on agricultural products for their livelihoods (Altieri 1999). Due to the vulnerability of livelihoods of people in rural communities, farmers have limited capacity to invest in coping strategies that require a lot of expenditure (Lin 2011). During focus group discussions, participants in the AAS focal communities mentioned food security, increased productivity and income as the main goals of crop producers. However, hedging, through the planting of multiple crops on land spatially or temporally, was practiced in the AAS focal communities as a strategy against crop failure and food insecurity.

	Kalabo District			Lukulu District		Mongu District			Senanga District		
	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
High yielding	Mt, Md	N/A	Md, Mt, Mu	Mt, Mu	Mt, Mu	Mt, Md	N/A	Mt, Md	Mt	Mt	Mt
Tolerant to drought	---	N/A	---	Mt, Mu	---	---	N/A	---	Mu	---	---
Bitter taste to avoid theft	---	N/A	---	Mt, Mu	---	---	N/A	---	---	---	---
Resistant to mealybug	---	N/A	---	---	Mt, Mu	---	N/A	---	---	---	---
Flood tolerant	---	N/A	---			---	N/A	---	S	S	---

Notes: N/A = crop not grown; --- not mentioned; Mt = *matongo,* Mu = *mushitu* (*matema*), S = *sishanjo,* and Md = *matunda* land types in the Borotse floodplain system.

Table 13. Characteristics of cassava for different cultivated land types.

	Kalabo District			Lukulu District		Mongu District			Senanga District		
	Mapungu	Mwandi Lower	Mwandi Upper	Kapanda	Kabula	Lealui	Situlu	Nanikelako	Sifuna	Nalitoya	Nembwele
Good *buhobe*	---	N/A	---	•	•	---	N/A	---	---	---	---
High yielding	---	N/A	•	•	•	•	N/A	•	•	•	•
Early maturing before floods (6 months)	•	N/A	•	•	•	•	N/A	•	•	•	•
Frost tolerance	---	N/A	---	---	---	---	N/A	---	•	•	---
Drought tolerance	---	N/A	---	---	---	---	N/A	---	•	•	•
Resistance to mealybugs	---	N/A	---	---	---	•	N/A	---	---	---	---

Notes: N/A = crop not grown; --- = not mentioned.

Table 14. Minimum characteristics desired in all cultivars of cassava.

This strategy for limiting vulnerability to livelihood insecurity is consistent with previous research findings (e.g. Pretty et al. 2011). Crop diversification is seen as one of the most feasible and rational ways of reducing uncertainties in agriculture, especially among small-scale farmers (Mugendi 2013).

Trapnell and Clothier (1996) report that, in the floodplain near Mongu, different crop varieties were grown to increase food security and that crop diversification was an adaptation strategy in response to changing flood scenarios, enabling farmers not to be dependent on a single crop variety. Farmers spread risks through temporal and/or spatial use of crop diversity to increase resilience. Future research could evaluate the total factor productivities of alternative crop diversification options, including valuation of ecosystem services, with a view to optimizing crop diversification on different land types. Related ecosystems research could also document the impact of alternative diversification options on ecosystem services (e.g. pest control) and the implications for sustainability of relevant production systems.

Low productivity

Some crops and their cultivars were reported by farmers as having low productivity (Table 15). The predominant culture of recycling grains as seed, including those from hybrids; unpredictable flooding; low yields from the local varieties; poor soils; and the late receipt of seeds from the formal seed sector were all factors that contributed to low productivity in maize. Damage from cold spells and mealybug attacks contributed to low productivity in cassava. Pearl or bulrush millet, finger millet, and sorghum cultivated in the Borotse floodplain were predominantly low-yielding local varieties (including landraces, which refer to locally adapted or traditional varieties), but they do have traits that appeal to farmers. In addition to fertility improvement of poor soils to increase productivity, we recommend participatory action research for comparative evaluation of newly bred and local varieties, including landraces from climatic analogue sites that are stored in genebanks or with Barotse farmers. This would provide opportunities for learning by all participants on relative performances and desirability of different millet cultivars.

District and villages	Men	Women	Youth
Mongu District			
Lealui	Recycled maize	Maize, pumpkin, squash	Maize
Situlu	Recycled maize, Blue bonnet and Malawi fire for rice	Local maize, watermelon, pumpkin, local cucumber	Groundnut, rice, cassava
Nanikelako	*Kandalendale* variety of maize, pumpkin, watermelon	Recycled MM 441, pumpkin	Maize, vegetables
Kalabo District			
Mapungu	Supa rice	Recycled MM 441 and recycled MM 603 for maize	Groundnut
Mwandi Lower	Maize when early flooding of *litapa* field occurs	Recycled maize, sweet potato, pumpkin, cucumber	Recycled maize
Mwandi Upper	Recycled maize, rice cultivars not adapted to low soil water	Supa rice because it is not adapted to low soil water in the area	Supa rice, maize
Senanga District			
Sifuna	*Nalumino* variety of cassava (damaged by cold spells), maize (due to late availability of seed), cowpea	All crops	Groundnut, Bambara nut, sweet potato, millet
Nalitoya	Cassava (damaged by cold spells and mealybugs)	Maize, cowpea, groundnut	Cowpea, groundnut, Bambara nut
Nembwele	*Nalumino* variety of cassava (due to cold spells), maize (formal seed distributed too late), cowpea	Maize, rice, groundnut, beans	Maize, sorghum, groundnut, millet
Lukulu District			
Kapanda	Recycled maize	Maize, sorghum, rice, millet, vegetables	Maize, sorghum, groundnut
Kabula	Maize, rice	Maize, rice, cowpea, watermelon, finger millet	Maize, rice

Table 15. Crops and cultivars with low productivity in AAS focal communities studied.

Flood risk to crops

In the Borotse floodplain, annual floods have positive and negative consequences for human and agricultural activities. People located in the Borotse floodplain are accustomed to the benefits and risks associated with annual flooding from the Zambezi River. Cropping calendars and other activities, particularly cattle grazing and movements, are highly influenced by the timing and severity of the floods. Lower-lying areas of the floodplain, such as *milapo* and *litapa* gardens, benefit from sediments eroded from the upper reaches of the Zambezi River and deposited there during the annual flooding. The negative effects of floods are experienced when flooding starts earlier and with greater severity than normal or expected, leading to the submergence of crops. When this happens, the productivity of crops not adapted to excess water is badly affected. This is because flooding and deeper submergence constitute major abiotic constraints on growth, species distribution and agricultural productivity (Jackson and Colmer 2005). Based on regional modeling of water resources in the Zambezi River basin countries, Beck and Bernauer (2010) point out that climatic change and other factors related to population and economic growth would result in drastically reduced runoff in the dry season and changing shares of runoff and water demand of the countries.

During the focus group discussions, study participants indicated that the key strategies farmers adopted in response to flood risk potential or in flood-prone areas were early planting of crops, planting early-maturing cultivars (e.g. MM 441, Pool 16 and Pan 53 maize cultivars) on *mazulu* and *litapa* land types, canal clearing to facilitate water flow, opting to grow Supa rice and cassava (*Nalumino* variety) on the *matongo* land type, and irrigating early-planted maize prior to the normal rains. Decisions on the specific flood risk adaptation strategies adopted were mostly made jointly by married couples or by the head of household in single-headed homes (usually widows).

Adaptation to the annual floods in aquatic systems is largely dependent on the frequency, extent and impacts of the floods as well as the technological advancement of the society (Trapnell and Clothier 1996). In addition, it has been noted that in some of the Barotse communities, social and gender norms may limit the capacity of women to adapt to the floods. According to Kwashimbisa and Puskur (2014), this is because women are less mobile and cannot easily move onto lands to start cultivating different kinds of crops whenever they want. Women's mobility is constrained, which may restrict their opportunities to adapt to flooding. Norms and power relations give men greater mobility, freedom of choice and other advantages (Steven Cole, personal communication).

Indigenous or local crops and wild food plants lost or at risk of loss

Some examples of indigenous or local crops were listed by study participants living in the AAS focal communities in Barotseland as "lost" or "at risk of being lost" (Table 16). Specific crop varieties mentioned were some landraces of local pearl or bulrush millet, and local finger millet. Study participants explained that the risk of losing desired pearl millet, finger millet and sorghum varieties was primarily due to bird damage. This is because when farmers experience substantial bird damage, they abandon the cultivation of millet and with time lose access to seeds. This suggests the need for breeding programs that prioritize how to make the millet grains less vulnerable to bird damage. Study participants in the AAS focal communities outlined specific individual and collective communal actions critical to preventing the total disappearance of desired local crops and varieties. These actions include encouraging many farmers to grow local sorghum and millet at the same time (as a way of spreading loss from bird damage across many farms), creating community seed banks, restoring lost materials, and educating youth about the nutritional values of millet and sorghum and their use as *buhobe*. In addition to the local millets, *Kapumba* variety of cassava, local yams (*Kalungwa* and *Malumba* varieties), *Maelepu* and *Makonga* varieties of sorghum, local sugarcane, and the *Kandalendale* variety of local maize were mentioned as being at risk of being lost. Appendix 5 contains data that show specific cultivars for which the communities would like crop improvement research to reselect or purify and restore to their communities.

District and villages	Men	Women	Youth
Mongu District			
Lealui	*Kandalendale* variety of maize, finger millet, aquatic plants	Local yams, *Maelepu* and *Makonga* varieties of sorghum, aquatic plants, *Kandalendale* variety of maize	Millet, sorghum
Situlu	Aquatic plants (*Mampana*, *Mashela*, *Linjefu*, *Nswe*), *Munanana* variety of pearl millet, *Tulungwa* variety of finger millet, local yams	Finger millet, *Munanana* variety of pearl millet, sorghum, *Kalungwa* and *Kapumba* varieties of cassava, *Siboyani* variety of local yam, aquatic plants (*Linjefu*, *Mashela*, *Makwangala*); *Sishungwa* (*Cleome gynandra*)	*Simikata* variety of maize, sorghum, *Tunkolala* and *Mupusi* varieties of pumpkin
Nanikelako	*Munanana* variety of millet, finger millet, local yam, *Makonga* variety of sorghum	Finger millet, Bambara nut, *Namakando* and *Kashala* varieties of sweet potato, *Munanana* variety of millet, *Tepe* (red leaf amaranth), watermelon and *Mucelo* (vegetable collected from the wild)	Sorghum, groundnut, Bambara nut, aquatic plant (*Nswe*), *Kandalendale* variety of maize, local yam
Kalabo District			
Mapungu	*Makonga* and *Maelepu* varieties of sorghum, millet	Millet, *Makonga* variety of sorghum, pumpkin, squash, local cucumber, local yam, aquatic plants (*Makwangala*, *Linjefu*, *Lindowa*)	Pumpkin, Bambara nut, *Kapumba* and *Mutembo* varieties of cassava, local maize, millet, sorghum
Mwandi Lower	*Maelepu* variety of sorghum, *Munanana* variety of millet, aquatic plants	Bambara nut, finger millet, cowpea, sorghum, pearl millet, aquatic plants (*Makwangala*, *Maoma*, *Linjefu*)	*Kankolola, Munali* variety of maize, *Kapumba* variety of cassava
Mwandi Upper	Millet, sorghum, local yam	Sorghum, millet, cowpea, finger millet, *Kapumba* and *Kamuliboko* varieties of cassava	Sorghum, millet
Senanga District			
Sifuna	Taro, finger millet	Finger millet, local yams, *Makonga* variety of sorghum, millet, local banana, local sugarcane, *Tepe* (red leaf *Amaranthus* spp.)	Millet, pumpkin, local yam, Bambara nut, groundnut, sweet potato, banana
Nalitoya	Taro, *Mubotu* and *Makonga* varieties of sorghum, *Munanana* variety of millet	Finger millet, local yam, pearl millet, *Makonga* variety of sorghum	Finger millet, Irish potato
Nembwele	Taro, finger millet	Finger millet, local yam, millet, sweet potato, *Sesheke* and *Mashewa* varieties of sorghum, *Munali* variety of maize, *Sishungwa* (*Cleome gynandra*), amaranths	Sorghum, millet, local maize
Lukulu District			
Kapanda	Millet, *Kapumba* and *Nguvu* varieties of cassava, cowpea	Groundnut, Bambara nut, cowpea, pumpkin, local cucumber	*Lukesha* variety of finger millet, pearl millet, *Sikuswani* variety of local yam
Kabula	Sorghum, millet, tobacco	Sorghum, millet, local yam, finger millet, *Tepe* (red leaf *Amaranthus* spp.)	Millet, sorghum, cowpea, local yam, finger millet, bulb onion, tobacco

Table 16. Local or indigenous plant materials lost or at risk of loss.

Materials not adapted to flooding and other environmental conditions in the floodplain

For most crops in flood-prone areas, excess water is a major constraint to productivity (Jackson 2004). This constraint is expressed through adverse effects on crop growth and yields. Advances have been made in developing cultivars for lowland areas prone to short-duration flooding (Siangliw et al. 2003; Toojinda et al. 2003). Based on the floods and environmental changes experienced recently in the AAS focal communities, some crops and varieties were described during the focus group discussions as no longer adapted to prevailing environmental and growing conditions in the Borotse floodplain (Table 17). The prominent reasons mentioned for a lack of adaptation included late maturity, pests and diseases, erratic rains, unpredictable floods, and granivorous bird risk to cereal grains.

Locational differences exist in the perceived suitability of crops. Study participants in Senanga District felt that maize and cassava were unsuitable crops for the growing conditions in their locations. Maize and rice were also cited as not suited to growing conditions in the AAS focal communities in Lukulu District. Farmers in Mwandi Upper, located on an upland area dependent on rains, felt that the much-appreciated Supa rice was not well-adapted to their area because Supa rice required more water than could be available in the predominant land types and soils. Also, Supa rice was not suitable for cultivation on *mabala* and *matunda* land types due to the short period of water availability. Pool 16 maize was cited as not adapted to cultivation on the *litapa* land type because of the short plant height that made it susceptible to submergence in flood waters. The late maturity of the MM 603 maize cultivar was also not adapted to growing conditions in the Borotse floodplain. However, where irrigation facilities were available on *litapa* and lower *mazulu* land types, early planting of MM 603 could take place in August and September, and this shift in planting time made it more adapted.

During the focus group discussions, study participants indicated that some varieties that are currently not adapted to flooding do contain desirable characteristics that crop improvement programs may want to explore and incorporate in new materials. For example, Pool 16 has the desirable traits of early maturity and resistance to lodging. Also, MM 603 has desired high yield, resistance to maize streak virus disease, good taste and long stalks. The key traits that cereal crops need to contain to become adapted to the environmental and growing conditions in the floodplain are early maturity, high yield, long stalks and resistance to lodging. Good taste and good aroma from food preparations are also quite important traits. However, when canal clearing opens up more fertile lands and helps to control flooding, the types of cultivars desired because of inundations, which plague many farmers, may change (Steven Cole, personal communication).

Species collected from the local ecology for food

Ethnic groups from all over Africa have a long history of consuming traditional leafy vegetables to supplement their diets (Chweya and Eyzaguirre 1999). Food resources collected from the local ecology are important for the livelihoods of resource-poor rural women and children in times of drought and when vulnerable groups in society have less access to land, labor and capital. However, vegetables collected from the local ecology are generally underutilized in favor of introduced non-native vegetables (Rubaihayo 1992). Also, investment in research and development to generate knowledge and improve the qualities of plants collected from the local ecology for food is miniscule compared to that for exotic vegetables.

While some literature report that there is increased consumption of indigenous vegetables, both annual and perennial, in Africa (Bharucha and Pretty 2010; Dweba and Mearns 2011), other research reports that the availability of indigenous vegetables has declined drastically because of the excessive cultivation of field crops, the use of chemicals to eliminate wild vegetables, and habitat change (Odhav et al. 2007). Young people were found to be unaware of the nutritional qualities of local vegetables (Odhav et al. 2007). The decline in the consumption of indigenous vegetables is reported to have contributed to poor diets and the increased incidence of nutritional

deficiency disorders and diseases in many parts of Africa (Kwapata and Maliro 1995). However, traditional vegetables represent inexpensive, high-quality nutrition sources for the resource-poor. Several publications (Nesamvuni et al. 2001; Steyn et al. 2001; Jansen van Rensburg et al. 2004) have documented the nutritional value of indigenous leafy vegetables.

During the focus group discussions in AAS focal communities, 18 species of vegetables collected from the local ecology for consumption were identified. The vegetable species commonly collected for consumption in almost all the AAS focal communities and cited by men, women and youth groups included *Cleome gynandra* (cat's whiskers or African cabbage, locally known as s*ishungwa*); *Amaranthus* spp. (commonly known as amaranths and locally called *libowa* or *musame,* although there are other local names for different varieties of amaranth); *Abelmoschus esculentus* Moench (commonly known as bush okra and locally called *delele*); and several varieties of *Hibiscus* spp. (commonly known as roselle and locally called *sindambi* or *mundambi*). Preferred species are marked with asterisks in Annex 1. *Cleome gynandra* is preferred for its high market value, good taste and aroma, and the fact that it could be eaten alone during lean food availability periods.

The high nutritional and medicinal properties of *Cleome gynandra* are well noted (Nyirenda et al. 2007; van den Heever and Venter 2007). Documented nutrient contents of *Cleome gynandra* include 14 milligrams (mg) per 100 grams (g) of vitamin C, 115 mg/100 g of

District and villages	Men	Women	Youth
Mongu District			
Lealui	All crops due to floods	MM 603 and local maize, *Kapumba* variety of cassava affected by pests	Cassava, sorghum, pearl millet
Situlu	All crops except Supa rice	*Munali*, yellow maize and Pool 16 for maize; pumpkin; local cucumber; aquatic plants (sweet reeds)	Groundnut, cowpea, finger millet, *Maelepu* and *Makonga* varieties of sorghum
Nanikelako	MM 441 and local *Kandalendale* for maize	Local and recycled maize varieties	*Nalumino* variety of cassava
Kalabo District			
Mapungu	All crops with duration > 6 months cycle	MM 441 and MM 603 for maize, Supa rice on upland and rainfed, groundnut, watermelon planted on *mabala* to use residual moisture	MM 441 for maize, *Nalumino* variety of cassava, Zaire variety of sweet potato, groundnut
Mwandi Lower	Local maize, groundnut, pumpkin	Recycled maize, sweet potato, pumpkin, cucumber	*Nalumino* variety of cassava for the area
Mwandi Upper	Rice—except when cultivated to deeply flooded areas	Supa rice grown in areas where water dries up before maturity	Supa rice, MM 441 for maize
Senanga District			
Sifuna	Cowpea, rice, cassava	Beans—due to black aphids	Maize when late maturing and cannot withstand floods
Nalitoya	No response	Pan 53 for maize, Supa for rice	Late-maturing maize
Nembwele	Xiangzhou 5 for rice, sorghum due to bird menace	Maize, sweet potatoes, groundnut, Bambara nut, cowpea, watermelon, pumpkin	Groundnut, maize
Lukulu District			
Kapanda	No response	Maize, cowpea, pumpkin, Bambara nut, watermelon, *Kapumba* variety of cassava	Sorghum, groundnut
Kabula	Rice not adapted to saline soils	Maize, rice, cowpea, watermelon, finger millet	Tomato, cabbage, onion, millet, sorghum

Table 17. Crops and cultivars lacking adaptation in the Borotse floodplain.

calcium, and 9 mg/100 g of iron (Muchuweti et al. 2009). Botanically, *Abelmoschus esculentus* (okra) is a perennial flowering plant belonging to the Malvaceae (mallow) family.

Nutritional information for okra show that its pods are low-calorie vegetables (30 calories per 100 g) and are rich sources of dietary fiber, minerals and vitamins, as well as a mucilage substance that helps smooth peristalsis of digested food through the gut and eases constipation (www.nutrition-and-you.com). In terms of nutrients, okra contains vitamin A and flavonoid antioxidants such as beta-carotene, xanthin and lutein; folates (providing about 22% of the recommended daily allowance per 100 g); vitamin C (about 36% of daily recommended levels); B-complex vitamins like niacin, vitamin B-6 (pyridoxine), thiamin and pantothenic acid; vitamin K (a co-factor for blood-clotting enzymes and required for strengthening of bones); and many important minerals such as iron, calcium, manganese and magnesium (www.nutrition-and-you.com).

Research on the nutritional (crude protein, potassium, iron and beta-carotene) contents of 17 genotypes belonging to six jute species (*Corchorus fascicularis*, *C. trilocularis*, *C. aestuans, C. tridens*, *C. capsularis* and *C. olitorius)* showed that *C. olitorius* genotypes were found to be the best performer for all the parameters except iron content, for which *C. aestuans* outperformed the others (Choudhary et al. 2013). Also, Choudhary et al. (2013) show that *C. olitorius* cv. JRO-204 had the highest leaf area (23.9 by 10.4 square meters) and foliage yield (276.67 kilograms [kg] per hectare) and a good amount of protein (3.79%), iron (67.93 mg/kg), beta-carotene (51.0 mg/kg) and potassium (4400 mg/kg).

Amaranthus spp. were collected in the AAS focal communities because they were plentiful, grew well, were easy to cook, provided good sources of income and had good taste. In addition to these characteristics, research findings (Achigan-Dako et al. 2014) reveal some reasons why *Amaranthus* spp. have become a promising food source. These include resistance to heat and drought; pest and disease resistance; and high nutritional value of both seeds and leaves, notably the richness of the leaves in protein and micronutrients such as zinc, vitamin C and vitamin A.

Varieties of *Hibiscus* spp. were collected for food from the local ecology in the communities studied because of their high market value, taste and value as a replacement food during lean periods. *Bidens pilosa* (blackjack) was also collected from the local ecology and consumed in the AAS focal communities. Literature reveals that *Bidens pilosa* is a valuable source of vitamin C (63 mg/100 g), iron (15 mg/100 g) and zinc (19 mg/100 g; Muchuweti et al. 2009). Odhav et al. (2007) report results of proximate analyses of 100 g fresh weight showing that blackjack or amalenjane (*Bidens pilosa* Asteraceae) contains copper (10 mg/100 g), fiber (2.92 g), energy (39 kilocalories), moisture (88 g), protein (5 g), fat (0.6 g), ash (2.82 g) and carbohydrates (estimated at 3.72 g). Other past analysis of *B. pilosa* shows that its essential oils and aqueous extracts possess antioxidant and antimicrobial activities that might be a natural potential source of preservative for use in food and other allied industries (Deba et al. 2008). Based on the high market and food value (taste and use as replacement food in lean periods), *Cleome gynandra*, *Amaranthus* spp. and *Hibiscus* spp. are three priority species that we recommend for horticultural research and development, particularly within the pursuit of an objective to promote a nutrition-sensitive cropping landscape in the floodplain.

We noted differences in groups and locations with respect to the collection of some indigenous vegetables from the local ecology. *Katokwani* was collected only by older women in villages in Kalabo and Mongu districts (Appendix 2). Out of the 18 species identified, women in Lukulu District collected only four species, namely *Amaranthus* spp., *Abelmoschus esculentus*, *Cleome gynandra* and *Hibiscus* spp. In addition, locational differences exist in species collected from local ecology for use as vegetables. *Kahinga*, *silelemi*, *kapusipusi*, *ndulweti*, *manansa* and *lulimi* were not collected by residents of communities in the AAS study villages in Lukulu and Senanga districts. Very little is known about the nutrient contents of many of the local plants collected and consumed as vegetables. We recommend research and development investment focused on establishing and documenting the bio-active nutrient profiles of these plants. This documentation would also need to address types and levels of toxicity where they occur and traditional knowledge applied by women, men and youth in communities to remove or attenuate potentially undesirable elements.

CONCLUSIONS

Focus group discussions conducted in AAS focal communities in Zambia revealed that the agroecologies and experiences within aquatic agricultural systems in the Zambezi River floodplain defined the human values that underpinned plant and varietal preferences and choices. Out of about 25 crops cultivated in the AAS focal communities, the predominant food crops were maize, rice, cassava and sweet potato. For each of these crops, farmers cultivated a diversity of varieties (including landraces) that provide options for follow-up participatory action research seeking to optimize crop and varietal diversification. Based on the findings from the research reported in this paper, crop diversification optimization studies would need to take into consideration the differing opportunities offered by available and suitable land types: from flood-prone *litapa* and *matongo,* to *mazulu* and *mabala*, and to drought-prone, rain-dependent, dry sandy soils on *mushitu*. The specific plant and consumer trait preferences for the most commonly grown rice, maize and cassava and their relevance to breeding and crop improvement research have been reported in this paper. However, since it is unlikely that all preferred traits would be present at the same time in one variety, there is a need for further research to examine possible tradeoffs in trait preferences through conjoint analyses. Similar trait tradeoff analyses could be obtained through the type of participatory action research that Bentley (1994) prescribes to involve farmers in collaborative research.

Of 18 plants collected from the local ecology for consumption as vegetables, the most widely preferred were local amaranths, cat's whiskers, bush okra, and roselle or sorrel. These leafy vegetables contain nutrients that enrich diet diversity and quality and therefore are good candidates for crop diversification within the context of nutrition-sensitive landscapes. The inclusion of improved varieties of the predominantly collected vegetables in participatory learning plots would provide useful pathways for motivating farmers to embed their preferred vegetables in crops on their fields. Research is needed to identify the scientific and common names of several plant species collected and consumed as vegetables.

In addition, it is recommended that nutrition studies be conducted to determine the bio-active ingredients (both nutritive and anti-nutritive elements) of many of the vegetables collected to inform public education on their usefulness as food. Additional follow-up crop improvement research may focus attention on enhancing desired qualities and reducing undesirable traits, on seed production, and on increasing storage shelf life to enhance marketing. We noted that men and youth focused on cultivating rice, maize, cassava and sweet potato for household food security. In addition to these staple crops, women cultivated vegetables for home consumption. This finding reveals gender and social roles of men and women in cultivation of crops and has implications for paying particular attention to gender and social categories, in addition to locational differences in terms of land suitability for crops in the research-in-development approach.

The scope of the studies and findings reported in this paper are of particular relevance to communities within the floodplain. However, the findings have didactic value for studies in similar aquatic agricultural systems. The limitations to the study reported in this paper include the following:

- Group responses recorded during focus group discussions do not necessarily translate into individual choices or decisions.

- Due to the length of time it took to complete the focus group discussions in each community, detailed explanations of underlying reasons for a number of responses could not be explored. Future studies may want to balance depth and breadth of issues to be covered.

- The study team was also unable to probe further where differences occurred within the peer groups. In particular, since the youth peer group comprised both males and females, the lack of in-depth examination of responses may have masked gender-related differences among young persons, and thus it is recommended that future studies separate young people according to their gender.

NOTES

[1] Definitions of Barotse and Borotse, as used in this paper: Barotse = Marotse, Malozi = People; and Borotse = Bulozi (Mukelabai Ndiyoi, University of Barotseland, Mongu, Zambia, personal communication).

[2] Research in development focuses on research within the context and taking cognizance of ongoing developmental activities by all actors.

[3] In this paper, "Borotse" is used in connection with the land (e.g. Borotse floodplain), while "Barotse" is used when referring to the communities or people.

[4] The Barotse community visioning is documented in Lunda J, Cole S, Apgar M, Mutimukuru T, Chisonga N, Muyaule C and Zulu F. Action planning in 10 AAS focal communities in the Barotse Hub. CGIAR Research Program on Aquatic Agricultural Systems, 12–20 June 2014, Western Province, Zambia. Unpublished document.

[5] A variety (abbreviated as "var.") is a plant that grows from its seeds or occurs naturally in the plant kingdom. This is distinct from a cultivar or cultivated variety (abbreviated "cult."), which is a plant produced through human selection for specific desired traits such as high yield, early maturity, tolerance or resistance to pests and diseases, etc. Included in the description of variety is a special class called landrace, which is a domesticated regional ecotype or locally adapted traditional variety that has evolved through adaptation to its natural and cultural environment. Zeven (1998) defines an autochthonous landrace as a variety with a high capacity to tolerate biotic and abiotic stress, resulting in high yield stability and intermediate yield level under a low-input agricultural system.

[6] The AAS hub in Western Province works in 10 focal villages, but one of the villages (Mwandi) is sometimes split into two, namely Mwandi Upper (upland areas) and Mwandi Lower (lowland areas). This is because some people reside in the lowland village most if not all year round, and thus it appears there are two subcommunities.

[7] This is a government of Zambia program through which farmers who are members of cooperatives access subsidized inputs.

[8] Calcium deficiency leads to restricted seed development, resulting in poor pod filling. Such pods are called "pops." Air fills the pods in the absence of proper seed development. When such pods are pressed between the fingers, air comes out, making a sound like "pop."

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APPENDIX 1. CROP SPECIES AND VARIETIES CULTIVATED IN AAS FOCAL COMMUNITIES STUDIED IN WESTERN PROVINCE, ZAMBIA

District: Mongu	Maize	Rice	Cassava	Sweet potato	Groundnut	Bullrush (pearl) millet	Sorghum
Village: Lealui							
Men	MM 441 recycled MMV 400 recycled MM 603 ZMS 521	Supa Angola Xiangzhou 5 Blue bonnet Kajacket	Cultivar name unknown	Lusaka Carrot Kalembula Hippo (big)	----	----	----
Women	MM 441 recycled MM 603 SC 513 Pool 16 recycled MRI 734 Yellow maize	Supa Xiangzhou 5 Angola Kajacket Blue bonnet	Cultivar name unknown	Mushungumani Carrot Namaoma Namakando Kenya Kashala Hippo	----	----	Makonga Maelepu Kuyuma
Youth	MM 441 Mazulu 3 months Pool 16 Litapa 3 months ZMS 402 MM 602 PANA 53 Grain on market	Supa Angola Xiangzhou 5 Kajacket Blue bonnet	Kapumba	Mushungumani 3 months Namaoma Teleza Kashala Nakashi (white) Namakando Hippo Carrot Kapulanga	----	----	----
Village: Situlu							
Men	MM 441 recycled Kandalendale MM 603 Simikata	Supa Xiangzhou 5 Angola Kajacket Burma Blue Bonnet	----	Lusaka Zaire Namaoma	----	----	Maelepu Makonga Munanana
Women	MM 441 recycled MRI 521 Munali Simikata Kandalendale	Supa Xiangzhou 5 Kajacket Blue bonnet Angola	----	----	----	----	----
Youth	MM 441 recycled MM 603 Pool 16 PANA 53 Yellow maize Simikata Grain from market Popcorn Kandalendale	Supa Xiangzhou 5 Blue bonnet Angola ITTA 212 Nerica Kajacket Burma Malawi faya	Mutembo adapted Nalumino Kapumba Nakamoya	Lusaka Namaoma Carrot MTN (yellow flesh) Kashala Nasilele	----	----	----
Village: Nanikelako							
Men	MM 441recycled Lyatolo Makunupo Pool 16 MM 603	Supa Angola Blue bonnet Kajacket	----	Zaire	Kadononga	----	----
Women	MM 441 recycled Kandalendale	Supa Kajacket Xiangzhou 5	Nalumino	Chingovwa Mukuwa Namakando Kaoma Mupulanga	Munamalali Mushungumani	----	----
Youth	Kandalendale MM 441 Pool 16 PANA 53	Supa Kajacket Xiangzhou 5 Blue bonnet Angola Burma	Nalumino Nakamoya Mutembo	Carrot/Zaire Lusaka Kashala Mupulanga Namaoma Namakando	Kadononga Mushungumani	----	----

District: Mongu	Cowpea	Tomato	Onion	Rape	Pumpkin	Irish potato	Cabbage
Village: Lealui							
Men	----	Tengelo Rodade Heinz Money maker	Bulb Spring	Hobson English rape Nanga	----	----	Copenhagen
Women	----	Tengelo Rodade Money maker Heinz	Bulb Spring	Hobson English rape Nanga	Round Oval Kankolola	----	Copenhagen Riana F1 Drumhead Sugar loaf
Youth	----	Tengelo Money maker	Spring	May ford English rape Hobson Nanga	----	----	----
Village: Situlu							
Men	----	Rodade Money maker Red khaki	Spring	Giant rape Nanga rape	Round Oval	----	Cultivar name unknown
Women	----	Money maker Roma Heinz	Spring Bulb	Giant rape Nanga English rape	Oval Kankolola Kababe	----	Drumhead Sugar loaf
Youth	----	Rodade Tengelo	Bulb Spring	Hobson Giant rape Nanga	Local cucumber Squash Kankolola	----	Riana F1
Village: Nanikelako							
Men	----	Rodade Tengelo	Bulb Spring	Hobson English rape Giant rape	Sibili (yellow, green)	----	Riana F1
Women	----	Rodade Money maker	----	Giant rape	----	----	----
Youth	Cultivar name unknown (brown, white)	Rodade Money maker Tengelo	----	Giant rape	Round Oval	----	----

District: Mongu	Other vegetables	Wheat	Beans	Sugarcane	Carrot	Eggplant/ Impwa (wild eggplant)	Bambara groundnut
Village: Lealui							
Men	Chinese cabbage	Lorrie 2	----	Nakambala	----	Eggplant Impwa	----
Women	Pepper Okra Chinese cabbage Sindambi	Lorrie 2	Kabulangeti	Nakambala	Nantes	Eggplant Impwa	----
Youth	Sindambi Sishungwa Okra Chinese cabbage	----	Kabulangeti	Nakambala	Nantes	Eggplant Impwa	----
Village: Situlu							
Men	Chinese cabbage	----	----	Nakambala	----	Eggplant	----
Women	Water melon Local cucumbers Squash	Lorrie 2 (Demos)	----	Nakambala	----	Eggplant	----
Youth	Okra	----	----	Nakambala Mamenge Nswe	----	Eggplant	----
Village: Nanikelako							
Men	Chinese cabbage Sindambi Okra	----	Shungumani	Nakambala	----	Eggplant	----
Women	Sindambi Okra	----	----	Nakambala	----	Eggplant	----
Youth	Sindambi Nswe Paprika	Makonga	----	----	----	Eggplant Impwa	----

APPENDIX 1

District: Senanga	Maize	Rice	Cassava	Sweet potato	Groundnut	Bullrush (pearl) millet	Sorghum
Village: Sifuna							
Men	Recycled grain Mashewa MM 603 PANA 53 MM 521	Supa Xiangzhou 5 Blue bonnet Angola Malawi faya	Nalumino Kapumba Mutembo Nakamoya Bangwuelu	Sisheke Chingovwa Namaoma Teleza Carrot	Mushungumani	Lubasi Kayuma	Makonga
Women	MM 441 MM 521 Munali Recycled	Supa Burma	Nalumino Nakamoya Kapumba Litale	Teleza Namakande Carrot Kanyopi	Red type, small early-maturing local (runner type)	Cultivar name unknown	Makonga
Youth	PANA 53 Local tall var. MM 603	Supa Angola Kajacket Blue bonnet Xiangzhou 5 Chitakwa	Nalumino Kapumba Mbambi Mutembo	Teleza Chungovwa Muzilili Sisheke	Mushungumani Local spreading	----	White local Makonga
Village: Nalitoya							
Men	Recycled grain Lozi local Mokola Mulonga (black and white seeds) Mashewa	Supa Angola Xiangzhou 5	Nalumino Kapumba Litale Mbambi Mutembo	Chingovwa Sisheke	Cultivar name unknown	Cultivar name unknown	Cultivar name unknown
Women	PANA 53 Mokula Munali MM 441 MM 400	Supa Burma Angola Blue Bonnet Xiangzhou 5 Kajacket Black rice	Nalumino Nakamoya Kapumba Bangweulu Portuguese Litale Kokota Kapulanga Mandelena (lost) Lingoma	Chingovwa Teleza Namakando Sisheke Carrot Namushakende Kanyopi L9	Natal common Chalimbana Sishango GV 4	Local Lubasi (no longer available)	Makonga Kanyemu - (lost) Mubofu Sipupe - (lost) Kuyuma Wakwinji (only flood-tolerant variety known)
Youth	PANA 53 MM 441 Market grain Local	Supa Burma Blue bonnet Xiangzhou 5 Malawi faya (lost) Angola	Nalumino Kapumba Bangweulu Nakamoya Mutembo	Chingovwa Teleza Carrot Sisheke Namakando Kanyopi	Cultivar name unknown	Local	Hybrid White big grain Local kabupo Mubofu
Village: Nembwele							
Men	MM 441 PANA 53 MM 603 Mashewa Serotsi Munali	Supa Malawi faya Angola Burma Blue bonnet Xiangzhou 5	Nalumino Kapulanga Kapumba Nakamoya Chila Mutembo Bangweulu	Teleza Carrot Sisheke Chungovwa Namushakende	Cultivar name unknown	Local Lozi variety	Sibolo Makonga Munanana
Women	PANA 53 SC 627 MM 441 Munali Recycled	Supa Xiangzhou 5 Angola Burma Kajacket Blue bonnet Malawi faya	Nalumino Kapulanga Kapumba Nakamoya Namashakende	Chingovwa Teleza Carrot Namakande Namushakende	Cultivar name unknown	Cultivar name unknown	Makonga Mubofu
Youth	MM 441 Simikata Popcorn (white, yellow) MM 305 MM 441 Local	Supa Burma Xiangzhou 5 Blue bonnet Angola Kajacket	Nalumino Kapumba Nakamoya Kapulanga	Teleza Carrot Chingovwa Kanyopi Namakando Sisheke	Shungumana Kadononga Namalala	Cultivar name unknown	Makonga Syndicate (Ma nyambe)

APPENDIX 1

District: Senanga	Cowpea	Tomato	Onion	Rape	Pumpkin	Irish potato	Cabbage
Village: Sifuna							
Men	Local Bubebe	Tengelo Rodade Money maker Romans	Cultivar name unknown	Cultivar name unknown	----	----	Cultivar name unknown
Women	Nyamunene Munamalali Ndondi Meshoangombe	Money maker Tengelo Rodade Local small	Spring Texas grano II	Cultivar name unknown	Red round Oval	----	Riana F1
Youth	Bubebe Nyamunene Nyamuzula Lutembwe	Cultivar name unknown	Cultivar name unknown	5 years English giant	Kankolola Mupusi	----	---
Village: Nalitoya							
Men	Cultivar name unknown	Cultivar name unknown	Cultivar name unknown	Cultivar name unknown	----	----	Cultivar name unknown
Women	Local Musandile Lutembwe Nyamunene Black pure	Cultivar name unknown	Cultivar name unknown	Giant rape	Local round type Long type	----	Riana F1 Drumhead
Youth	----	Money maker Local	----	Choumolia Giant rape 5 years Chibandankonde	----	----	Cultivar name unknown
Village: Nembwele							
Men	Cultivar name unknown	Rodade Money maker Romans Tengelo	Spring Bulb onion	Giant rape (same as English giant)	Ndombe-looking Mucus Kankolola Malaka	----	Cultivar name unknown
Women	Munamalali Shungumana	Tengelo Money maker Roma Rodade	Bulb Spring	Giant rape	Round Oval Kankolola	----	Riana F1 Copenhagen
Youth	Cashew (red and yellow)	Tengelo Money maker Small local	Bulb Spring	Giant rape 5 years Chibandankonde	Ndombe-looking Mupusi Kankolola Malaka	Cultivar name unknown	Cultivar name unknown

District: Senanga	Other vegetables	Wheat	Beans	Sugarcane	Carrot	Eggplant/Impwa (wild eggplant)	Bambara nut
Village: Sifuna							
Men	----	----	----	----	----	----	Cultivar name unknown (black and white types)
Women	Watermelon (red flesh and white flesh) Cucumber (round and oval) Squash (round and oval)	----	----	Nakambala Solwezi wasilozi	----	----	----
Youth	Mundambi/Sindambi (red, Angola, Nyaleleka)	----	----	Mamenge	----	----	Black White Red
Village: Nalitoya							
Men	----	----	----	Nakambala Solwezi wasilozi Mamenge	----	----	Black White Red
Women	Cucumber (local Kankoya)	----	----	----	----	----	Local
Youth	Sindambi (Nyaleleka, Nyalolombe) Likelengwe	----	----	----	----	----	----
Village: Nembwele							
Men	----	----	----	----	----	----	----
Women	Pepper (paprika and green)	----	----	----	----	----	----
Youth	----	----	----	----	----	----	----

APPENDIX 1

District: Lukulu	Maize	Rice	Cassava	Sweet potato	Groundnut	Bullrush (pearl) millet	Sorghum
Village: Kapanda							
Men	Namwenyi Munali Kandale MM 603 MM 441 PANA 6363 MM 604	Supa Angola Xiangzhou 5 Blue bonnet Kajacket	Nalumino Litale Tumbangezhi Nalitoya	Teleza Ndola	Kadononga Chalimbana	----	----
Women	MM 603 MM 441 Popcorn Namwenyi Yellow maize	Supa Blue bonnet Angola Kajacket Xiangzhou 5	Nalumino Litale Rabbeca Tumbangezhi Lingoma Mutembo	Makeni Lusaka Mukasela Ndola Carrot Muzilili Teleza Selumona Kashale	Cultivar name unknown	Tau Lozi tall variety	Syndicate Makonga Maelepu
Youth	MM 603 MM 602 MM 441 Pool 16 PANA 53 Local yellow Kandalendale Not-not	Supa Angola Blue bonnet Kajacket	Nalumino Litale Rabbecca Mutembo Kapumba Nakamoya Lingoma Tumbangezi	Makeni Ndola Namaoma Teleza Kapokoto Lusaka Muzilili Mukansela Nakashi	Makulu red (no shattering grains) Kadonongo Chalimbana	Lozi local variety	Sindeketi (not easily eaten by birds) Makonga Local red
Village: Kabula							
Men	Recycled Kandalendale Namwenyi	Supa Angola Blue bonnet Burma	Nalumino Litale Mwakamwenge Mutembo	Lusaka Ndola Kashala Namaoma	----	----	Makonga Maelepu Syndicate
Women	MM 441 recycled Yellow Kadalendale	Supa Blue bonnet Xiangzhou 5 Burma Angola	Nalumino Litale Mutembo Kapumba ka Nyengo	Makeni Mukwilela Lusaka Chingovwa Ndola Mubulenga Namakando Nselumuna	Chalimbana Natal common Makulu red	----	Syndicate Makonga Maelepu
Youth	MM 603 MM 604 Yellow MM 441recycled	Supa Blue bonnet Angola Burma	Nalumino Mutembo Litale Makamwengo	Lusaka Ndola Makeni Teleza Carrot Musoma Chingovwa Selumuna Muzilili Namaoma Nakashi Namakando Kashala	----	----	Syndicate (Sindiketi) Local

APPENDIX 1

District: Lukulu	Cowpea	Tomato	Onion	Rape	Pumpkin	Irish potato	Cabbage
Village: Kapanda							
Men	Selozi	----	----	----	----	----	----
Women	----	Money maker Rodade Tengelo	Bulb Spring	----	Oval red Round red	----	Drumhead Main crop
Youth	----	Money maker Rosell Rodade	----	Giant Chibangankonde Choumolia 5 years	----	----	----
Village: Kabula							
Men	----	Cultivar name unknown	Cultivar name unknown	Cultivar name unknown	----	----	Cultivar name unknown
Women	Local	Money maker Roma Rodade	Spring	English giant (same as giant rape)	----	----	Copenhagen
Youth	----	Cultivar name unknown	Cultivar name unknown	Giant rape 5 years Chibuga	Mupusi Namundalangwe Malaka Maliupu	----	Cultivar name unknown

District: Lukulu	Other vegetables	Wheat	Beans	Sugarcane	Carrot	Eggplant/Impwa (wild eggplant)	Bambara nut
Village: Kapanda							
Men	----	----	----	----	----	----	----
Women	Pepper (big and oval)	----	----	----	----	----	White Black Brown
Youth	Sindambi	----	----	----	----	----	Black and white White Black Brown
Village: Kabula							
Men	----	----	----	----	----	----	----
Women	----	----	----	----	----	----	----
Youth	----	----	----	----	----	----	----

Notes: Underlined variety is most preferred.

District: Kalabo	Maize	Rice	Cassava	Sweet potato	Groundnut	Bulrush (pearl) millet	Sorghum
Village: Mapungu							
Men	MM 441 MM 603 MM 600 (all above recycled)	Supa Xiangzhou 5 Burma Kajacket Blue bonnet	Nalumino Mutembo	Zaire Kenya	Kandalendale Kadononga	----	----
Women	MM 441 recycled MM 603 recycled Pool 16 Yellow maize Popcorn recycled	Supa Xiangzhou 5 Burma Blue bonnet	Nalumino	Chingovwa Kenya	Shungumani Kadononga Makulu red	----	----
Youth	MM 441 recycled Pool 16 recycled MRI 514 Grain recycled	Supa Xiangzhou 5 Kajacket Burma Blue bonnet	Nalumino Kapumba Mutembo Nakamoya Musele Butiki Litale	Zaire Liyi Kenya Muzilili Ndola Luapula Namaoma Namakando Boyd Carrot Temusimbunde	Local Shungumani	----	----
Village: Mwandi Lower							
Men	MM 441 Pool 16 MMV 400	----	Nalumino	Zaire Namakando Carrot	Kadononga Local	----	----
Women	MM 441 MM 603 Pool 16 (all above recycled)	----	Nalumino Mutembo Nakamoya	Chingovwa Kalembula Kenya Salaula	----	----	----
Youth	MM 441 MM 603 Pool 16 (all above recycled)	----	Nalumino Nakamoya Mutembo	Zaire Kenya Mbowe Carrot Namakando Mubiana Shakapele Ya purple	Shungumani Muzauli Local (Lozi)	----	----
Village: Mwandi Upper							
Men	MM 441 MM 603 (all above recycled)	Supa Xiangzhou 5 Angola	Nalumino Mutembo Butiki Kapumba	Zaire Carrot	Shungumani Munamalali	Sesame	Makonga (white)
Women	MM 441 (mounds) MM 603 Pool 16 (wetlands) (all above recycled) Kandalendale Yellow maize	Supa Xiangzhou 5	Nalumino Mutembo Kapumba Butiki	Kenya Carrot Monde Kashala Lii	Munamalali (spread) Chalimbana Shungumani (dwarf)	Local	Makonga white Makonga red
Youth	MM 441 MM 603 Pool 16 (all above recycled) Local	Supa Xiangzhou 5	Nalumino Kapumba Mutembo Butiki Nakamoya	Kenya Zaire	Shungumani Munamalali	Dollar	Makonga white Makonga red

APPENDIX 1

District: Kalabo	Cowpea	Tomato	Onion	Rape	Pumpkin	Irish potato	Cabbage
Village: Mapungu							
Men	----	Rodade Tengelo	Spring Bulb	Angola	Round	----	Copenhagen
Women	Local cowpeas	Tengelo recycled Rodade Money maker Heinz	Bulb Spring	Hobson Nanga	Round Oval	----	Copenhagen Riana F1 Sugar loaf
Youth	----	Tengelo Heinz Rodade Roma	Spring Bulb	Hobson 5 years Giant rape Angola	Round	----	Copenhagen Riana F1 Sugarloaf
Village: Mwandi lower							
Men	----	----	----	Giant rape	Mutopo Round	----	----
Women	----	Tengelo Money maker Rodade Roma	Bulb Spring	Giant rape Hobson Angola	Oval Round Variety with different colors	----	Riana F1 Copenhagen
Youth	----	Tengelo Rodade	----	Giant rape Angola	----	----	Copenhagen Riana F1
Village: Mwandi Upper							
Men	----	Rodade Tengelo	Spring Bulb	English giant (same as giant rape) Hobson	Round	----	Copenhagen
Women	Munamalali (spread) Mushungumani (dwarf)	Tengelo Rodade Money maker Local small	Bulb Spring	Giant Hobson	Ndombe-shaped	----	Riana F1 Drumhead Sugar loaf
Youth	----	Tengelo Rhodade Money maker	Spring	Giant rape Robson Angola	Round	----	Chinese Chibandankonde

District: Kalabo	Other vegetables cultivated	Wheat	Beans	Sugarcane	Carrot	Eggplant/Impwa (wild eggplant)	Bambara nut
Village: Mapungu							
Men	Chinese cabbage Sidambi	----	----	Nakambala	----	----	----
Women	Cucumbers Sidambi Amaranthus Watermelon	----	White (cooks fast) Local	----	----	----	Local
Youth	----	----	----	----	----	----	----
Village: Mwandi Lower							
Men	----	----	----	Nakambala	----	Impwa	----
Women	Cucumbers Watermelon Gourd	----	----	Nakambala	----	Big and oval Small	----
Youth	----	----	----	Nakambala	----	----	White Brown Black
Village: Mwandi Upper							
Men	----	----	----	Nakambala	----	----	----
Women	Spinach Lettuce	----	----	Nakambala	----	----	White Black
Youth	----	----	----	Nakambala	----	----	----

APPENDIX 1

District: Mongu	Maize	Rice	Cassava	Sweet potato	Groundnut	Bullrush (pearl) millet	Sorghum
Village: Lealui							
Men	MM 441 recycled MMV 400 recycled MM 603 ZMS 521	Supa Angola Xiangzhou 5 Blue bonnet Kajacket	Cultivar name unknown	Lusaka Carrot Kalembula Hippo (big)	----	----	----
Women	MM 441 recycled MM 603 SC 513 Pool 16 recycled MRI 734 Yellow maize	Supa Xiangzhou 5 Angola Kajacket Blue bonnet	Cultivar name unknown	Mushungumani Carrot Namaoma Namakando Kenya Kashala Hippo	----	----	Makonga Maelepu Kuyuma
Youth	MM 441 Mazulu 3 months Pool 16 Litapa 3 months ZMS 402 MM 602 PANA 53 Grain on market	Supa Angola Xiangzhou 5 Kajacket Blue bonnet	Kapumba	Mushungumani 3 months Namaoma Teleza Kashala Nakashi (white) Namakando Hippo Carrot Kapulanga	----	----	----
Village: Situlu							
Men	MM 441 recycled Kandalendale MM 603 Simikata	Supa Xiangzhou 5 Angola Kajacket Burma Blue bonnet	----	Lusaka Zaire Namaoma	----	----	Maelepu Makonga Munanana
Women	MM 441 recycled MRI 521 Munali Simikata Kandalendale	Supa Xiangzhou 5 Kajacket Blue bonnet Angola	----	----	----	----	----
Youth	MM 441 recycled MM 603 Pool 16 PANA 53 Yellow maize Simikata Grain from market Popcorn Kandalendale	Supa Xiangzhou 5 Blue bonnet Angola ITTA 212 Nerica Kajacket Burma Malawi faya	Mutembo Nalumino Kapumba Nakamoya	Lusaka Namaoma Carrot MTN (yellow flesh) Kashala Nasilele	----	----	----
Village: Nanikelako							
Men	MM 441 recycled Lyatolo Makunupo Pool 16 MM 603	Supa Angola Blue bonnet Kajacket	----	Zaire	Kadononga	----	----
Women	MM 441 recycled Kandalendale	Supa Kajacket Xiangzhou 5	Nalumino	Chingovwa Mukuwa Namakando Kaoma Mupulanga	Munamalali Shungumani	----	----
Youth	Kandalendale MM 441 Pool 16 PANA 53	Supa Kajacket Xiangzhou 5 Blue bonnet Angola Burma	Nalumino Nakamoya Mutembo	Carrot/Zaire Lusaka Kashala Mupulanga Namaoma Namakando	Kadononga Shungumani	----	----

APPENDIX 1

District: Mongu	Cowpea	Tomato	Onion	Rape	Pumpkin	Irish potato	Cabbage
Village: Lealui							
Men	----	Tengelo Rodade Heinz Money maker	Bulb Spring	Hobson English rape Nanga	----	----	Copenhagen
Women	----	Tengelo Rodade Money maker Heinz	Bulb Spring	Hobson English rape Nanga	Round Oval Kankolola	----	Copenhagen Riana F1 Drumhead Sugar loaf
Youth	----	Tengelo Money maker	Spring	May ford English rape Hobson Nanga	----	----	----
Village: Situlu							
Men	----	Rodade Money maker Red khaki	Spring	Giant rape Nanga rape	Round Oval	----	Cultivar name unknown
Women	----	Money maker Roma Heinz	Spring Bulb	Giant rape Nanga English rape	Oval Kankolola Kababe	----	Drumhead # Sugar loaf
Youth	----	Rodade Tengelo	Bulb Spring	Hobson Giant rape Nanga	Local cucumber Squash Kankolola	----	Riana F1
Village: Nanikelako							
Men	----	Rodade Tengelo	Bulb Spring	Hobson English rape Giant rape	Sibili (yellow, green)	----	Riana F1
Women	----	Rodade Money maker	----	Giant rape	----	----	----
Youth	Cultivar name unknown (brown, white)	Rodade Money maker Tengelo	----	Giant rape	Round Oval	----	----

District: Mongu	Other vegetables	Wheat	Beans	Sugarcane	Carrot	Eggplant/Impwa (wild eggplant)	Bambara groundnut
Village: Lealui							
Men	Chinese cabbage	Lorrie 2	----	Nakambala	----	Eggplant Impwa	----
Women	Pepper Okra Chinese cabbage Sindambi	Lorrie 2	Kabulangeti	Nakambala	Nantes	Eggplant Impwa	----
Youth	Sindambi Sishungwa Okra Chinese cabbage	----	Kabulangeti	Nakambala	Nantes	Eggplant Impwa	----
Village: Situlu							
Men	Chinese cabbage	----	----	Nakambala	----	Eggplant	----
Women	Watermelon Local cucumbers Squash	Lorrie 2 (Demos)	----	Nakambala	----	Eggplant	----
Youth	Okra	----	----	Nakambala Mamenge Nswe	----	Eggplant	----
Village: Nanikelako							
Men	Chinese cabbage Sindambi Okra	----	Shungumani	Nakambala	----	Eggplant	----
Women	Sindambi Okra	----	----	Nakambala	----	Eggplant	----
Youth	Sindambi Nswe Paprika	Makonga	----	----	----	Eggplant Impwa	----

APPENDIX 1

District: Senanga	Maize	Rice	Cassava	Sweet potato	Groundnut	Bullrush (pearl) millet	Sorghum
Village: Sifuna							
Men	Recycled Mashewa MM 603 PANA 53 MM 521	Supa Xiangzhou 5 Blue bonnet Angola Malawi faya	Nalumino Kapumba Mutembo Nakamoya Bangwuelu	Sesheke Chingovwa Namaoma Teleza Carrot	Shungumana	Lubasi Kufuna	Makonga
Women	MM 441 MM 521 Munali recycled	Supa Burma	Nalumino Nakamoga Kapumba Litale	Teleza Namakande Carrot Kanyopi	Red type small early maturing Local (runner type)	Cultivar name unknown	Makonga
Youth	PANA 53 Local tall var. MM 603	Supa Angola Kajacket Blue bonnet Xiangzhou 5 Chitakwa	Nalumino Kapumba Mbambi Mutembo	Teleza Chungovwa Muzilili Sisheke	Shungumana Local spreading	----	White local Makonga
Village: Nalitoya							
Men	Recycled grain Lozi local Mokola Mulonga (black and white seeds) Mashewa	Supa Angola Xiangzhou 5	Nalumino Kapumba Litale Mbambi Mutembo	Chingovwa Sisheke	Cultivar name unknown	Cultivar name unknown	Cultivar name unknown
Women	PANA 53 Mokola Munali MM 441 MM 400	Supa Burma Angola Blue bonnet Xiangzhou 5 Kajacket Black rice	Nalumino Nakamoya Kapumba Bangweulu Portuguese Litale Kokota Kapulanga Mandelena (lost) Lingoma	Chingovwa Teleza Namakando Lisheke Carrot Namushakende Kanyopi L9	Natal Chalimbana Sishango GV4	Local Lubasi (no longer available)	Makonga Kanyemu (no longer available) Mubofu Sipupe (no longer available) Kuyuma Wakwinji (only flood-tolerant variety known)
Youth	PANA 53 MM 441 Local grain	Supa Burma Blue bonnet Xiangzhou 5 Malawi faya (no longer available) Angola	Nalumino Kapumba Bangweulu Nakamoya Mutembo	Chingovwa Teleza Carrot Sisheke Namakando Kanyopi	Cultivar name unknown	Local Dollar Hybrid (no longer available)	Hybrid White big grain Local Kabupo Mubofu
Village: Nembwele							
Men	MM441 PANA 53 MM 603 Mashewa Serotsi Munali	Supa Malawi faya Angola Burma Blue bonnet Xiangzhou 5 PANA 13	Nalumino Mapulanga Kapumba Nakamoya Chila Mutembo Bangweulo	Teleza Carrot Sesheke Chungovwa Namushakende	Cultivar name unknown	Local Lozi variety	Sibolo Makonga Munanana
Women	PANA 53 SC 627 MM 441 recycled Munali	Supa Xiangzhou 5 Angola Burma Kajacket Blue bonnet Malawi faya	Nalumino Kapulanga Kapumba Nakamoya Namashakende	Chingovwa Teleza Carrot Namakande Namushakende	Cultivar name unknown	Cultivar name unknown	Makonga Mubofu
Youth	MM 441 Simikaka Popcorn (white, yellow) MM 305 MM 441 Local grain	Supa Burma Xiangzhou 5 Blue bonnet Angola Kajacket	Nalumino Kapumba Nakamonga Kapulanga	Teleza Carrot Mamakando Chingovwa Kanyopi Namakando Sisheke	Shungumana Kadongo Namalala	Cultivar name unknown	Makonga Syndicate (Ma nyambe)

District: Senanga	Cowpea	Tomato	Onion	Rape	Pumpkin	Irish potato	Cabbage
Village: Sifuna							
Men	Local Bubebe	Tengeru Rodade Money maker Romans	Cultivar name unknown	Cultivar name unknown	----	----	Cultivar name unknown
Women	Nyamunene Munawani Ndondi Meshoangombe	Money maker Tengelo Rodade Local small	Spring Texas grano	Cultivar name unknown	Red round Oval	----	Riana F1
Youth	Bubebe Nyamunene Nyamuzula Lutembwe	Cultivar name unknown	Cultivar name unknown	5 years English giant	Kakolola Mupusi	----	----
Village: Nalitoya							
Men	Cultivar name unknown	Cultivar name unknown	Cultivar name unknown	Cultivar name unknown	----	----	Cultivar name unknown
Women	Local Musandile Lutembwe Nyamunene Black pure	Cultivar name unknown	Cultivar name unknown	Giant rape	Local round type Long type	----	Riana Drumhead
Youth	----	Money maker Local	----	Choumolia Giant rape 5 years Chibanga Nkonde	----	----	Cultivar name unknown
Village: Nembwele							
Men	Cultivar name unknown	Rodade Money maker Romans Tengeru	Spring Bulb	Giant rape (same as English giant)	Ndombe-looking Mupusi Kankolola Malaka	----	Cultivar name unknown
Women	Munamalali Shungumanan	Tengelo Money maker Roma Rodade	Bulb Spring	Giant rape	Round Oval Kankolola	----	Riana F1 Copenhagen
Youth	Cashew (red and yellow)	Tengelo Money maker Small local	Bulb Spring	Giant rape 5 years Chibangankonde	Ndombe Mupusi Kankolola Malaka	Cultivar name unknown	Cultivar name unknown

District: Senanga	Other vegetables	Wheat	Beans	Sugarcane	Carrot	Eggplant/Impwa (wild eggplant)	Bambara nut
Village: Sifuna							
Men	----	----	----	----	----	----	Cultivar name unknown (black and white types)
Women	Watermelon (red flesh and white flesh) Cucumber (round and oval) Squash (round and oval)	----	----	Nakambala Solwezi wasilozi	----	----	----
Youth	Mundambi/Sindambi (red, Angola, Nyaleleka)	----	----	Mamenge	----	----	Black White Red
Village: Nalitoya							
Men	----	----	----	Nakambala Solwezi wasilozi Mamenge	----	----	Black White Red
Women	Cucumber (Local Kankoya)	----	----	----	----	----	Local
Youth	Sindambi (Nyaleleka, Nyalolombe) Likelengwe	----	----	----	----	----	----
Village: Nembwele							
Men	----	----	----	----	----	----	----
Women	Pepper (paprika and green)	----	----	----	----	----	----
Youth	----	----	----	----	----	----	----

District: Lukulu	Maize	Rice	Cassava	Sweet potato	Groundnut	Bullrush (pearl) millet	Sorghum
Village: Kapanda							
Men	Namwenyi Munali Kandale MM 603 MM 441 PANA 53 MM 604	Supa Angola Xiangzhou 5 Blue bonnet Kajacket	Nalumino Litale Tumbangezhi Nalitoya Litale	Teleza Ndola	Kadononga Chalimbana	----	----
Women	MM 603 MM 441 Popcorn Namwenyi Yellow maize	Supa Blue bonnet Angola Kajacket Xiangzhou 5	Nalumino Litale Rabbeca Tumbangezhi Lingoma Mutembo	Makeni Lusaka Mukasela Ndola Carrot Muzilili Teleza Selumona Kashala	Cultivar name unknown	Tau Lozi tall variety	Syndicate Makonga Maelepu
Youth	MM 603 MM 602 MM 441 Pool 16 PANA 53 Local yellow Kandalendale Not-not	Supa Angola Blue bonnet Kajacket	Nalumino Litale Rabbecca Mutembo Kapumba Nakamoya Lingoma Tumbangezhi	Makeni Ndola Namaoma Teleza Kapokoto Lusaka Muzilili Mukansela Nakashi	Makulu red (no shattering grains) Kadonongo Chalimbana	Lozi local variety	Sindeketi (not easily eaten by birds) Makonga Local red
Village: Kabula							
Men	Recycled Kandale Namwenyi	Supa Angola Blue bonnet Burma	Nalumino Litale Mwakamwenge Mutembo	Lusaka Ndola Kashala Namaoma	----	----	Makonga Maelepu Syndicate
Women	MM 441 recycled MM 603 Yellow Kadalendale	Supa Blue bonnet Xiangzhou 5 Burma Angola	Nalumino Litale Mutembo Kapumba ka Nyengo	Makeni Mukwilela Lusaka Chingovwa Ndola Mubulenga Namakando Nselumuna	Chalimbana Natal common Makulu red	----	Syndicate Makonga Maelepu
Youth	MM 603 MM 604 Yellow 90 days recycled	Supa Blue bonnet Angola Burma	Nalumino Mutembo Litale Makamwengo	Lusaka Ndola Makeni Teleza Carrot Musoma Chingovwa Selumuna Muzilili Namaoma Nakashi Namakando Kashala	----	----	Syndicate Local

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District: Lukulu	Cowpea	Tomato	Onion	Rape	Pumpkin	Irish potato	Cabbage
Village: Kapanda							
Men	Selozi	----	----	----	----	----	----
Women	----	Money maker Rodade Tengelo	Bulb Spring	----	Oval red Round red	----	Drumhead Main crop
Youth	----	Money maker Rosell Rodade	----	Giant Chibangankonde Choumolia 5 years	----	----	----
Village: Kabula							
Men	----	Cultivar name unknown	Cultivar name unknown	Cultivar name unknown	----	----	Cultivar name unknown
Women	Local	Money maker Roma Rodade	Spring	English giant (same as giant rape)	----	----	Copenhagen
Youth	----	Cultivar name unknown	Cultivar name unknown	Giant rape 5 years Chibuga	Mupusi Namundalangwe Malaka Maliupu	----	Cultivar name unknown

District: Lukulu	Other vegetables	Wheat	Beans	Sugarcane	Carrot	Eggplant/Impwa (wild eggplant)	Bambara nut
Village: Kapanda							
Men	----	----	----	----	----	----	----
Women	Pepper (big and oval)	----	----	----	----	----	White Black Brown
Youth	Sindambi	----	----	----	----	----	Black & white White Black Brown
Village: Kabula							
Men	----	----	----	----	----	----	----
Women	----	----	----	----	----	----	----
Youth	----	----	----	----	----	----	----

District: Kalabo	Maize	Rice	Cassava	Sweet potato	Groundnut	Bulrush (pearl) millet	Sorghum
Village: Mapungu							
Men	MM 441 MM 603 MM 600 (all above recycled)	Supa Xiangzhou 5 Burma Kajacket Blue bonnet	Nalumino Mutembo	Zaire Kenya	Kandalendale Kadononga	----	----
Women	MM 441 (recycled) MM 603 (recycled) Pool 16 Yellow maize Popcorn (recycled)	Supa Xiangzhou 5 Burma Blue bonnet	Nalumino	Chingovwa Kenya	Shungumani Kadononga Makulu red	----	----
Youth	MM 441 (recycled) Pool 16 (recycled) MRI 514 Grain (recycled)	Supa Xiangzhou 5 Kajacket Burma Blue bonnet	Nalumino Kapumba Mutembo Nakamoya Musele Butiki Litale	Zaire Liyi Kenya Muzilili Ndola Luapula Namaoma Namakando Boyd Carrot Temusimbunde	Local Shungumani	----	----
Village: Mwandi Lower							
Men	MM 441 Pool 16 MMV 400	----	Nalumino	Zaire Namakando Carrot	Kadononga Local	----	----
Women	MM 441 MM 603 Pool 16 (all above recycled)	----	Nalumino Mutembo Nakamoya	Chingovwa Kalembula Kenya Salaula	----	----	----
Youth	MM 441 MM 603 Pool 16 (all above recycled)	----	Nalumino Nakamoya Mutembo	Zaire Kenya Mbowe Carrot Namakando Mubiana Shakapele Ya purple	Shungumani Muzauli Local (Lozi)	----	----
Village: Mwandi Upper							
Men	MMV 441 MM 603 (all above recycled)	Supa Xiangzhou 5 Angola	Nalumino Mutembo Butiki Kapumba	Zaire Carrot	Shungumani Munamalali	Sesame	Makonga (white)
Women	MM 441 (mounds) MM 603 Pool 16 (wetlands) (all above recycled) Kandalendale Yellow maize	Supa Xiangzhou 5	Nalumino Mutembo Kapumba Butiki	Kenya Carrot Monde Kashala Liyi	Munamalali (spread) Chalimbana Shungumani (dwarf)	Local	Makonga white Makonga red
Youth	MM 441 MM 603 Pool 16 (all above recycled) Local	Supa Xiangzhou 5	Nalumino Kapumba Mutembo Butiki Nakamoya	Kenya Zaire	Shungumani Munamalali	Dollar	Makonga white Makonga red

APPENDIX 1

District: Kalabo	Cowpea	Tomato	Onion	Rape	Pumpkin	Irish potato	Cabbage
Village: Mapungu							
Men	----	Rodade Tengelo	Spring Bulb	Angola	Round	----	Copenhagen
Women	Local cowpeas	Tengelo (recycled) Rodade Money maker Heinz	Bulb Spring	Hobson Nanga	Round Oval	----	Copenhagen Riana F1 Sugar loaf
Youth	----	Tengelo Heinz Rodade Roma	Spring Bulb	Hobson 5 years Giant rape Angola	Round	----	Copenhagen Riana F1 Sugarloaf
Village: Mwandi lower							
Men	----	----	----	Giant rape	Mutopo Round	----	----
Women	----	Tengelo Money maker Rodade Roma	Bulb Spring	Giant rape Hobson Angola	Oval Round Variety with different colors	----	Riana F1 Copenhagen
Youth	----	Tengelo Rodade	----	Giant rape Angola	----	----	Copenhagen Riana F1
Village: Mwandi Upper							
Men	----	Rodade Tengelo	Spring Bulb	English giant (same as giant rape) Hobson	Round	----	Copenhagen
Women	Munamalali (spread) Mushungumani (dwarf)	Tengelo Rodade Money maker Local small	Bulb Spring	Giant Hobson	Ndombe-shaped	----	Riana F1 Drumhead Sugar loaf
Youth	----	Tengelo Rhodade Money maker	Spring	Giant rape Robson Angola	Round	----	Chinese Chibandankonde

District: Kalabo	Other vegetables cultivated	Wheat	Beans	Sugarcane	Carrot	Eggplant/Impwa (wild eggplant)	Bambara nut
Village: Mapungu							
Men	Chinese cabbage Sindambi	----	----	Nakambala	----	----	----
Women	Cucumbers Sindambi Amaranthus spp. Watermelon	----	White (cooks fast) Local	----	----	----	Local
Youth	----	----	----	----	----	----	----
Village: Mwandi Lower							
Men	----	----	----	Nakambala	----	Impwa	----
Women	Cucumbers Watermelon Gourd	----	----	Nakambala	----	Big and oval Small	----
Youth	----	----	----	Nakambala	----	----	White Brown Black
Village: Mwandi Upper							
Men	----	----	----	Nakambala	----	----	----
Women	Spinach Lettuce	----	----	Nakambala	----	----	White Black
Youth	----	----	----	Nakambala	----	----	----

APPENDIX 1

APPENDIX 2. VEGETABLE SPECIES COLLECTED BY HOUSEHOLDS FROM LOCAL ECOLOGY FOR CONSUMPTION IN AAS FOCAL COMMUNITIES

	Amaranth [*Amaranthus* spp.] – locally called Libowa (including Musame – tall Libowa variety, Tepe or Thepe variety of amaranth)	Bush okra [*Abelmoschus esculentus* Moench] – locally called Delele [2 vars: Lunembwe – grows in Matongo; Seto – grows in Njelelo]	Cat's whiskers or African cabbage [*Cleome gynandra*] – locally called Sishungwa	Litindi	Katokwani	Nasilele (same as Njakele)	Malumba (leaves called Lumuna)	Roselle [*Hibiscus* spp.] – locally called Sindambi or Mundambi (including Nyalombe, White, Nyaleleka, Likwasha, Angola, Makuku, Likelenge, Chilelemu, Mutete)
Women								
Senanga District villages								
Sifuna	1	1	1*	0	0	0	0	1
Nalitoya	1	1	1*	1	0	1	1	1
Nembwele	1	0	1	0	0	0	0	1*
Kalabo District villages								
Mwandi Lower	1	1	1	1	1	0	1	1
Mwandi Upper	1	1	1*	1	1	1	1	1*
Mapungu	1	1	1	1	1	0	0	1*
Lukulu District villages								
Kapanda	1	1	1*	0	0	0	0	1
Kabula	1	1	1*	0	0	0	0	1
Mongu District villages								
Lealui	1	1	1	1	1	0	0	1*
Situlu	1	1	1*	1	1	0	0	1
Nanikelako	1	1	1*	1	1	1	1	1
Men								
Lukulu District villages								
Kapanda	0	1	0	0	0	0	0	1
Kabula	0	0	1	0	0	0	0	1
Kalabo District villages								
Mwandi Lower	1	1	1	1	0	1	1	1*
Mwandi Upper	1	1	1	1	0	0	0	1*
Mapungu	1*	1	1	1	0	1	0	1
Mongu District villages								
Lealui	1*	1	1	1	0	1	1	1
Situlu	1	1	1	1	0	1	1	1*
Nanikelako	1*	1	1	1	0	1	1	1
Senanga District villages								
Sifuna	0	0	0	0	0	0	0	0
Nalitoya	0	0	0	0	0	0	0	0
Nembwele	0	0	0	0	0	0	0	0
Youth								
Lukulu District villages								
Kapanda	1	1	1*	0	0	0	0	1
Kabula	1*	1	1	0	0	1	0	1
Kalabo District villages								
Mwandi Lower	1	1	1	1	0	1	0	1*
Mwandi Upper	1	1	1*	1	0	0	0	1
Mapungu	1	1	1*	1	0	1	0	1
Mongu District villages								
Lealui	1*	1	1	1	0	1	1	1
Situlu	1*	1	1	1	0	1	1	1
Nanikelako	1	1	1*	1	0	1	0	1
Senanga District villages			1					
Sifuna	1*	1		0	0	1	0	1
Nalitoya	1*	1	1	1	0	1	0	1
Nembwele	1	1	1*	1	0	0	0	1
	*Plentiful, grows well, cooks easily. Good taste, source of income, grows easily.		*Highly preferred for market value and food; tasty and good aroma. Replace *buhobe* in lean period.					*Taste and market value. Replace staple in lean period.

Notes: 1 = collected by group in the community; 0 = not collected by group in the community.

	Mambumbwe or Libumbwe	Limbembe or Litokola	Mucelo	Sihali or Katete or Katetekalunga or Kanyokamulamu or Kamulamu	Blackjack or Amalenjane [*Bidens pilosa*] – locally called Mbububu or Mbwanyo or Mbuwanyao	Manansa or Lulimi or Iwa Komu
Women						
Senanga District villages						
Sifuna	0	0	0	0	0	0
Nalitoya	0	0	0	1	0	0
Nembwele	0	1	0	0	0	0
Kalabo District villages						
Mwandi Lower	1	1	1	1	0	0
Mwandi Upper	1	1	1	1	1	0
Mapungu	1	1	1	1	1	0
Mongu District villages						
Lealui	1	1	1	1	0	1
Situlu	1	0	0	0	0	0
Nanikelako	1	1	1	1	1	1
Lukulu District villages						
Kapanda	0	0	0	0	0	0
Kabula	0	0	0	0	0	0
Men						
Senanga District villages						
Sifuna	0	0	0	0	0	0
Nalitoya	0	0	0	0	0	0
Nembwele	0	0	1	1	0	0
Lukulu District villages						
Kapanda	0	0	0	0	0	0
Kabula	0	0	0	0	0	0
Mongu District villages						
Lealui	1	1	0	1	0	1
Situlu	1	1	0	1	1	1
Nanikelako	1	1	1	1	1	1
Kalabo District villages						
Mwandi Lower	1	1	1	1	0	1
Mwandi Upper	0	1	0	1	0	0
Mapungu	1	1	1	1	0	0
Youth						
Lukulu District villages						
Kapanda	1	1	0	0	0	0
Kabula	1	0	1	1	1	0
Kalabo District villages						
Mwandi Lower	1	1	1	1	0	1
Mwandi Upper	1	1	0	1	0	0
Mapungu	1	1	1	1	1	0
Mongu District villages						
Lealui	1	0	1	0	0	1
Situlu	0	1	1	1	0	1
Nanikelako	1	1	1	1	1	1
Senanga District villages						
Sifuna	0	0	0	0	0	0
Nalitoya	0	1	1	1	1	0
Nembwele	0	1	1	1	0	0

	Kahinga	Silelemi	Ndulweti	Kapusipusi
Women				
Senanga District villages				
Sifuna	0	0	0	0
Nalitoya	0	0	0	0
Nembwele	0	0	0	0
Kalabo District villages				
Mwandi Lower	0	1	1	1
Mwandi Upper	0	1	1	1
Mapungu	0	1	1	1
Lukulu District villages				
Kapanda	0	0	0	0
Kabula	0	0	0	0
Mongu District villages				
Situlu	0	1	1	1
Lealui	0	1	1	1
Nanikelako	0	1	1	1
Men				
Lukulu District villages				
Kapanda	0	0	0	0
Kabula	0	0	0	0
Senanga District villages				
Sifuna	0	0	0	0
Nalitoya	0	0	0	0
Nembwele	0	0	0	0
Kalabo District villages				
Mwandi Lower	0	1	1	1
Mwandi Upper	0	1	1	1
Mapungu	0	1	1	1
Mongu District villages				
Situlu	0	1	0	0
Lealui	0	0	1	1
Nanikelako	0	0	1	0
Youth				
Lukulu District villages				
Kapanda	0	0	0	0
Kabula	0	0	0	0
Kalabo District villages				
Mwandi Lower	0	1	1	1
Mwandi Upper	1	1	1	1
Mapungu	1	1	1	1
Mongu District villages				
Situlu	0	1	1	1
Lealui	0	0	1	1
Nanikelako	0	0	1	1
Senanga District villages				
Sifuna	0	0	0	0
Nalitoya	0	0	0	0
Nembwele	0	0	0	0

APPENDIX 3. PROBLEM TREE ANALYSES FOR CASSAVA PRODUCTION IN AAS FOCAL COMMUNITIES STUDIED

District and villages	Men	Women	Youth
Mongu District			
Lealui	No data	No data	No data
Situlu	No data	No data	No data
Nanikelako	No data	No data	Branches*: cassava crop failure leading to low yields, low production and hunger Stem**: flash floods (Mabuba) Root***: lack of adapted early-maturity cassava varieties; late access to planting materials
Kalabo District			
Mapungu	No data	No data	Branches*: small fields leading to low production and low income; poor plant growth and crop failure; hunger Stem**: lack of planting materials Root***: flood damage to plants; low income; lack of transport to distant sources of planting materials; poor plant stands from diseases and infertile soils
Mwandi Lower	No data	Branches*: small cassava fields leading to low production and hunger Stem**: lack of animal draft power for cassava fields Root***: cattle diseases	Branches*: small fields leading to low production and hunger Stem**: lack of planting materials (cuttings) Root***: distance to source of cuttings and expensive transport costs; lack of money; flood damage to crop contributing to lack of planting material
Mwandi Upper	No data	Branches*: small fields leading to low production and hunger Stem**: lack of animal draft power Root***: diseases affecting cattle	Branches*: poor crop and yields leading to hunger, low income and malnutrition Stem**: poor infertile soils Root***: lack of manure; sandy soils; continuous mono-cropping due to lack of alternative fields; lack of seeds for crop rotation
Senanga District			
Sifuna	No data	Branches*: low cassava yields and production leading to hunger Stem**: frost damage Root***: climate change; deforestation	Branches*: low cassava yields and production; low income; food insecurity and hunger; lack of diversification Stem**: small cassava fields Root***: lack of farm implements and animal draft power
Nalitoya	No data	Branches*: cassava plants die, leading to low yields and low production, leading to hunger Stem**: frost Root***: climate	Branches*: small cassava fields leading to low production, low income, hunger and malnutrition Stem**: lack of cassava planting materials Root***: frost damage; diseases; drought; lack of capital
Nembwele	No data	Branches*: low cassava yields and production Stem**: frost damage Root***: climate	No data
Lukulu District			
Kapanda	No data	No data	Branches*: malnutrition; poverty from lack of income Stem**: low crop yields and low production Root***: small fields cultivated; lack of farm implements; high labor demand due to bulky planting material for cassava
Kabula	No data	No data	Branches*: low yields and low production; low income; hunger; malnutrition Stem**: infertile soils Root***: continuous cropping; lack of manure or fertilizer; sandy soils

Notes: *Branches denote the effects of main problem experienced; **stem denotes the perceived main problem; ***root denotes the perceived causes of the main problem.

No data means either crop is not grown or no problem was identified for discussion by a group.

APPENDIX 3

APPENDIX 4. PROBLEM TREE ANALYSES FOR CEREALS (MAIZE AND/OR RICE) PRODUCTION IN AAS FOCAL COMMUNITIES STUDIED

District and villages	Men	Women	Youth
Mongu District			
Lealui	No data	Branches*: submerged maize crop; loss of manure; hunger; poverty Stem**: flood destruction of maize crop Root***: lack of canal drainage	Branches*: poor growth leading to low maize yields and low production, hunger and malnutrition; small rice fields and inability to diversify crops Stem**: infertile soils affecting maize; lack of oxen and plow for rice cultivation Root***: lack of manure; continuous mono-cropping; soil erosion due to floods; low income; lack of cooperation in sharing farm implements
Situlu	Branches*: forced to harvest reeds to support livelihood; poverty Stem**: early flooding of maize fields Root***: frequent high floods; climate	Branches*: recycled maize seeds leading to low yields and low production; pests and diseases; hunger Stem**: lack of maize seeds adapted to Borotse floodplain Root***: no money; no business opportunities	Branches*: small rice fields cultivated; low rice yields and low production; hunger; low income; flood damage to late-maturity maize leading to low yields, low production, hunger and low income from maize Stem**: lack of farm implements for rice fields; lack of early-maturity maize cultivars Root***: lack of credit; low income from rice production; planting un-adapted maize seeds; lack of timely availability of adapted maize seeds; expensive adapted maize seeds
Nanikelako	Branches*: poverty Stem**: small maize fields Root***: limited suitable arable land (sitapa and mazulu) for maize	Branches*: maize crops submerged, leading to low yields; flooding deposits soils Stem**: floods destroy maize crops Root***: no embankments along major waterways; lack of cooperation	Branches*: flood damage to late-maturity maize, leading to low maize yields and production Stem**: lack of early-maturity maize Root***: untimely availability of adapted maize seeds; expensive adapted maize seeds; low income to afford maize seed purchases
Kalabo District			
Mapungu	Branches*: poverty; incapacity to invest in rice production Stem**: poor markets Root***: undefined weight measures for rice; low productivity on rice fields	Branches*: low maize and rice yields and low production, leading to hunger Stem**: droughts and floods Root***: deforestation	Branches*: small fields leading to diversification; low yields; low production; low income; hunger; malnutrition Stem**: lack of farm implements Root***: low income; lack of market access and transport
Mwandi Lower	Branches*: low maize yields and production, contributing to food insecurity and poverty Stem**: floods on mazulu and sitapa lands cultivated to maize Root***: late rains and flooding	Branches*: low maize yields, small rice plots and low production, leading to hunger and malnutrition Stem**: lack of adapted maize seeds; lack of animal draft power Root***: no money; diseases affecting cattle	Branches*: recycling of seeds; delayed crop planting; crop failure from floods; low yields, leading to hunger Stem**: lack of improved seeds Root***: low income; lack of capital; lack of outlets
Mwandi Upper	Branches*: low rice production; low maize production; low income and poverty Stem**: small rice fields; erratic rains on fields cultivated to maize Root***: floods; lack of animal draft power; declining residual moisture in soils; deforestation	Branches*: maize crop failure, leading to low production and hunger Stem**: erratic rains Root***: climate	Branches*: inability to cultivate large fields; poor crop and yields leading to hunger, low income and malnutrition Stem**: poor or infertile soils; lack of farm implements Root***: lack of manure; sandy soils; continuous mono-cropping due to lack of alternative fields; lack of income; lack of seeds for crop rotation
Senanga District			
Sifuna	Branches*: low demand for maize seeds due to unresponsive national seed system Stem**: small maize fields Root***: inadequate animal draft power because of cattle deaths; poor soil fertility; no seasonal loans	Branches*: small maize fields, leading to low production and hunger Stem**: lack of farm implements Root***: low income; customary rules guiding land access by women	Branches*: low rice production, contributing to low income and hunger; poor maize plant growth, leading to poor harvest, hunger, poverty and malnutrition Stem**: small rice fields; infertile soils on maize fields Root***: lack of farm implements and animal draft power; lack of credit; continuous cropping of maize fields; lack of manure; deforestation
Nalitoya	Branches*: hunger Stem**: low maize yields and production Root***: infertile soils; no fertilizers due to lack of money	Branches*: recycling of maize seed; low yields and production leading to hunger Stem**: lack of maize seed Root***: no money due to poverty	Branches*: small maize fields, leading to low maize yields and production, low income, poverty and hunger Stem**: lack of improved maize seeds (both varieties and hybrids) Root***: low maize yields; expensive improved seeds; low income resulting in no money
Nembwele	Branches*: low income Stem**: low rice production Root***: clogged canals; no incentive to clear canals	Branches*: waterlogging maize fields; low maize yields and production and small rice fields, leading to hunger Stem**: lack of canal drainage, affecting maize; lack of farm implements, affecting rice fields Root***: lack of canal drainage equipment as a result of poverty and lack of cooperation due to social conflicts and non-enforcement of bylaws; cattle diseases and theft of livestock	Branches*: low maize yields and production, contributing to food insecurity and hunger, low income, and poverty; small rice fields, leading to low rice production, low income and hunger Stem**: drought on maize fields; lack of farm implements (plow and oxen) for cultivating rice Root***: erratic rainfall; deforestation; animal diseases affecting oxen; lack of capital
Lukulu District			
Kapanda	Branches*: subsistence production; no cash income Stem**: low yield and low production Root***: lack of good seed; inadequate access to fertilizer and manure; lack of implements (oxen and plow); poor road infrastructure	Branches*: late planting; recycling of grains as seed; low yields Stem**: late delivery of seeds and fertilizer Root***: inactive local cooperative; no transport; poor roads	Branches*: low production and low yields; hunger and low income, leading to poverty; malnutrition Stem**: small fields Root***: lack of oxen and plow implements; lack of credit; death of oxen from diseases
Kabula	Branches*: low production; poverty Stem**: small fields cultivated Root***: lack of farm implements; poor soils; cattle deaths; poor market access due to poor roads	Branches*: low productivity leading to low yields; hunger Stem**: small fields Root***: lack of farm implements; no money; cattle diseases	Branches*: low yields and low production; food insecurity; hunger Stem**: small fields Root***: lack of farming implements (plow and oxen); lack of good seed; limited suitable soils

Notes: *Branches denote the effects of main problem experienced; **stem denotes the perceived main problem; ***root denotes the perceived causes of the main problem.

No data means either crop is not grown or no problem was identified for discussion by a group.

APPENDIX 5. LAND TYPES AND CROPPING CYCLE FOR MAJOR CROPS PLANTED TO THEM IN BOROTSE FLOODPLAIN, WESTERN PROVINCE, ZAMBIA

Land type	Land, soil and moisture characteristics	Mongu District		
		Lealui	Situlu	Nanikelako
MATONGO (plural of litongo)	Rarely flooded landforms often found either within or at the margins of the Borotse floodplain. These fields are located a few meters from homesteads. The soils are sandy and have little water retention capacity. In the upper land, matongo also describes ndamino or kitchen gardens.	Maize Plant—Sep.; harvest—Jan. Rice Plant—Nov.; harvest—May Rice (irrigated or residual moisture) Plant—Jun.; harvest—Nov. Wheat Plant—May; harvest—Feb.	Not applicable	Rice, maize, cassava, pumpkin, sweet potato, cucumber, groundnut Plant—Nov.; harvest—Mar.
MATEMA (plural of litema)	These are found in the forest or woodland areas. This land type is suitable for crops that do not require a lot of soil moisture. Soil types are predominantly sandy and sometimes mixed with decaying leaves.	Not applicable	Not applicable	Not applicable
MAZULU (plural of lizulu)	These are large mound fields (made by white ants over the ages) located on raised gardens anywhere within and above the general floodplain level. They have clay and loamy soils, which are some of the best soils in the floodplain but are also exposed to risks from flooding and drought. Some of this land type is left fallow due to inaccessibility.	Maize (MM 441, Pool 16, MM 603, local maize), rice, vegetables Maize Plant—Nov.; harvest—Jan. Rice Plant—Nov.; harvest—Jan. Vegetables Plant—Jan.; harvest—Apr.	Maize, rice, vegetables, sweet potato Maize (MM 441) Plant—Sep.; harvest—Feb. Sweet potato Plant—Jan.; harvest—Jun. Rice Plant—Nov.; harvest—May Vegetables (pumpkin, tomato, cabbage) Plant—Nov.; harvest—May	Maize (MM 441), sorghum, rice (Xiangzhou 5), watermelon, sweet potato, *nswe*, vegetables (pumpkin, squash, local cucumber) Maize (MM 441) Plant—Sep.; harvest—Mar. Vegetables (pumpkin, watermelon) Plant—Jan.; harvest—May *Nswe* Plant—Jan.; harvest—May Sorghum Plant—Jan.; harvest—May Sweet potato Plant—Jan.; harvest—May Rice (Zhou 5) Plant—Nov.; harvest—May

Land type	Land, soil and moisture characteristics	Mongu District		
		Lealui	Situlu	Nanikelako
MATUNDA (plural of litunda)	These land types, mostly located in the Borotse floodplain, have loamy soils and little water retention capacity.	Maize (MM 441, Pool 16), rice, sweet potato, vegetables Plant—Sep.; harvest—Feb.	Maize Plant—Aug.; harvest—Jan.	Sweet potato, maize (MM 441), cassava Plant—Sep.; harvest—Feb.
LITAPA (plural of sitapa)	These fields are found in flooded waterways in the Borotse floodplain. They represent landforms on which annual flooding of the plain deposits silt and humus from vegetation and decaying aquatic plants. These deposits enrich the fertility of the land on the plains, creating fertile arable land for crop production. However, in the late-season heat, after the floods have receded, the soils harden. These high-moisture fields provide residual moisture for cropping.	Maize (MM 441, Pool 16, local maize), vegetables (giant rape and Hobson rape) Maize Plant—Aug.; harvest—Jan. Vegetables Plant—May or Jun.; harvest—Dec.	Maize, vegetables (including pumpkins) Vegetables Plant—Aug.; harvest—Dec. Maize Plant—Aug.; harvest—Jan.	Maize (MM 441), sweet potato, vegetables (tomato, pumpkin) Maize Plant—Aug.; harvest—Jan. Sweet potato Plant—Jul.; harvest—Dec. Vegetables Plant—Jul.; harvest—Dec.
Flooding period (start month to end month)		Oct. – May (Flooding starts when Zambezi River is full in Oct. and ends in May when major waterways dry up.)	Dec. – Jun. (Flooding begins in Dec. when main waterways outflow and ends in Jun. when they dry out.)	Sep. – Jul. (Flooding starts when Zambezi River is full in Sep. and ends in Jul. when main waterways dry out.)
Community-desired changes in use of agrobiodiversity resources to fulfill dreams and visions		Irrigate crops on litapa and mazulu. Plant early-maturity varieties; e.g. MM 441. Form cooperatives to access farm inputs.	Irrigate crops on litapa and mazulu. Embark on major waterways clearance.	Embank on major waterways clearance.
Agrobiodiversity resources recommended for conservation, purification and restoration strategies		Munanana (sorghum variety) Kuyuma (sorghum variety) Finger millet Kalungwa (local yam variety) Kapumba (cassava variety) Millet (bulrush or pearl) Local cowpea	Kandalendale (local maize) Munanana (sorghum variety) Makonga (sorghum variety) Angola (rice variety) Supa (rice variety) Wheat	Makonga (sorghum variety) Munanana (sorghum variety) Lewanika (maize variety) Finger millet Wheat

Notes:
1. In Situlu, crops required for diversification are those that can grow on residual moisture. Alternatively, there is the need for technology to cultivate current crops during the off season.
2. In Situlu, "liabelela" refers to land with residual moisture ("inpomposentle"), while rainfed soil is referred to as "lishata."
3. In Nanikelako, vegetables are seen as the first choice for diversification of an enterprise mix since fishing is no longer a dependable source of livelihood.

Land type	Land, soil and moisture characteristics	Senanga District		
		Sifuna	Nalitoya	Nembwele
MATONGO	Rarely flooded landforms often found either within or at the margins of the Borotse floodplain. These fields are located a few meters from homesteads. The soils are sandy and have little water retention capacity. In the upper land, matongo also describes ndamino or kitchen gardens.	Maize (early-maturing varieties), sweet potato, cassava (Kapumba variety), vegetables (including tomato and okra), beans, pumpkin Plant—Sep.; harvest—Feb.	Maize (PANA 53 variety), millet, cassava, cowpea, *Hibiscus* spp., banana Plant—Sep.; harvest—Mar.	Maize (early-maturing varieties), cowpea, cassava Plant—Sep.; harvest—Mar.
SISHANJO (plural of lishanjo)	Sishanjo or shishango—drained seepage gardens. They describe marsh gardens on the edge of a forest or upper land. These land types are found in permanently waterlogged areas where crop cultivation is risky due to flooding. They have peat soils, which are poorly drained and difficult to till. The farming practices on sishanjo soils involve the digging of trenches around garden beds to drain mounds. The fertility of the acidic peats can be increased by burning them to raise the pH and nutrient availability.	Maize (early-maturing varieties), sweet potato, vegetables (onion, rape, tomato, pumpkin), cassava (Kapumba variety), rice Vegetables Plant—Mar.; harvest—Jul. Other crops Plant—Sep.; harvest—Jan.	Maize (early-maturing varieties), sweet potato, pumpkin, cassava (Kapumba and Nakamoya varieties) Plant—Aug.; harvest—Jan.	Maize, sweet potato, rice, vegetables (onion, tomato, rape), cassava (Kapumba, Nakamoya and Nalumino varieties), groundnut, cowpea, pineapple Rice Plant—Dec.; harvest—May All other crops Plant—Aug.; harvest—Dec.
MUSHITU	Cropped land within forest or woodland, most likely on upper land, which rarely floods, if ever. Suitable for crops that do not require a lot of soil moisture or drought-tolerant crops.	Bambara nut, cassava (Nalumino variety), maize, millet, cowpea, yam, squash, *Hibiscus* spp., sorghum Plant—Oct.; harvest—Apr.	Cassava, yam, maize, *Hibiscus* spp., millet, groundnut, cowpea Plant—Nov.; harvest—Mar.	Cassava, cowpea, maize, yam, Bambara nut, groundnut, millet, squash Plant—Oct.; harvest—Feb.
MAZULU (plural of lizulu)	These are large mound fields (made by white ants over the ages) located on raised gardens anywhere within and above the general floodplain level. They have clay and loamy soils, which are some of the best soils in the floodplain but are also exposed to risks from flooding and drought. Some of this land type is left fallow due to inaccessibility.	Maize from market Plant—Nov.; harvest—Mar.	Maize, millet, vegetables (okra, tomato), sorghum Plant—Nov.; harvest—May	Sorghum, maize, pumpkin, sweet potato, watermelon, vegetables (okra) Plant—Nov.; harvest—Mar.
MATABA	Swamp, morass, marsh and waterlogged areas where there are moderate amounts of water. Land is cultivated to rain-fed and residual moisture crops.	Not applicable	Not applicable	Not applicable
MATEMA (fields in **MUSHITU**)	These are found in the forest or woodland areas. This land type is suitable for crops that do not require a lot of soil moisture. Soil types are predominantly sandy and sometimes mixed with decaying leaves.	Cassava (early-maturing varieties) Plant—Aug.; harvest—after 2–3 years	Cassava, maize Maize Plant—Sep.; harvest—Mar. Cassava Plant—Sep.; harvest—after 2 years	Cassava, maize, cowpea, groundnut, millet Plant—Aug. (dry plant); harvest—Mar.

Land type	Land, soil and moisture characteristics	Senanga District		
		Sifuna	Nalitoya	Nembwele
LITAPA (plural of sitapa)	These fields are found in flooded waterways in the Borotse floodplain. They represent landforms on which annual flooding of the plain deposits silt and humus from vegetation and decaying aquatic plants. These deposits enrich the fertility of the land on the plains, creating fertile arable land for crop production. However, in the late-season heat, after the floods have receded, the soils harden. These high-moisture fields provide residual moisture for cropping.	Not applicable	Not applicable	Not applicable
MALAPO (plural of milapo)	Landforms along waterways. The landforms are lower than the general level of the floodplain or are bound by matongo.	Not applicable	Not applicable	Not applicable
Flooding period (start month to end month)		Jan. – May	Nov. – May	Jan. – May
Community-desired changes in use of agrobiodiversity resources to fulfill dreams and visions		Seeds: early maturity and high yielding	Seeds: withstand bad weather	Seeds: early maturity
Agrobiodiversity resources recommended for conservation, purification and restoration strategies		Maize, cassava	Maize, cassava	Maize, cassava

Land type	Land, soil and moisture characteristics	Kalabo District		
		Mapungu	Mwandi Lower	Mwandi Upper
MATONGO (plural of litongo)	Rarely flooded landforms often found either within or at the margins of the Borotse floodplain. These fields are located a few meters from homesteads. The soils are sandy and have little water retention capacity. In the upper land, matongo also describes ndamino or kitchen gardens.	Maize, sweet potato Plant—Oct.; harvest—Feb.	Cassava, groundnut Plant—Jul.; harvest—Mar.	Cassava Plant—Jun.; harvest—Mar.
MATEMA (plural of litema)	These are found in the forest or woodland areas. This land type is suitable for crops that do not require a lot of soil moisture. Soil types are predominantly sandy and sometimes mixed with decaying leaves.	Cassava, maize, groundnut, Bambara nut, cowpea, sweet potato Plant—Nov.; harvest—Mar.	Maize, cowpea, pumpkin, cassava Plant—Nov.; harvest—Apr.	Maize (local and MM 603), cowpea, cassava (Nalumino variety), rice (Supa) Plant—Nov.; harvest—Mar.
MAZULU (plural of lizulu)	These are large mound fields (made by white ants over the ages) located on raised gardens anywhere within and above the general floodplain level. They have clay and loamy soils, which are some of the best soils in the floodplain but are also exposed to risks from flooding and drought. Some of this land type is left fallow due to inaccessibility.	Maize, sweet potato, rice, groundnut, cowpea Plant—Nov.; harvest—Mar.	Maize, vegetables (tomato, pumpkins), groundnut, sweet potato Plant—Nov.; harvest—Mar.	Maize (MM 441, Pool 16), pumpkin Plant—Oct.; harvest—Mar.
MATUNDA (plural of litunda)	These land types, mostly located in the Borotse floodplain, have loamy soils and little water retention capacity.	Maize, pumpkin, groundnut, sweet potato, vegetables (tomato) Plant—Aug.; harvest—Dec.	Cassava, groundnut, Bambara nut, pumpkin, maize, cowpea Plant—Sep.; harvest—Mar.	Maize (MM 441, Pool 16, local grain), pumpkin, groundnut, sweet potato Plant—Aug.; harvest—Feb.
LITAPA (plural of sitapa)	These fields are found in flooded waterways in the Borotse floodplain. They represent landforms on which annual flooding of the plain deposits silt and humus from vegetation and decaying aquatic plants. These deposits enrich the fertility of the land on the plains, creating fertile arable land for crop production. However, in the late-season heat, after the floods have receded, the soils harden. These high-moisture fields provide residual moisture for cropping.	Maize, sweet potato, groundnut, vegetables (tomato, pumpkin, others) Plant—Sep.; harvest—Dec.	Maize, vegetables Plant—Aug.; harvest—Jan.	Maize (MM 441, Pool 16—to mature before floods), sweet potato, pumpkin, groundnut Plant—Sep.; harvest—Jan.
Community-desired changes in use of agrobiodiversity resources to fulfill dreams and visions		Need to grow drought-resistant and early-maturing varieties or hybrids (e.g. Makonga and Maelepu [for sorghum]; millet; MM 441 [maize]).	Grow early-maturing varieties; e.g. MM 441. Use irrigation pumps in gardening.	Need to grow drought-resistant and early-maturing varieties or hybrids (e.g. MM 441 for maize, Xiangzhou 5 and Nerica for rice, millet).
Agrobiodiversity resources recommended for conservation, purification and restoration strategies		Yellow maize, Kandalendale (for maize), finger millet, millet, local cowpea, sweet reeds, local sorghum, *Hibiscus* spp. (Sindambi)	Yellow maize, Makonga and Maelepu varieties (sorghum), Kapumba (cassava)	Nerica (rice), Makonga (sorghum), millet

Notes:
1. Sindambi or Mudambi is the local name for *Hibiscus* spp.
2. Floods start in December to end of September depending on location.
3. Mwandi Upper sits on an upland plain (Simunyange); therefore, upland rice is desired in view of the uncertainty of flooding in the plain. Non-photoperiodic varieties are needed for planting to shallow waters or the forest.

Land type	Land, soil and moisture characteristics	Lukulu District	
		Kapanda	Kabula
MATONGO	Rarely flooded landforms often found either within or at the margins of the Borotse floodplain. These fields are located a few meters from homesteads. The soils are sandy and have little water retention capacity. In the upper land, matongo also describes ndamino or kitchen gardens.	Groundnut (Shungumana variety), sweet potato (Makeni variety), Bambara nut, cowpea, maize (MM 441), cassava (Kapumba variety) Plant—Oct.; harvest—Apr.	Maize, cassava, sorghum, groundnut, sugarcane, *nswe*, cowpea, Bambara nut Plant—Nov.; harvest—Mar.
MUSHITU	Cropped land within forest or woodland, most likely on upper land, which rarely floods, if ever. Suitable for crops that do not require a lot of soil moisture or drought-tolerant crops.	Cassava, Bambara nut, maize (MM 603 and local varieties, which do not require a lot of moisture) Plant—Aug.; harvest—Feb. or Mar.	Cassava, sorghum, millet, maize, cowpea (runner variety not requiring moist soil), watermelon, groundnut, Bambara nut Plant—Oct.; harvest—Apr.
MAZULU (plural of lizulu)	These are large mound fields (made by white ants over the ages) located on raised gardens anywhere within and above the general floodplain level. They have clay and loamy soils, which are some of the best soils in the floodplain but are also exposed to risks from flooding and drought. Some of this land type is left fallow due to inaccessibility.	Maize (MM 603 and local varieties), sorghum, pumpkin Plant—Oct.; harvest—Mar. or Apr.	Not applicable
LITAPA	These fields are found in flooded waterways in the Borotse floodplain. They represent landforms on which annual flooding of the plain deposits silt and humus from vegetation and decaying aquatic plants. These deposits enrich the fertility of the land on the plains, creating fertile arable land for crop production. However, in the late-season heat, after the floods have receded, the soils harden. These high-moisture fields provide residual moisture for cropping.	Not applicable	Maize, pumpkin, rice (soils in Kabula are saline, hence saline-tolerant rice varieties needed), sweet potato, vegetables Plant—Sep.; harvest—Feb.
MABALA (plural of libala)	Plains may get waterlogged by floods.	Rice (Supa), maize (maturing early before floods) Plant—Oct.; harvest—May	Not applicable
MALAPO (plural of milapo)	Landforms along waterways. The landforms are lower than the general level of the floodplain or are bound by matongo.	Not applicable	Rice Plant—Nov.; harvest—Jun.
MATONGO	Rarely flooded landforms often found either within or at the margins of the Borotse floodplain. These fields are located a few meters from homesteads. The soils are sandy and have little water retention capacity. In the upper land, matongo also describes ndamino or kitchen gardens.	Groundnut (Shungumana variety), sweet potato (Makeni variety), Bambara nut, cowpea, maize (MM 441), cassava (Kapumba variety) Plant—Oct.; harvest—Mar.	Not applicable
Flooding period (start month to end month)		Jan. – Mar.	Dec. – Mar.
Community-desired changes in use of agrobiodiversity resources to fulfill dreams and visions		No response	No response
Agrobiodiversity resources recommended for conservation, purification and restoration strategies		Cassava Maize Rice	Maize—tolerant to floods and drought and must be early maturing Cassava—early maturing Rice that does not require a lot of water

APPENDIX 6. FOUR-CELL ANALYSES FOR ALL CROPS, MAIZE, RICE AND CASSAVA CULTIVARS PLANTED IN AAS FOCAL COMMUNITIES STUDIED IN WESTERN PROVINCE, ZAMBIA

Four-cell methods

1. Many households + large area (>= 0.25 ha or 1 *lima*)	2. Many households + small land area
3. Few households + large land area	4. Few households + small area (< 0.125 ha or 0.5 *lima* = 0.25 of football field)

District: Mongu	All crops Many + large	All crops Few + small	Maize Many + large	Maize Few + small	Rice Many + large	Rice Few + small	Cassava Many + large	Cassava Few + small
Village: Lealui								
Men	**Maize**	**Cassava, groundnut, sweet potato** - new crops	**Recycled grain** - cheap seed - easy seed access - early maturity	**MM 603** - expensive seed - hard to access seed - late maturity	**Supa** - high market value	**Xiangzhou 5, Kajacket** - low market demand - no aroma - get flooded	-	**Nalumino** - low market demand
Women	**Maize, rice, tomato, rape, okra, eggplant** - staple (maize) - market value (rice, vegetables)	**Onion, sorghum, beans, pepper, carrot, Irish potatoes** - lack of knowledge (onions, pepper, carrot, Irish potatoes) - high labor for bird scaring (sorghum)	**MM 441 recycled** - cheap seed - early maturity	**Local variety** - late maturity - not adapted to Barotse floodplain system	**Supa** - source of income	**Kajacket, Xiangzhou 5, Angola** - hard to access seed - not adapted to Barotse floodplain system	-	**Kapumba** - not adapted to Barotse floodplain system - pest attack - lack of cuttings
Youth	**Maize, rice, rape, cabbage, tomato** - staple - source of income	**Sweet potatoes, *impwa*, okra, eggplant, wheat, carrot, green pepper, beans** - new crops - limited non-flooded land - lack of production knowledge	**MM 441, Pool 16 recycled** - cheap seed - drought tolerant - adapted to the floodplain (MM 441)	**Local maize** - late maturity	**Supa** - high market value - does well in Barotse floodplain system	**Kajacket, Angola, Blue bonnet** - low market demand	-	**Nalumino** - no cuttings
Village: Situlu								
Men	**Maize, rice**	**Sorghum, groundnut** - disappearing crops, high labor demand for bird scaring (sorghum)	**MM 441, Pool 16 (recycled)** - cheap seed - easy seed access	**Pool 16, MM 603** - expensive seed - not adapted to Barotse floodplain system	**Supa** - high market value - tasty - aroma - adapted to Barotse floodplain system	**Xiangzhou 5, Blue bonnet, Angola** - hard to access seed - not adapted to Barotse floodplain system	-	-
Women	**Maize, rice** - staple - source of income	**Sweet potato, rape, tomato, okra, onion, pumpkin, cabbage, *sindambi*, watermelon** - expensive seed	**MM 441 recycled** - cheap seed - easy seed access	**Kandalendale, Munali, Simikata, MRI 521** - lack of seed (Kandalendale, Simikata) - late maturity (Munali) - low market demand	**Supa** - high market value - taste, aroma	**Kajacket, Angola, Xiangzhou 5, Blue bonnet** - low market demand - not adapted to the floodplain	-	-
Youth	**Maize, rice** - source of income (rice, maize) - staple (maize)	**Banana, cassava** - lack of suitable arable lands not affected by flood	**Grain (recycled)** - easy seed access - cheap seed	**Popcorn, yellow maize** - snack food	**Supa** - source of income	**Blue bonnet, Angola, Nerica, ITTA 212, Burma, Malawi faya** - low market demand - new variety - hard to access seed	**Mutembo** - adapted - good flour	**Kapumba, Nakamoya** - snack food - poor flour - lack of cuttings
Village: Nanikelako								
Men	**Maize, rice, sweet potato**	**Watermelon, pumpkin, vegetables**	**MM 441 (recycled)** - cheap seed - early maturing	**MM 441** - expensive seed	**Supa** - high market value - adapted to the floodplain - staple	**Nerica** - new variety	**Nalumino** - staple - adapted to the floodplain	**Nakamoya** - snack food - lack of cuttings
Women	**Maize, rice, cassava, sweet potato** - staple - source of income (rice)	**Pumpkin, sweet reeds, watermelon**	**MM 441 (recycled)** - cheap seed - early maturity	**Pool 16** - low yield - not adapted to Barotse floodplain system	**Supa** - high market value - adapted to Barotse floodplain system	**Xiangzhou 5, Kajacket** - low market value - hard to access seed	**Nalumino** - early maturity - high market value - good food quality	**Kapumba, Nakamoya** - lack of cuttings
Youth	**Maize, rice, sweet potato** - staple - source of income - good taste (maize)	**Tomato, vegetables** - damaged by floods - short shelf life - require chemicals - require irrigation	**MM 441 (recycled)** - cheap seed - easy seed access - early maturity	**Pool 16** - early maturity - not adapted to Barotse floodplain system	**Supa** - source of income - aroma - good taste - high market value	**Angola, Burma** - staple - hard to access seed - low market value	**Nalumino** - adapted to Barotse floodplain system - staple - drought resistant	**Nakamoya** - not adapted to Barotse floodplain system - poor tuber storage

APPENDIX 6

District: Kalabo	All crops Many + large	All crops Few + small	Maize Many + large	Maize Few + small	Rice Many + large	Rice Few + small	Cassava Many + large	Cassava Few + small
Village: Mapungu								
Men	**Maize recycled, Sicikwele** - easy seed access	**Bambara nut, vegetables, sorghum, millet, cowpea** - late maturity (cowpea) - bird menace (millet and sorghum) - low market demand (cowpea)	**MM 441, MM 603** - early maturity (MM 441) - high yielding (MM 603)	**Yellow maize** - late maturity	**Supa** - high market value - aroma - tasty	**Xiangzhou 5, Kajacket** - high labor demand for bird scaring - hard to access seed	**Nalumino** - easy cuttings access - adapted to Barotse floodplain system - high yielding	**Kapumba** - no cuttings - low yielding - not adapted to Barotse floodplain system
Women	**Rice, maize, groundnuts, sweet potato** - staple	**Cabbage, local beans** - pest attack - expensive seed - require irrigation	**MM 441, MM 603** - early maturity (MM 441) - high yielding (MM 603)	**Yellow maize, popcorn, Pool 16** - hard to access seed (popcorn) - low yielding (Pool 16) - late maturity (yellow maize)	**Supa** - high market value - tasty	**Xiangzhou 5, Burma, Blue bonnet** - lack of market - staple	**Nalumino** - easy cuttings access - high yielding	**Nakamoya, Kapumba, Kapulanga, Mutembo** - no cuttings - low yielding (Kapumba)
Youth	**Maize, cassava** - staple - adapted to Barotse floodplain system (cassava)	**Vegetables, Bambara nuts** - expensive seed	**MM 441, MM 603 (recycled)** - adapted to Barotse floodplain system - easy seed access - cheap seed	**Pool 16** - expensive seed - hard to access seed - low yielding	**Supa** - source of income - easy seed access	**Xiangzhou 5, Kajacket, Burma, Blue bonnet** - hard to access seed - low market demand - low prices - no aroma	**Nalumino** - easy cuttings access - high yielding - adapted to Barotse floodplain system - low theft due to bitter taste	**Kapumba, Nakamoya, Mutembo, Litale, Butiki, Busele** - no cuttings - require more moist soils than Nalumino
Village: Mwandi Lower								
Men	**Maize**	**Groundnut, sweet potato, vegetables, *impwa*, tomato**	**Recycled grain** - easy seed access - cheap seed	**Pool 16** - expensive seed	-	-	-	-
Women	**Maize, cassava** - staples - source of income	**Cabbage, onion, *impwa*, *delele*, eggplant, Chinese cabbage** - pest and diseases - expensive seed	**Recycled grain** - taller than Pool 16, which gets submerged in flooded areas	**Pool 16** - expensive seed - not adapted to Barotse floodplain system (too short)	-	-	**Nalumino** - staple - high yielding - resistant to mealybug	**Nakamoya, Mutembo, Kapumba, Butiki, Namunji** - no cuttings - bitter (Butiki)
Youth	**Maize** - staple - source of income	**Groundnut, Bambara nut, sweet potato** - lack of seed access - expensive seed - low market demand - grown for relish	**Recycled grain** - cheap seed	**Pool 16** - expensive seed	-	-	**Nalumino, Butiki** - staple - high yielding - resistant to mealybug	**Kapumba, Mutembo, Nakamoya** - no cuttings
Village: Mwandi Upper								
Men	**MM 441 (recycled)** - early maturity - drought resistant	**Millet, sorghum, vegetables** - lack of seed access (millet and sorghum) - high labor for bird scaring - limited production skills - expensive pesticides (vegetables)	**MM 441 (recycled)** - early maturity	**Pool 16** - expensive seed	**Supa** - high market value - staple	**Xiangzhou 5** - low market demand	**Nalumino** - adapted to Barotse floodplain system - easy access to cuttings - high yielding	**Kapumba, Nakamoya** - not adapted to Barotse floodplain system
Women	**Maize, rice, cassava, groundnut** - staple - grown for relish	**Bambara nut, Bulrush millet, sorghum** - hard to access seed	**MM 441 (recycled)** - adapted to Barotse floodplain system	**Kandalendale** - low market demand	**Supa** - high market value - grain whole when milled	**Kajacket, Angola, Xiangzhou 5** - low market demand - hard to access seed	**Nalumino** - early maturity - staple - high yielding	**Kapumba, Butiki, Mutembo** - no cuttings - pest attack - disease attack
Youth	**Rice, maize, cassava** - high yielding - high market value - staple	**Sweet potato, vegetables** - hard to access seed - require chemicals - damaged by floods	**Recycled grain** - cheap seed	**Pool 16** - expensive seed - low yielding	**Supa** - high market value	**Xiangzhou 5** - low market demand - grains break	**Nalumino** - high market value - staple	**Kapumba, Mutembo, Nakamoya, Butiki** - no cuttings - snack food

APPENDIX 6

District: Senanga	All crops Many + large	All crops Few + small	Maize Many + large	Maize Few + small	Rice Many + large	Rice Few + small	Cassava Many + large	Cassava Few + small
Village: Sifuna								
Men	**Cassava, maize** - staple - source of income	**Groundnut, cowpea, Bambara nut, Livingstone yam, rice (Xiangzhou 5)** - hard to access seeds - pops in groundnut	**Recycled grain, market grain**	**PANA 53, hybrids**	**Supa**	**Black rice** - new variety **Kajacket, Burma, Angola** - eaten by birds	**Nalumino**	**Kapumba** - lack of cuttings **Nakamoya** - tastiness vulnerable to theft
Women	**Cassava, maize** - staple	**Rice, sweet potato, tomato, pumpkin** - need money for seed	**Recycled** - cheap seed	**Munali** - late maturity **MM 441, MM 521** - need money for seed - expensive seed	**Supa** - high market value - tasty - good *buhobe*	**Burma** - low market demand	**Nalumino** - drought resistant - pest and disease resistant - bitter taste prevents theft	**Litale, Kapumba, Nakamoya** - tastiness vulnerable to theft - lack of cuttings
Youth	**Cassava** - low external input - long harvest period - multiple food uses	**Rice, sorghum, cowpea, Bambara nut** - lack of inputs - limited land **Millet** - bird damage **Vegetables** - waterlogged	**Recycled grain** - easy seed access	**MM 441, Pool 16, hybrids** - expensive seed	**Supa** - high market value - aroma - taste	**Kajacket** - new cultivar - hard to access seeds	**Nalumino** - staple - adapted to Barotse floodplain system soils - easy cuttings access	**Mutembo, Kapumba, Mbambi** - snack food - suited to moist plain edges - lack of cuttings
Village: Nalitoya								
Men	**Cassava, maize** - cheap seed - easy cuttings access - staple	**Tobacco, Bambara nut, sorghum, millet** **Groundnut** - pops in groundnut	**MM 441, PANA 53** - market grain	**Local maize**	**Supa**	**Angola, Blue bonnet**	**Nalumino**	**Kapumba, Litale, Nakamoya**
Women	**Rice, maize, cassava** - staple	**Bambara nut, cowpea, groundnut** - low market demand **Sorghum** - bird menace	**Recycled maize, PANA 53, MM 441** - cheap seed	**PANA 53** - hard to access seed **Mokola** - late maturity **MM 441, Munali** - displaced by hybrids	**Supa** - taste - high market value	**Burma, Karjacket** - low market demand **Blue bonnet** - hard to access seed	**Nalumino** - pest and disease resistant - high yield - bitter taste prevents theft	**Litale, Bangweulu, Kakota, Nakamoya, Portuguese** - lack of cuttings **Kapumba** - susceptible to mealybug
Youth	**Cassava, rice, maize** - staple - income source - good yields	**Vegetables, sorghum, millet, Bambara nut, cowpea, sugarcane** - limited suitable land - low market demand - low productivity	**Local maize** - easy seed access	**PANA 53, MM 441** - seeds expensive - hard to access seeds	**Supa** - easy seed access - high market demand - adapted to flooded areas	**Burma, Xiangzhou 5, Blue bonnet, Angola** - hard to access seeds - low market demand	**Nalumino** - staple - high market value - easy cuttings access - adapted to Barotse floodplain system soils	**Nakamoya, Bangweulu, Kapumba, Mutembo** - snack food - lack of cuttings
Village: Nembwele								
Men	**Rice, cassava**	**Millet, sorghum** - bird menace **Bambara nuts** - hard to access seeds	**Recycled grain, hybrids**	**PANA 53**	**Supa**	**Blue bonnet, Kajacket Xiangzhou 5, P 13, Nerica**	**Nalumino**	**Chila, Bangweulu, Kapulanga, Portuguese**
Women	**Maize, rice, cassava** - staple	**Tomato, cabbage, onion, pepper** - new crops - pests and disease menace	**Recycled grain** - cheap recycled seed **PANA 53** - high yield	**MM 441, SC 627, MMV 400** - low yield **Munali** - late maturity	**Supa** - high market value - aroma - taste	**Malawi faya, Blue bonnet, Kajacket** - hard to access seed	**Nalumino** - drought resistant - high yields	**Bangweulu** - lack of cuttings
Youth	**Rice, maize, cassava** - high market value - staple - adapted to Barotse floodplain system soils - easy access to seed - easy cuttings access	**Sugarcane, banana, Bambara nut, cowpea** - limited land, for relish, lack of chemicals	**Local maize, MM 603** - early-maturity hybrid - easy seed access - high yield - good-quality grains	**Popcorn, yellow maize, *simikata*** - hard to access seed - limited land - low market demand	**Supa** - aroma - high market value - milled whole grain	**Burma, Angola, Kajacket, Xiangzhou 5, Blue bonnet** - low market price - hard to access seed - no aroma - poor taste	**Nalumino** - staple - source of income - adapted to Barotse floodplain system soils - high yield - easy cuttings access	**Kapumba, Nakamoya, Kapulanga** - lack of cuttings

APPENDIX 6

District: Lukulu	All crops Many + large	All crops Few + small	Maize Many + large	Maize Few + small	Rice Many + large	Rice Few + small	Cassava Many + large	Cassava Few + small
Village: Kapanda								
Men	**Maize, cassava** - staple - high yield **Maize** - early maturity **Cassava** - long storability	**Cabbage, sorghum, millet, Bambara nut, *hibiscus*, *delele*** **Cowpea** - hard to access seed **Millet, sorghum** - pest attack - low market demand **Bambara nut, *hibiscus*, *delele*** - low use	**Market grain, MM 604**	**Munali, Kandalendale** - late maturity **Hybrids** - expensive seed	**Supa** - high yield - high market value - aroma	**Burma, Blue bonnet** - low market demand - hard to access seed	**Nalumino** - staple	**Litale, Tumbangezhi, Bangweulu, Portuguese, Rabbecca, Lingoma, Nakamoya** - lack of cuttings
Women	**Maize, cassava** - staple - high market value - low labor needs	**Sorghum** - hard to access seed **Pepper, onion** - low market demand **Cabbage** - no irrigation facility	**MM 603, MM 604** - high yield, medium maturity	**MM 441, yellow maize, other locals** - low yield - late maturity	**Supa** - high yield - high market value - aroma	**Xiangzhou 5, Burma, Angola, Kajacket, Blue bonnet** - low market demand - hard to access seed	**Nalumino** - high yield - drought tolerant	**Tumbangeshi Bangweulu, Portuguese, Rabbecca, Lingoma, Nakamoya** - new variety
Youth	**Cassava, maize, rice** - staple - adapted to Barotse floodplain system soils - easy seed access - easy cuttings access	**Cowpea, Bambara nut, Irish potato, sorghum** - difficult to grow - hard to access seed	**Local grain** - easy seed access - does well with limited fertilizer	**Yellow, Kandalendale, PANA 53** - late maturity - low yield	**Supa** - high market value - easy seed access - taste - big grain	**Kajacket, Blue bonnet** - new variety - hard to access seed - low market demand (Blue bonnet)	**Nalumino** - easy cuttings access - recycling cuttings - tubers store well	**Lingoma, Rabbecca** - lack of cuttings - new variety **Nakamoya** - snack food
Village: Kabula								
Men	**Maize, cassava**	**Millet** **Tobacco** - low soil fertility and low production **Vegetables** - pest attack **Bambara nut** - labor constraint - low yield - low market demand	**Market grain**	**Mumbali (lost), Munali, Kandalendale, hybrid**	**Supa** - high market value - easy seed access - taste - big grain	**Kajacket** - hard to access seed **Blue bonnet** - low market demand	**Nalumino** - easy cuttings access	**Lingoma, Nakamoya, Rabbecca**
Women	**Maize, cassava** - staple	**Sorghum, groundnut, Bambara nut, sweet potato** - hard seed access	**Recycled grain** - cheap	**MM 603, MM 604** - expensive seed **Local yellow, Kandalendale** - long maturity **MM 441** - low yield	**Supa** - high market value	**Burma, Angola, Blue bonnet, Xiangzhou 5** - lack of animal draft power to cultivate large fields	**Nalumino** - staple	**Litale, Mutembo, Kapumba, Nyengo** - no cuttings
Youth	**Maize, cassava** - staple - high market value - adapted to Barotse floodplain system soils	**Vegetables, groundnut, sorghum, millet, cowpea, sweet potato, Bambara nut** - hard seed access - limited fields - bird menace - lack of production knowledge	**90-day local** - cheap seed - adapted to Barotse floodplain system soils	**Yellow maize** - hard seed access	**Supa** - high market value - easy seed access - taste - aroma	**Blue bonnet, Burma, Angola** - hard seed access - low market demand	**Nalumino, Litale** - staple - easy cuttings access - high market demand	**Mutembo, Makamwengo** - no cuttings - labor constraint

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