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Cassava Commercialization in Mozambique

by

Cynthia Donovan, Steven Haggblade, Venâncio Alexandre Salegua, Constantino Cuambe, João Mudema, and Alda Tomo

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Department of Agricultural, Food, and Resource Economics
Department of Economics
MICHIGAN STATE UNIVERSITY
East Lansing, Michigan 48824

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Donovan and Haggblade are professors, International Development, Department of Agricultural, Food, and Resource Economics, Michigan State University, Salegua and Cuambe are researchers, at Northeastern Zonal Center, IIAM, and Tomo and Mudema are researchers at the Center for Socioeconomic Studies, IIAM.

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EXECUTIVE SUMMARY

Cassava supplies roughly 30% of all calories consumed in Mozambique, making it the country's most important food security crop. Over the past several decades, growing urbanization and shifting demand patterns have led to growing opportunities for cassava processing and commercialization. This paper examines the commercial dynamics in Mozambique's cassava value chain as well as the food security implications of growing cassava commercialization.

The study is based on detailed farm-household survey data as well as qualitative field interviews with value chain participants in northern and southern Mozambique.

In northern Mozambique, cassava commercialization centers on trade in dried flour, while in the south a prepared cassava-based convenience food called *rale* accounts for the bulk of marketed cassava. Given cassava's high productivity per unit of land and labor, cassava prices in Mozambique's northern cassava belt average about 55% of the cost of wheat and 60% of the cost of maize. This cost advantage underpins considerable commercial opportunities for cassava-based foods, feeds, and starches. As a result, an array of private firms is currently experimenting with cassava-based biofuels, composite flour baked goods, cassava beer, and packaged prepared foods using cassava roots and leaves.

Because cassava is a perennial crop, farm households can store cassava roots in the ground for multiple years, adjusting harvests as required to ensure household food security during times of cereal shortfalls. Marketed volumes of cassava also increase during drought years, when maize harvests falter, enabling urban households to substitute cassava for maize during lean years. Because cassava commercialization in Mozambique remains in its formative stages, strategic investment in a set of key public goods (breeding, training in food sciences and food safety, and research on in-ground cassava storage) can help to shape this transition in ways that benefit both commercial interests and the food security of vulnerable households.

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ACRONYMS

ADAF-SF	National Association for the Development of Agriculture and Livestock- Family Sector/*Associação Nacional de DesenvolvimentoAgro-pecuário do sector familiar*
CLUSA	Cooperative League of the USA
Agro.GES	*Sociedade de Estudos e Projectos* (Consulting firm)
CAP	National Agricultural and Livestock Census
CDM	Beers of Mozambique/*Cerveijas de Mocambique*
DE	Directorate of Economics
DNC	National Department of Trade
DNSA	National Directorate of Agricultural Services
DPIC	Directorate of Commerce and Industry
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agricultural Organization Online Statistical Database
HCN	Hydrocyanic Acid
IAF IOF	Household Budget and Expenditure Surveys
IIAM	Mozambican National Institute of Agricultural Research/ *Instituto de Investigação Agrária de Moçambique*
IITA	International Institute of Tropical Agriculture
INE	National Statistics Institute
INIA	National Institute of Agronomic Research/*Instituto Nacional de Investigação Agronómica*
MPD	Ministry of Planning and Development
MSU	Michigan State University
MT	Metric Tons
NGOs	Non-governmental Organizations
SIMA	Agricultural Market Information System/*Sistema de Informação de Mercados Agrícolas*)
TIA	National survey of smallholder agriculture/*Trabalho do Inquérito Agrícola*
USAID	United States Agency for International Development

1. INTRODUCTION

1.1. Objectives

Cassava supplies roughly 30% of all calories consumed in Mozambique, making it the country's most important food staple (FAOSTAT 2011). Although production data vary across years and over time, comparisons of available data series suggest that cassava production surpasses maize, the country's number two food staple, by about 50%.[1] In addition to its large caloric contribution, cassava offers critical food security benefits. Its drought tolerance, coupled with its flexible planting and harvest schedule, make cassava a reliable food security crop, particularly during low rainfall years.

Cassava production in Mozambique has grown steadily over the past 40 years, though more slowly than population, particularly since the outbreak of cassava brown streak virus disease in the mid-2000s (Figure 1). Over this period, rapid urbanization has contributed to dietary diversification as well as increasing demand for processed convenience foods. As a result, wheat- and rice-based foods have assumed increasing importance in national diets. Today, they account for nearly 20% of calories consumed.

Growing urbanization leads to growing opportunities for cassava processing and commercialization. At the same time, increasing demand for prepared and convenience foods increases pressure to develop food products, processing technology, and packaging that will match the food demands of growing urban markets. These shifting demand patterns, together with production pressure from plant diseases, raise concerns about possible erosion in cassava's capacity to continue its role as Mozambique's primary food safety net.

This paper focuses on two fundamental features of cassava commercialization. First, it examines key commercial opportunities in Mozambique's cassava value chain. In doing so, the paper evaluates existing commercial activity, market dynamics, key players, critical constraints, and emerging commercial opportunities for cassava value chain development. Second, the paper examines the food security implications of growing cassava production and commercialization in Mozambique.

1.2. Methods

This paper incorporates a mix of quantitative analysis, primarily using national survey data, with more qualitative key informant interviews with value chain participants. Estimates of broad national production aggregates change over time, and geographic differences in production and food consumption come from a variety of national household surveys. The national survey of smallholder agriculture (TIA) conducted by the Ministry of Agriculture enables regional estimates of cassava production and sales while the National Agricultural and Livestock Census (CAP) of 2009/2010 provides estimates of area and numbers of producing households. The household budget and expenditure surveys (IAF and IOF) provide a detailed breakdown of rural and urban consumption patterns within Mozambique. Important specialist surveys of cassava production and marketing by the Food and Agriculture Organization (FAO) and Mozambican National Institute of Agricultural Research furnish valuable supplementary information as does prior work on cassava value chain by

[1] See, for example, the various production data series in Table 1, below, as well as the consumption data in Table 3.

Mozambique's cassava task force (Agro.GES and Austral Consulting 2007; Pimentel et al. 2010; Zacarias, Cuambe, and Maleia 2004; Zacarias, Cuambe, and Damba. 2005; Cuambe et al. 2008).

Key informant interviews with value chain participants have enabled the authors to identify key cassava-based commercial products and processing technologies, trace out major supply channels, and gain insights into value chain dynamics and key driving forces.[2] Because of very different food consumption patterns in northern and southern Mozambique, two waves of field work proved necessary, with one team focusing on southern Mozambique (below the Zambezi River) and another focusing on northern Mozambique.

In northern Mozambique, fieldwork concentrated on the three most populous provinces of Nampula, Zambézia, and Cabo Delgado. To capture the pronounced seasonality of cassava marketing, consumption, and production, the team conducted field visits at three different times of the year, in November 2009, February 2010, and August 2010. To capture the spatial dimensions of product flows, the team visited 20 market centers and assembly points throughout the region. They visited major consumption markets ranging from Moçambique de Praia in the north to Nampula in the center and on to Quelimane in the southern part of the region. The working paper by Salegua, Donovan, and Haggblade (2011) provides full details on the activities and findings of the northern value chain team.

In southern Mozambique, field visits focused on the province of Inhambane, the city of Inharrime, epi-center of cassava processing and trade in the south. The bulk of cassava processing takes place there, where a small army of individual women and a handful of semi-industrial enterprises transform cassava into *rale*, a fermented, pre-cooked convenience similar to West African gari. The southern team visited five districts along the southern Mozambique coast, between Inharrime and Maputo, including major cities of Inhambane, Maxixe, and Maputo. To capture the seasonality of processing and commercial activity, the team conducted three separate field visits, in November 2009, February 2010, and June 2010. The working paper by Mudema, Tomo, and Donovan (2011) details the findings of the southern study team.

A wide range of support institutions provided details on various facets of cassava production and commercialization in Mozambique. Breeders at IIAM and the International Institute of Tropical Agriculture (IITA) elaborated on important properties of Mozambique's major cassava varieties, current disease problems and seed distribution systems. Key NGOs working with cassava include Save the Children, Associação Nacional de Desenvolvimento Agro-pecuário do Sector Familiar (ADAF-SF) and the Cooperative League of the USA (CLUSA). Discussions with their field personnel offered insights into current production, consumption, and disease control efforts in Mozambique. Faculty members at Eduardo Mondlane University, who have been working actively on cassava processing technologies and nutritional issues, provided helpful insights into cassava processing technologies, opportunities, constraints, and trajectories.

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[2] The interview guides in Annex A provided a framework for discussion with marketing agents, processors, farmers and field staff working on cassava promotion efforts.

1.3. Structure of the Report

Section 2 of this report begins by looking at cassava production aggregates over time, across seasons and at the striking spatial differences in the prevalence of cassava production. The next section looks at cassava consumption, identifying key products prepared for human consumption, livestock feeds, and industrial uses. Section 4 traces out the supply chains linking farmers with final consumers of cassava-based products. This chapter addresses the first major objective of the paper, by exploring existing and future opportunities for cassava commercialization. Section 5 explores the food security implications of cassava commercialization, the second major theme addressed in this paper. The remainder of the paper examines policies, opportunities, and constraints to further commercial developments in Mozambique's cassava value chain.

2. PRODUCTION

2.1. Levels

Production data used in national food balance sheets suggest that Mozambique's cassava farmers supply the country's largest single source of calories, accounting for about 30% to total national calorie intake (FAOSTAT 2011). According to the recent National Agricultural Census 2009/2010, roughly 2.3 million small and medium-scale farms, out of the country's 3.8 million total, produce all of the cassava consumed in Mozambique (INE 2011).

Yet national cassava production remains notoriously difficult to quantify with precision, in Mozambique and elsewhere in Africa. In addition to the normal logistic problems associated with estimating output from large numbers of scattered, small farms, cassava poses special difficulties. Unlike annual food crops, which farmers harvest during a single period at the end of the rainy season, cassava is a perennial crop harvested over a much longer time, often over multiple years. Most farmers harvest cassava in small lots over many months. Indeed some harvest occurs throughout the year. Depending on the variety and location, cassava matures over a period of eight months to three years. As a result, most cassava farmers grow a portfolio of cassava plots of differing varieties and maturities. Therefore, total cropped area at any given point in time includes a wide range of maturities, potential yields, and prospective carry-over capacity.

Based on authority given by the National Statistics Institute (INE), Mozambique's Ministry of Agriculture conducts several national surveys that enable estimation of national crop production. In between the decennial censuses of agriculture and livestock (the CAP), the Ministry's Directorate of Agricultural Services (DNSA) conducts an annual crop forecast survey (the Aviso Prévio) to estimate annual farm production. The Aviso Prévio uses district extension officers to estimate cropped areas and then to conduct crop cuts in selected farmers' fields to estimate average yields in each region. They then estimate total production as area times yield. In addition, in most years since 2002, a second department within the Ministry, the Directorate of Economics (DE), has conducted a national agricultural household sample survey (the TIA survey). The TIA survey gathers in-depth information on farm household demographics, cropping patterns, input use, production, marketing, and non-farm activities of farm households. The TIA survey estimates crop production based on farmer recall of area planted and quantities harvested. In the case of root crops, they ask farmers about monthly harvesting levels (high, medium and zero) and average harvesting during each of these three seasons. DE then converts these monthly estimates into an annual total production quantity of fresh roots and tubers.

Because the two survey methods and sample frames differ, so do the resulting national production estimates (Table 1). In most years, the TIA survey has produced lower estimates of national cassava production, although in 2007 the two surveys produced virtually identical estimates of 5 million tons of fresh roots. On average, during the second half of the 2000's, estimated cassava production has ranged between five and six million tons of fresh cassava annually, equivalent to two million tons of cereal-equivalent dry weight.

Table 1. Alternate Estimates of Staple Food Production in Mozambique

Data Sources	2002	2004	2005	2006	2007	2008	2010
Cassava production (million metric tons, fresh weight)							
Ministry of Agriculture Crop Forecast Survey (AP)	5.9	6.4	6.5	6.7	5.0	5.4	9.7
FAOSTAT	5.9	6.4	6.5	6.7	5.0	5.4	n.a.
National Household Post-Harvest Survey (TIA)	3.4	n.a.	4.8	5.5	5.0	3.8	n.a.
TIA/AP (percent)	58%		74%	82%	98%	71%	
Maize production (million tons, dry weight)							
AP	1.2	1.1	0.9	1.4	1.2	1.3	1.7
FAOSTAT	1.1	1.1	0.9	1.4	1.2	1.3	n.a.
TIA	1.1	n.a.	0.9	1.4	1.1	1.2	n.a.
TIA/AP	90%		100%	98%	98%	94%	

Sources: FAOSTAT, Aviso Prévio (unpublished data), TIA.

Despite differences in Aviso Prévio and TIA cassava production totals for any given year, the two series trace out broadly similar production trajectories. The following section explores these general movements in cassava production over time using the only long-term series available in Mozambique, the Aviso Prévio, which is in turn adopted by the FAO in their FAOSTAT series (Table 1).

2.2. Trends

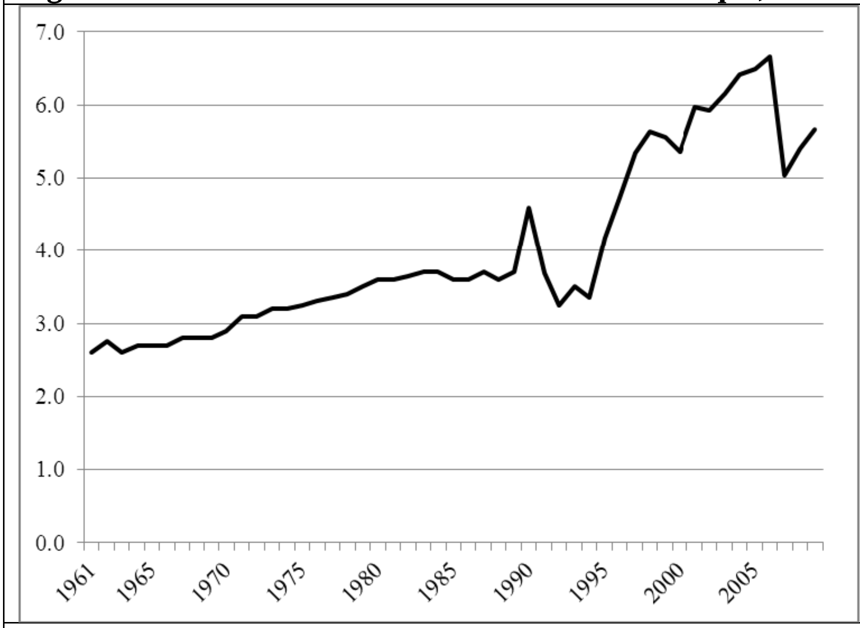
Cassava production in Mozambique appears to have grown at about 1.8% per year over past 50 years (Figure 1a). Because population has grown slightly faster, at about 2.2% per year over that same period, per capita cassava production has gradually declined. Between the early 1960's and 2006, per capita production fell from about 350 kilograms per year to about 300 (Fig 1b).

A severe outbreak of cassava brown streak virus, beginning in the late 1990s, dampened cassava production over the ensuing decade, particularly along the northern coast (McSween et al. 2006; Walker 2010). The subsequent testing and release of tolerant varieties by IIAM and distribution of improved cuttings by a variety of NGOs has helped to stabilize the situation. Since, 2006 an upward growth trajectory appears to have resumed (Figure 1).

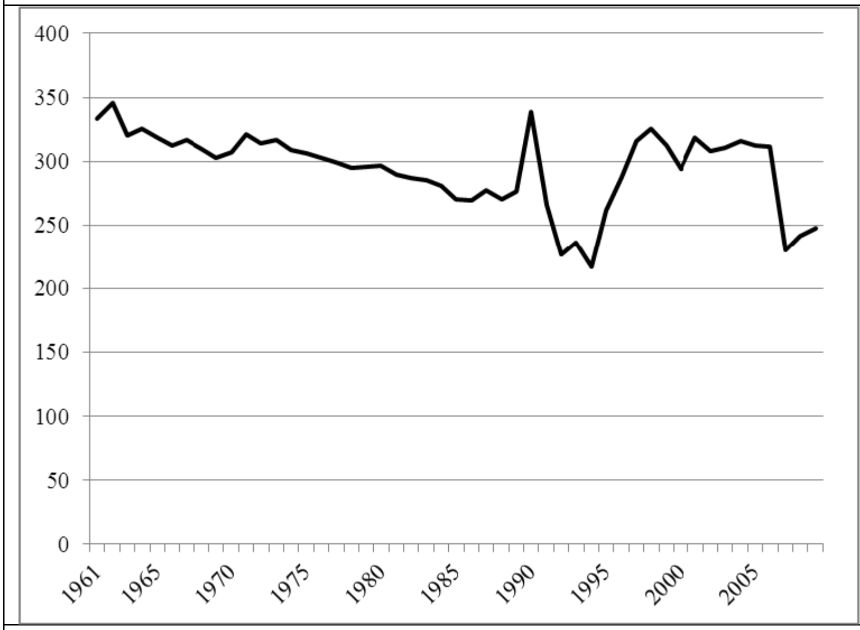
2.3. Cultivation Practices

Mozambican farmers grow over 100 different varieties of cassava, including a wide array of both bitter and sweet varieties. The bitter varieties, though high in hydrogen cyanide content, typically predominate because of their high yield, multiple-year in-ground storage potential, and pest tolerance. Farmers particularly appreciate their resistance to human pests! Even though they require greater care in processing, bitter varieties account for the bulk of national cassava production. Sweet varieties that are lower in hydrogen cyanide and mostly consumed fresh account for a smaller proportion of cassava produced.

Figure 1. Cassava Production Trends in Mozambique, 1961-2009



a. Total Production (Millions of Tons of Fresh Cassava per Year)



b. Per Capita Production (kg/person)

Source: FAOSTAT.

Using marketed volumes as a rough proxy for total cassava production suggests that bitter varieties account for about 90% of national cassava production in Mozambique, with sweet varieties accounting for about 10% (TIA 2005).[3]

[3] A proliferation of local names for individual cassava varieties makes it very difficult to obtain national estimates of varietal use based on farmer recall. For that reason, the TIA survey does not include information on cassava varieties planted.

A study by Walker et al. (2010) found increasing adoption of sweet varieties (especially Nikwaha) tolerant to cassava brown streak disease in the northern coastal regions, so this ratio may be shifting over time.

Most cassava farmers intercrop cassava with other food crops (beans, groundnuts or maize) in the first year of production. In some long-duration cropping cycles, they prune back their cassava at the start of the second year to increase plant longevity and permit intercropping during the second rainy season.

Because cassava is a vegetatively propagated crop, many farmers retain a small reserve field of cassava. It serves, simultaneously, as a source of cuttings for planting and as a reserve supply of food during crisis time.

2.4. Seasonality

Cassava offers an unusually flexible planting and harvesting calendar. Farmers can harvest cassava year-round and over a period of up to three years for some varieties. However, because water content and root quality varies seasonally, farmers typically harvest the bulk of their crop in specific seasons. With bitter varieties, they harvest the greatest volumes at the end of the rainy season (between June and October), after 12 to 24 months in the ground, to enable processing and sun drying during the long dry season (Table 2). With sweet varieties, farmers in northern Mozambique harvest mostly towards the middle and end of the rainy season, during the peak lean season months before the maize harvest when cereal supplies are in shortest supply and their prices peak. In southern Mozambique, farmers generally begin harvesting sweet varieties towards the end of rainy season (May and June) to benefit from high prices, while bitter varieties are harvested after the rains to permit processing into rale.

Cassava planting offers similar seasonal flexibility. Although agronomists recommend planting at the beginning of the rainy season, in November and December, most farmers devote this peak-planting season to cereals and cash crops, which offer little tolerance for late planting. Cassava likewise establishes best when planted in November and December. However, unlike other crops, cassava can accommodate a broader range of planting dates and still produce a viable crop.

In northern Mozambique, cassava farmers typically plant in one of two broad time frames. The first involves planting late in the dry season, starting in August and going through October (Table 2, A cycles). This schedule enables farmers to plant in relay, after their prior harvest and thus to use planting material from the previous harvest. Under this planting cycle, farmers can harvest after 12, 18, or 24 months depending on their family food needs and on market prices for substitute crops. The second common planting schedule involves early- to mid-rainy season planting, mostly after cereal and cash crops have been planted (Table 2, B cycles). Under this planting cycle, farmers require vegetative planting material from reserve plots or from long-term storage of cuttings from the prior harvest.

Table 2. Cassava Planting and Harvesting Calendars in Mozambique

	Year 1								Year 2												Year 3												Cycle duration
cycle	May	J	J	A	S	O	N	D	Jan	F	M	A	M	J	J	A	S	O	N	D	Jan	F	M	A	M	J	J	A	S	O	N	D	(months in ground)
North																																	
A1				P	P	P										HD																	12
A2				P	P	P																	HF										18
A3				P	P	P													prune									HD					24
B1							p	p	P	P	p	p											HF										15
B2							p	p	P	P	p	p																HD					20
South																																	
C1		P	P	P	P	p	p	p	HF																								6
C2	P	P	P	P	P	p	p	p						HD/HF																			10-12
C3	P	P	P	P	P	p	p	p										prune								J HD							24-30

P: main planting months
p: other common planting months
HD: harvest and dry chips for milling into flour
HF: harvest fresh roots

Source: Salegua, Donovan, and Haggblade (2011); Mudema, Tomo, and Donovan (2011).

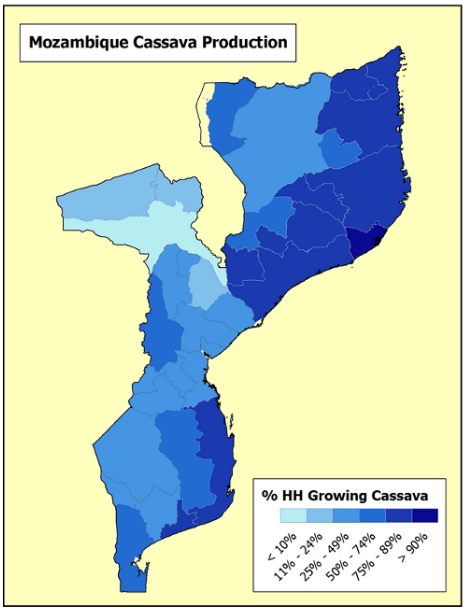
In southern Mozambique, most farmers plant at the tail end of the rainy season, starting in May (Table 2, C cycles). This enables the cassava cuttings to root sufficiently to survive the long dry season and thus begin rapid vegetative growth with the first rains in November. Depending on the variety planted, farmers can harvest early, at 6-8 months, or more commonly at one year or 24-30 months after planting.

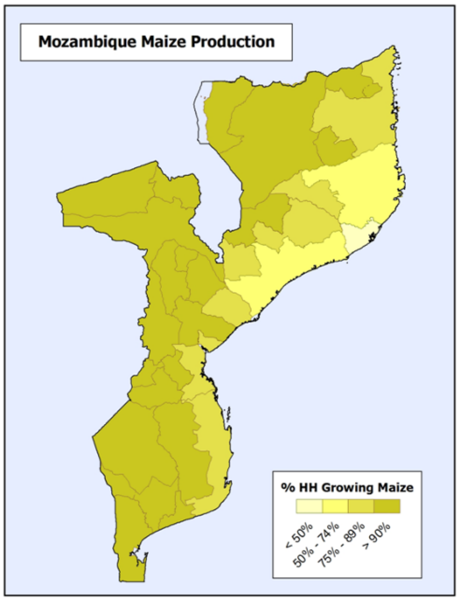
2.5. Spatial Distribution across Food Staple Zones

Cassava production is concentrated geographically in northern Mozambique and along the southern coast (Figure 2). Maize, the country's second most important staple, tends to predominate in the interior and southern zones. In many rural areas, production of these two main staples coincides, with farm families growing both. These dual staple zones predominate in northern Mozambique where the heaviest concentration of rural population lies (Figure 3).As a result, northern Mozambique accounts for 85% of Mozambique's cassava production. In particular, the provinces of Zambezia and Nampula dominate as suppliers of cassava (Figure 4).

These spatial differences in food staple production stem from differences in climate, ethnicity, historical trade flows, and tastes. They result in differing consumption and marketing patterns in northern and southern Mozambique, as the following sections reveal.

Figure 2. Food Staple Production in Mozambique





Source: TIA data as reported in Haggblade and Nielsen (2007).

Figure 3. Population Density in Mozambique

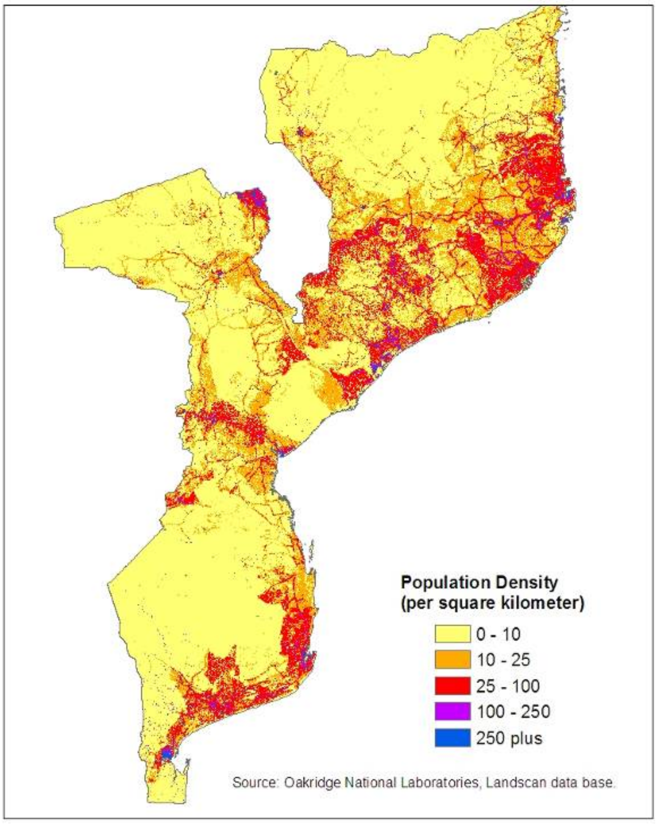
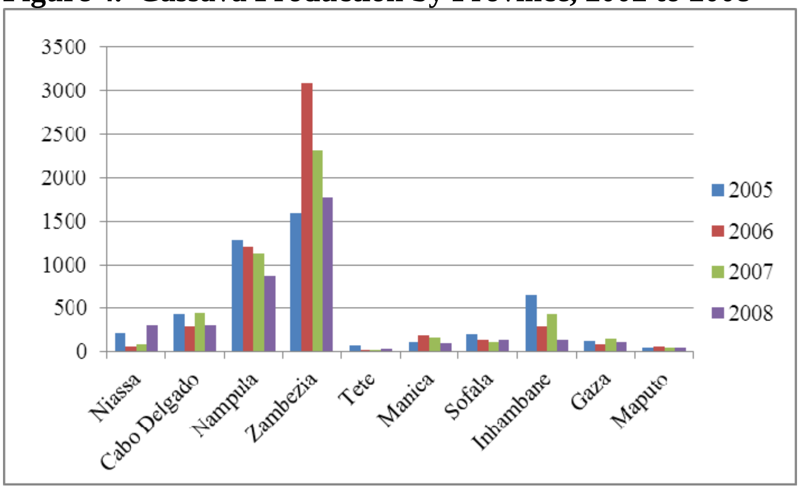


Figure 4. Cassava Production by Province, 2002 to 2008



Source: TIA surveys.

3. CONSUMPTION

3.1. Aggregate Shares

Human foods account for the vast majority of total cassava utilization in Mozambique. Estimates from the national food balance sheets put human consumption at 94% of total cassava utilization (FAOSTAT 2011). Animal feeds account for about 4% and industrial users the remaining 2%%, although this appears likely to change in the coming years. The following discussion examines each of these three categories in turn.

Among food staples, cassava provides the largest single source of calories in Mozambique. However, that share is gradually eroding as urbanization, changing tastes and preferences for prepared, convenience foods increase. Over the past 45 years, cassava's share in food consumption has fallen from 46% of national calorie availability in the early 1960's to 30% in the late 2000's (Table 3). Sorghum and millet similarly have likewise declined, while maize has held roughly constant at a 20% share. Imported wheat and rice have grown most rapidly, nearly 20% of calorie consumption. Sweet potato consumption has also increased, in recent years accounting for 5% of national calorie consumption.

3.2. Human Foods

3.2.1. Cassava Flour

Cassava flour accounts for about 90% of cassava consumption in Mozambique. Farm household survey data on the composition of cassava products sold by farm households (Table 4) and national household consumption data from both rural and urban areas (Table 5) bracket cassava flour consumption at between 87% and 94% of household cassava consumption.

Table 3. Trends in Staple Food Consumption in Mozambique

Commodity	Calorie share			
	1961	1980	2000	2007
Cassava	46%	41%	34%	30%
Maize	19%	15%	26%	20%
Rice	4%	5%	5%	10%
Wheat	2%	6%	5%	9%
Sweet potatoes	0%	0%	3%	5%
Other cereals	9%	6%	5%	3%
Other foods	19%	25%	23%	24%
Total	100%	100%	100%	100%

Source: FAOSTAT Food Balance Sheets.

Table 4. Regional Differences in Cassava Products Sold by Farm Households

	Composition of Cassava Products Sold by Farm Households				
Region	fresh roots	dry roots	rale	flour	total
North	1%	99%	0%	0%	100%
Center	58%	39%	3%	0%	100%
South	33%	0%	67%	0%	100%
National average	3%	94%	3%	0%	100%

Source: TIA Survey 2008.

Table 5. Rural and Urban Consumption of Cassava Products in Mozambique

Location	Cassava Consumption (person/year)	Share of Total Consumption				
		Fresh Cassava	Porridge flour	Porridge dried	Rale	Total
Value of consumption	(US dollars)					
North	$49	12%	74%	14%	0%	100%
Central	$2	55%	41%	4%	0%	100%
South	$12	76%	2%	2%	19%	100%
National						
rural	$35	17%	68%	13%	2%	100%
urban	$13	29%	58%	10%	2%	100%
total	$28	19%	67%	13%	2%	100%
Quantity consumed	(Kg)					
North	155	8%	71%	21%	0%	40%
Central	3	60%	31%	9%	0%	0%
South	19	74%	2%	5%	19%	0%
National						
rural	110	12%	65%	22%	1%	0%
urban	32	16%	69%	13%	2%	7%
total	85	12%	67%	20%	1%	44%

Source: Mozambique Household Budget and Expenditure Survey (IOF) 2008/09.

Consumers prepare cassava porridge by bringing water to a boil, adding cassava flour and then stirring as the starches solubilize to produce a viscous, stiff porridge. In many of Mozambique's dual-staple zones, consumers combine maize and cassava flour together. Because maize flour requires a longer cooking time, households first cook the maize flour until it becomes thick and then add the cassava flour at the end to produce a composite flour porridge. Seasonally, as maize availability and pricing vary, households adjust the mixture to accommodate taste preferences and available budgets.

Given high levels of cyanogenic glycosides in most bitter varieties of cassava, processing becomes important for dissipating potential hydrocyanic acid (HCN) and ensuring human food safety (Rosling 1986; Tivana et al. 2009; Zvauya et al. 2002). For this reason, farmers process their cassava in one of two ways after peeling and cutting the large roots into smaller pieces. Some ferment the peeled cassava roots by piling them in heaps and covering them for four to five days before drying them in the sun. Fermentation reduces HNC content by about 90% and raises protein content slightly, from 1.3% to 1.8% (Tivana et al. 2007). Alternatively, farmers may simply peel the cassava roots and then leave them to dry in the sun for up to two months. Sun drying, though less effective in removing cyanide content, requires less labor. Most farmers store their cassava as dried roots and chips and then mill the cassava into flour as required for home use.

3.2.2. Fresh Cassava Roots

Fresh cassava roots account for roughly 10% of total cassava consumed in Mozambique. However, this share rises considerably in central and southern Mozambique, where fresh roots account for the majority of quantities consumed (Table 5). Sweet varieties, with low levels of cyanogenic glycosides, are required for fresh consumption. Typically, households peel and boil the fresh roots before eating. Consumers can also eat them raw.

3.2.3. Rale

In southern Mozambique, households consume about 20% of their cassava in the form of rale, a fermented, precooked convenience food similar to West African gari (Table 5, Figure 5). Inhambane Province constitutes the center of rale production in Mozambique.

Preparation of rale begins with peeling and washing the roots. The processors, primarily women, then grate the roots, pour off excess water, and place them in bags to ferment for four to five days. They then squeeze out the water using heavy stones or screw presses. After pressing, they toast the fermented cassava flakes on contoured wok-like cooking trays before screening and packing for storage or sale. Most processing takes places on an artisanal level in individual households, although a handful of semi-industrial processing businesses have emerged to process and package rale for sale in urban supermarkets (Figure 6).

3.2.4. Cassava Leaves

Most households in the cassava belt and in dual-staple zones of Mozambique eat cassava leaves. High in protein and vitamins, they offer a prized source of greens to be used in sauces and relishes (Nassar and Marques 2006). Households often combine cassava leaves with groundnuts or onions in preparing stews and sauces that accompany maize or cassava porridge. Widespread marketing of cassava leaves enables both rural and urban households consume substantial quantities of cassava leaves. At least one processing firm in Nampula is experimenting with production of packaged cassava leaf powder and frozen cassava leaves (Promar 2011).

Figure 5. Cassava Products

a. Fresh roots

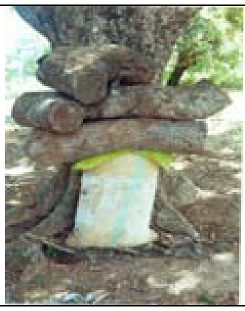
c. Rale

b. Cassava flour (right)

d. Cassava cheese bread mix

Source: Authors' photographs.

Indeed, the official poverty consumption baskets for northern Mozambique include cassava leaves as an explicit food expenditure item. Depending on the location, cassava leaves account for 3-6% of food expenditures among low-income households (MPD 2010). Looking across all households groups and locations, our analysis of the 2008 household expenditure data for northern Mozambique indicate that the value of cassava leaves consumed averages 4% of food expenditure among the bottom quintile of northern households. That share falls across quintiles, reaching 1% among the top expenditure quintile. These data suggest widespread consumption of cassava leaves among both rural and urban households in northern Mozambique.

Figure 6. Rale Processing	
Household Production	Semi-Industrial Firms
	
a. Grating	
	
b. Pressing	
	
c. Toasting	
	
d. Retailing	

Source: Authors' photographs.

3.2.5. Oteka

Traditionally, many households produce a cassava-based home-brewed beer called oteka. They begin with malting sorghum by soaking and allowing it to germinate for several days, then milling the sprouts, which contain diastatic enzymes. They then cook cassava flour to form a thin starchy porridge. The addition of sorghum malt helps to break down the starches into sugars which wild yeasts subsequently convert to alcohol. Many households use the oteka as a reward for work parties.

Quantities are difficult to estimate. Some rapid appraisals suggest that as much as 15-20% of cassava harvested may go to oteka during heavy work seasons. Yet national consumption surveys fail to measure significant overall volumes.

3.2.6. Composite Flour Breads

With the collaboration of university researchers, some bakeries have experimented with production of composite flour breads by blending wheat flour with up to 25% cassava flour. Taste panels suggest that 10% mixture results in bread of acceptable texture and taste (Figure 7). Given that cassava flour sells for roughly half of the cost of wheat flour in most northern markets, cassava-for-wheat-flour substitution offers prospects for modest cost savings in low-cost bread and baked goods. In fact, the governor of Nampula Province mandated that bread prepared with composite flours that partially substitute cassava for wheat flour should be sold for a lower price than 100% wheat flour breads. In the south, the relatively high cost of cassava makes this alternative less attractive, at least in the greater Maputo urban area.

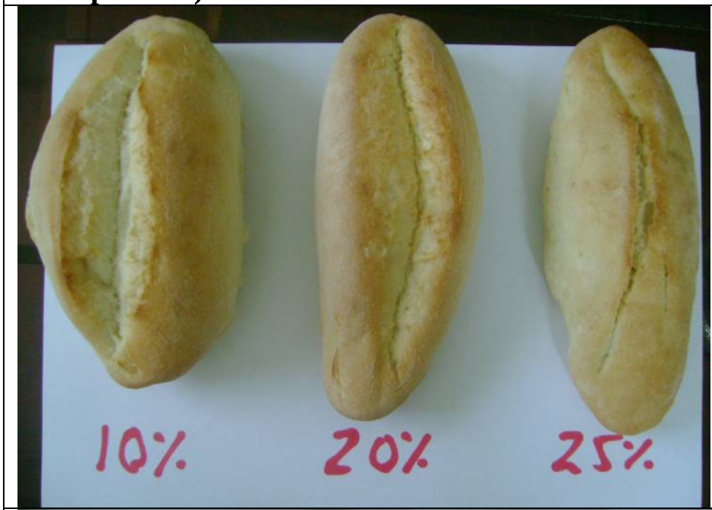
3.2.7. Other Cassava-based Convenience Foods

Packaged, prepared cassava-based convenience foods are available in some supermarkets, particularly in Maputo. Urban retailers sell imported package mixes for cassava cheese puffs, cassava crisps, high quality cassava flour, and rale (Figure 5).

3.3. Livestock Feeds

While important in some African countries, cassava-based livestock feeds are seldom used in Mozambique. Food balance sheets estimate only 4% of total cassava utilization as livestock feed. In part, this small feedstock ration results from low levels of animal traction in Mozambique and consequently small cattle herds in the agricultural production zones. In addition, the growing urban poultry industry currently relies primarily on maize-soya feeds, with little experimentation in formulating feeds that incorporate cassava as an alternate source of carbohydrates.

Figure 7. Composite Flour Bread (Percentages Refer to % of Cassava Flour Incorporated)



Source: Salegua, Donovan, and Haggblade (2011).

3.4. Industrial Processing

In Mozambique, embryonic industrial processing of cassava remains focused primarily on two trial product lines. The first involves cassava-based ethanol production. Figure 8 shows the 30,000-liter stainless steel cookers and distiller being installed at an ethanol plant north of Mocuba, Mozambique. The factory owners have planted 50 hectares of cassava to supply the plant. Early trials resulted in large losses from hand peeling, so the plant managers are considering tropical sugar beets as a possible alternative starch source. Final products produced from this plant will include distilled alcohol and fuel gel. A second large-scale processing plant is being built in Sofala Province to produce cassava-based ethanol and kerosene for home fuel use.

Figure 8. Ethanol Plant under Construction, Mocuba Mozambique

Source: Authors' photographs.

A second industrial product line revolves around production of cassava-based clear beer. Currently, Cerveijas de Mocambique (CDM) is testing cassava beer production at its Nampula brewery and in December 2011 launched Impala Beer for the northern markets. Its parent company, South African Breweries, has successfully marketed a cassava-based clear beer in Uganda. Given plentiful cassava supplies and taste preferences in northern Mozambique, they believe a similar product may also prove viable in Mozambique.

4. COMMERCIALIZATION

4.1. Marketed Volumes

In recent years, Mozambican farmers have marketed about 11% of total cassava production compared to 16% to 18% of their maize crop (Table 6). Regionally, this figure varies considerably.

Northern farmers not only produce more cassava per household than other regions, they also sell a greater proportion. They sell 13% of their cassava crop compared to only 3% to 4% marketed by farms in central and southern Mozambique. During the 2005 drought year, northern farmers sold a greater proportion of their maize than other regions, although during the normal rainfall year of 2008 they and the central farms sold 20% of maize produced. These data suggest that northern farmers are the most commercial maize and cassava farmers in Mozambique.

Higher per capita cassava production in northern Mozambique, coupled with a higher propensity to market cassava there, results in the region's dominant cassava market share. Farmers in northern Mozambique account for 85% of national cassava production and for over 90% of marketed volumes (Table 7). For that reason, discussion below begins by exploring the structure and dynamics of cassava commercialization in the north.

Table 6. Per Capita Staple Food Production and Sales, by Region

	Production (kg per hh)		Sales/Production	
	cassava*	maize	cassava	maize
2005				
North	606	237	13%	18%
Center	204	566	4%	15%
South	485	113	3%	6%
National	502	281	11%	16%
2008				
North	554	255	12%	20%
Center	111	588	3%	20%
South	172	198	6%	5%
National	380	326	11%	18%

Source: TIA 2005 and 2008.
* Cassava quantities computed in calorie-equivalent dry weight, 1 kg fresh = 0.35 kg dry.

Table 7. Staple Food Production and Marketing, by Region in 2008

	Cassava*		Maize	
Region	production	sales	production	sales
Quantity (thousand tons)				
North	1,208	141	556	109
Center	100	3	531	104
South	110	7	127	7
National total	1,418	151	1,214	220
Percentage				
North	85%	94%	46%	50%
Center	7%	2%	44%	47%
South	8%	5%	10%	3%
National total	100%	100%	100%	100%

Source: TIA 2008.
* Cassava quantities given in dry weight.

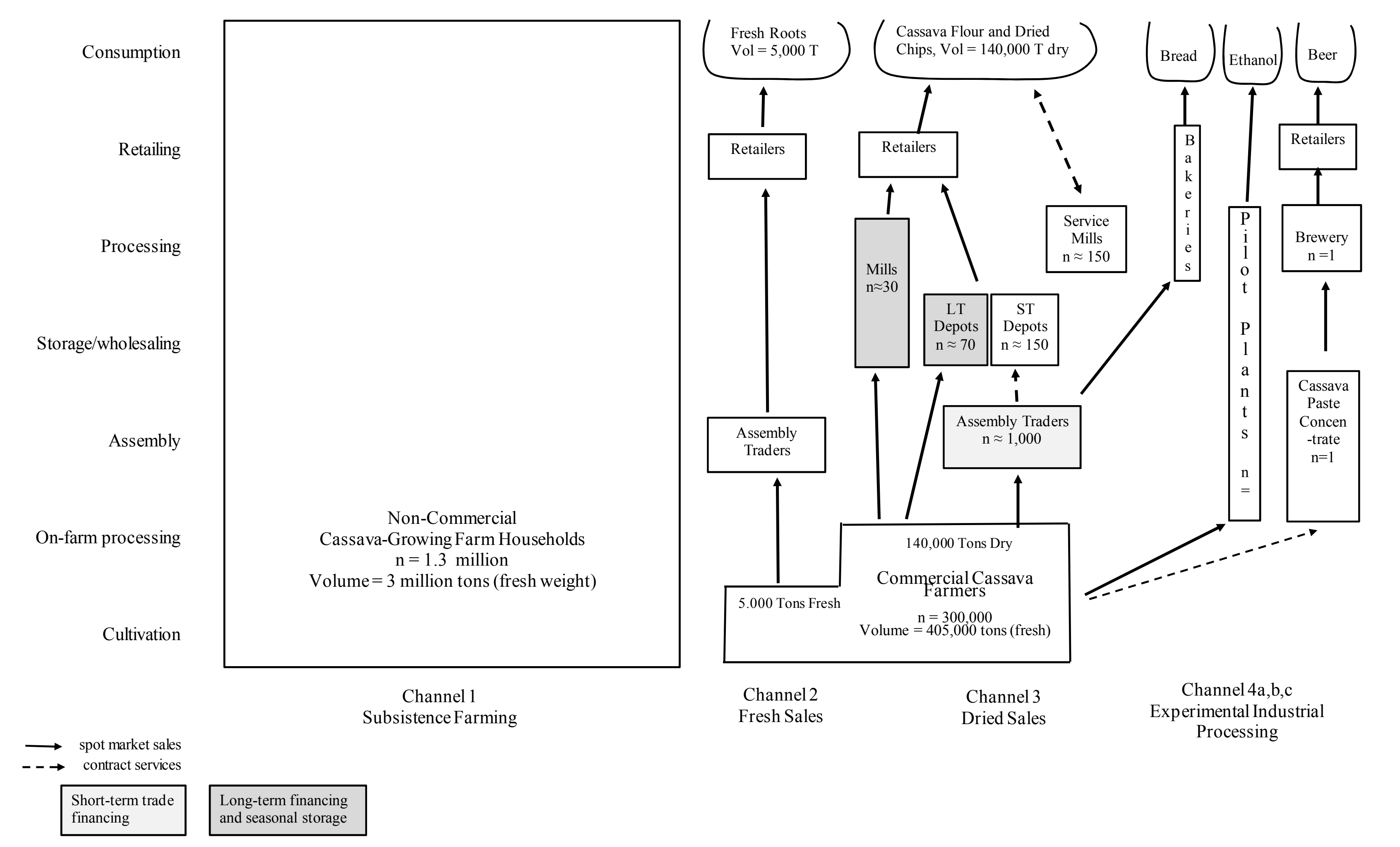
4.2. Northern Mozambique

4.2.1. Structure

Three major channels supply cassava to final consumers in Northern Mozambique (Figure 9). Over 85% of the region's cassava remains on subsistence households, in Channel 1. On average, these 1.3 million farm households manage 0.5 hectares of cassava, of differing maturities, and harvest 2.2 tons of fresh cassava per household per year. They harvest in small lots throughout the year for family consumption. During the dry season, they harvest extra that they dry for on-farm seasonal storage. These dried roots provide the family with cassava flour during the rainy season, when cereal crops are scarce, food prices spike and rainy weather prevents sun drying of their cassava.

Channel 2, the marketing of fresh roots, accounts for only 0.1% of total cassava production and about 1% of marketed volumes in Northern Mozambique (Table 4 and Figure 9, Channel 2). A loose network of itinerant traders purchases fresh cassava roots on farms and at roadside assembly points in surplus rural zones (Figure 10). They pack the fresh roots in 25-kilogram cereal bags topping them off with a large chapeau (a hat) which brings the filled weight closer to 45 kilograms. Fresh cassava tends to pass through few hands, since it must move quickly from farm to table to avoid losing quality. Farmers sell to itinerant traders who transport the cassava to urban markets. They, in turn, sell to retailers who sell to consumers, usually all within 24 to 48 hours after harvesting.

Figure 9. Northern Mozambique Cassava Value Chain, 2010



Source: Salegua, Donovan, and Haggblade (2011).

Figure 10. Fresh Cassava Marketing in Northern Mozambique

a. Assembly trader waiting for transport

b. Loading the fresh cassava bags

c. Transport over unpaved roads

d. Off-loading fresh cassava at Nampula train station

Source: Authors' photographs.

Because of the heavy labor involved in carting water-laden fresh roots, young men dominate assembly trading in this supply chain. They transport a handful of bags of fresh cassava from assembly points to major urban markets, mostly by truck and bus but also occasionally by train (Figure 10). Retailers, mostly women, purchase individual bags in terminal markets for sale in urban market places or as sidewalk hawkers.

In Channel 3, the remaining 10% to 15% of regional cassava production is marketed as dried roots and flour (Figure 9). About 300,000 small farms produce cassava for sale in northern Mozambique. On average, they farm larger plots (about 0.75 ha per household), produce more cassava (about 3.5 tons fresh weight) and sell more than the non-commercial farms. They sell about 45% of the cassava they harvest as well as 30% of their maize production (Table 8). Cassava harvesting for sale takes place primarily during the dry season, after the farmers have harvested their annual crops. During this the slack agricultural season, family labor is available and sun drying is feasible. This makes the months of August, September, and October the heaviest months for cassava harvesting and on-farm processing (Table 11). On-farm processing involves peeling, sometimes followed by fermentation in the shade for 4-5 days, and always followed by long-term sun drying on raised platforms or on the ground. Farms that do not ferment their cassava sun dry their roots for up to two months to volatilize hydrogen cyanide.

Table 8. Characteristics of Commercial and Subsistence Cassava-Growing Households

Cassava farm category	Household size	Area Cultivated (ha/capita)			Harvest (kg/capita)		Sales/Production	
		cassava	maize	all crops	cassava	maize	cassava	maize
North								
subsistence	4.8	0.12	0.08	0.36	482	51	0%	18%
commercial	4.6	0.16	0.08	0.42	755	50	45%	30%
all cassava growers	4.7	0.12	0.08	0.37	532	51	12%	20%
Central								
subsistence	6.4	0.03	0.14	0.34	311	103	0%	10%
commercial	6.8	0.03	0.15	0.36	477	182	9%	33%
all cassava growers	6.5	0.03	0.14	0.34	348	120	3%	18%
South								
subsistence	5.6	0.08	0.11	0.33	165	36	0%	5%
commercial	6.2	0.12	0.09	0.39	516	49	18%	20%
all cassava growers	5.6	0.09	0.11	0.33	205	38	5%	7%
National total								
subsistence	5.0	0.10	0.09	0.35	412	52	0%	15%
commercial	5.0	0.14	0.09	0.41	703	62	40%	30%
all cassava growers	5.0	0.11	0.09	0.36	463	54	11%	18%

Source: TIA 2008. Commercial farmers are those who participate in marketing at least a portion of their cassava production.

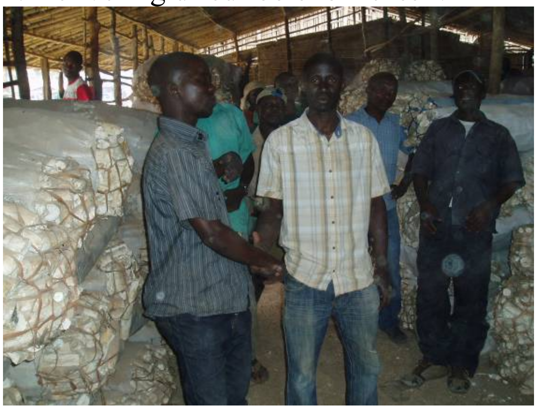
After drying their cassava roots and chips, farmers bag them. They retain some on farm for consumption during the rainy season, when maize prices spike and cereals become scarce. They sell the remainder to a large network of itinerant buyers who come to their farms or to rural assembly markets. Given large seasonal prices swings, some farmers retain commercial stocks on farm for later sales during the rainy season when prices are highest. However, most sell during the dry season, when roads are easily passable in order to earn cash required for school fees and farm inputs for the coming planting season.

As a result, most commercial storage of dried cassava roots takes place in depots and warehouses clustered at major crossroads leading out of the surplus zones or on the fringes of large urban markets (Figure 11). A small but influential group of perhaps a hundred long-term storage depots, some attached to cassava flour mills, engages in long-term seasonal storage of dried cassava roots. They provide the major source of financing for the cassava trade. In return, they earn the often considerable gains from spatial price arbitrage and from seasonal storage. Price swings of roughly 100% between the dry season lows and the rainy season highs three to eight months later, make seasonal storage the most profitable segment of the cassava value chain (see the shaded boxes in Figure 9).

Figure 11. Seasonal Storage of Dried Cassava in Northern Mozambique

a. Delivering dried roots to a cassava mill

b. Cassava flour bagged for storage



c. Short-term cassava storage depot

d. Seasonal storage of dried cassava

Source: Authors’ photographs.

Dried cassava generally passes through more market intermediaries and more complex marketing chains than fresh cassava does (Figure 9, Channel 3). Because dried cassava can store for 6 to 10 months, it generally transits longer distances as well. A large network of small scale traders compete to execute rapid purchase and sales transactions, mostly completed within one to two weeks. Cassava flour, the form in which households ultimately consume dried cassava, relies on several sets of additional market intermediaries. In some cases, retailers buy dried cassava at the wholesale markets, then go to one of the small nearby service mills to have the flour ground, and return to their stalls and sell the flour directly to consumers. In other instances, households will purchase dried cassava chips and then pay to have them milled at local service mills. Very few of the small mills purchase dried cassava to mill into flour for sale. Instead, they function primarily as service mills.

Alongside the three large existing commercial cassava market channels, a handful of firms have begun to experiment with several sets of new cassava-based products. The first involves the bakery industry and recent experiments described above with composite flour cassava-wheat flour breads (Figure 9, Channel 4a).

In addition, several large investors are experimenting with commercial cassava-based ethanol products in northern Mozambique (Figure 9, Channel 4b). As mentioned previously, a South African company has set up a distillery north of Mocuba to produce spirits, ethanol and fuel gel (Figure 8). They have planted 50 hectares of cassava for their initial trials as well as smaller plots of tropical sugar beets. Future trials will determine which proves more viable. A second company has set up a similar cassava-based ethanol plant in the town of Dondo in Sofala province. Designed by the Beira-based company Clean Star Mozambique Ltd, the new plant will use cassava-based ethanol to produce kerosene for use in domestic lighting. The Dondo factory expects to become operational in March 2012 (Diário de Moçambique 2011).

Finally, CDM is experimenting with a cassava-based clear beer to supplement its offerings in the Mozambican market. They are working with a private sector investor with experience processing cassava in Nigeria. This contractor has commissioned 50 hectares of cassava for use as planting material using selected varieties from IIAM. In addition, the firm has contracted with smallholder farmers in Nampula Province for production of another 100 hectares of cassava for processing using these same varieties. Using a mobile production facility, the firm will process raw cassava roots into a paste in order to reduce water content prior to shipping. They will then sell the concentrated cassava paste to the beer company for starch conversion and fermentation into beer. Testing over the next two years will provide the experience necessary for evaluating the commercial viability of this cassava development effort (Figure 9, Channel 4c).

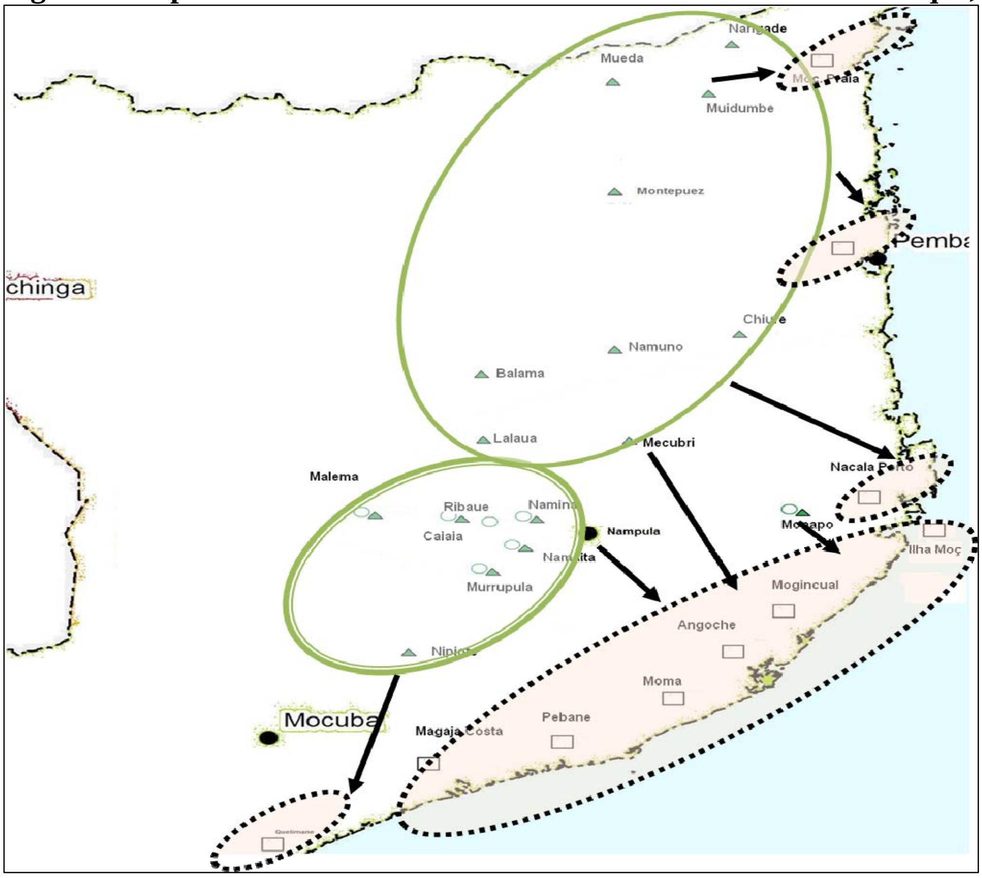
4.2.2. Spatial Flows

Commercial cassava flows trace out distinct spatial patterns across northern Mozambique (Figure 12). Surplus cassava production zones lie in the interior plateau area where better soils, more reliable rainfall, and lower disease prevalence favor cassava production, along with a wide variety of other food and cash crops. As a result, major collection centers operate in and around Ribaue, Morrupula, Monapo, Namuno, Nangade, Muidumbe, Mueda, Chiure, Montepuez, and Balama. Given large consumer preference for cassava flour in the coastal markets, most flows of dried cassava move from the interior to various market clusters along the coast. Major coastal markets include Nacala Porto, Angoche, Pebane, Quelimane, Maganja da Costa, Moma, Mogincual, Ilha de Moçambique, Pemba, and Mocimboa da Praia.

On a typical supply route, from the surplus interior zones to Nampula and then on to the coastal market in Nacala, the wholesale price of a 50-kilogram bag of dried cassava roughly doubles over a 200 kilometer distance, from about 160 MT/bag in Namina to 350 MT/bag in Nacala port (Table 9). Although fresh cassava typically transits shorter distances, the urban consumer prices often reaches 2 to 2.5 times the producer price, due to the heavy transport costs for this bulky commodity.

Several dozen large-scale clusters of storage depots occur at strategic crossroads linking surplus zones with major arteries to the coastal markets, including substantial supplies that pass through markets in Nampula City (see Figure 12). From these vantage points, traders monitor prices in the major coastal markets in order to determine where to route their stocks and when. They pay close attention to maize harvest in both Mozambique and Malawi, since major maize-trading links with southern Malawi strongly influence maize and cassava prices in northern Mozambique.

Figure 12. Spatial Flows of Marketed Cassava in Northern Mozambique, 2010



Source: Salegua, Donovan, and Haggblade 2011.

▲= fresh cassava surplus production zone

O = dried cassava surplus zone

□= deficit zones

Table 9. Spatial Differences in Dried Cassava Price (MT/bag)

	Price of a 50-kg bag (MT/bag)		
	rainy season	dry season	average
Coastal city market			
Nacala	450	250	350
Inland wholesale market			
Nampula	320	220	270
Interior supply zone			
Namina	190	140	160

Source: Salegua, Donovan, and Haggblade 2011, Table 3.1.

4.2.3. Seasonality

Large seasonal swings in the availability of alternate food staples and their prices generate distinct seasonal shifts in consumption. After the cereal harvest, in May, June and July, when maize prices are lowest, consumers eat large quantities of maize. As stocks dwindle and cereal prices rise, households in northern Mozambique shift an increasing proportion of consumption to fresh cassava and cassava porridge. Many combine cassava with maize and simply shift the composition over time as maize becomes scarce. From August through February, cassava flour becomes an increasingly important component of northern diets. During the worst of the lean season, in March and April, when cereal prices reach their seasonal peak and when fresh cassava is the only food crop available for harvest, the fresh cassava market peaks (Table 10).

Harvesting follows a similar seasonal pattern. About 10% of farm households harvest throughout the year. A small surge in fresh harvest for sale occurs during the March/April lean season. The large spike in on farm activity occurs during the dry season when, after the cereal and cash crop harvest, commercial cassava farmers harvest, process, and dry the bulk of their commercial cassava chips for market (Table 11).

Table 10. Consumption Seasonality of Staple Foods in Northern Mozambique

	Months (Cropping Year)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Fresh cassava	-	-	-	-	-	X	X	-	-	-	-	-
Cassava flour	X	X	X	X	X	-	-	-	-	-	X	X
Maize	-	-	-	-	-	-	-	X	X	X	-	-

Source: Salegua, Donovan, and Haggblade (2011).

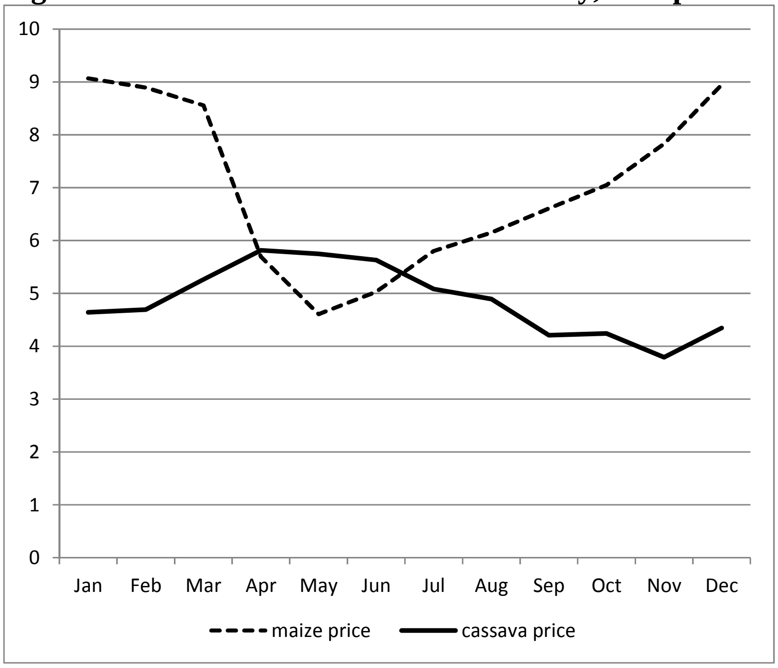
Table 11. Seasonality of Cassava Harvest in Mozambique

	Percent of Growing Households Harvesting Cassva											
cassava harvest	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
North												
large	1	1	1	2	2	7	18	51	60	42	14	3
small	8	7	8	13	21	30	36	24	17	25	26	15
zero	91	92	91	86	77	63	47	25	23	33	59	81
Center												
large	3	3	4	8	15	26	27	32	26	21	8	3
small	13	13	15	18	22	27	28	25	29	26	27	20
zero	84	84	80	74	63	47	45	43	45	53	65	77
South												
large	5	6	9	14	24	40	42	38	26	18	12	7
small	24	26	29	37	37	29	31	34	34	34	30	26
zero	71	69	62	49	39	31	27	28	40	48	58	67
National total												
large	2	2	3	5	8	15	23	47	50	36	13	4
small	11	11	13	18	24	30	34	26	21	27	27	18
zero	87	87	84	78	69	55	43	27	28	38	60	78

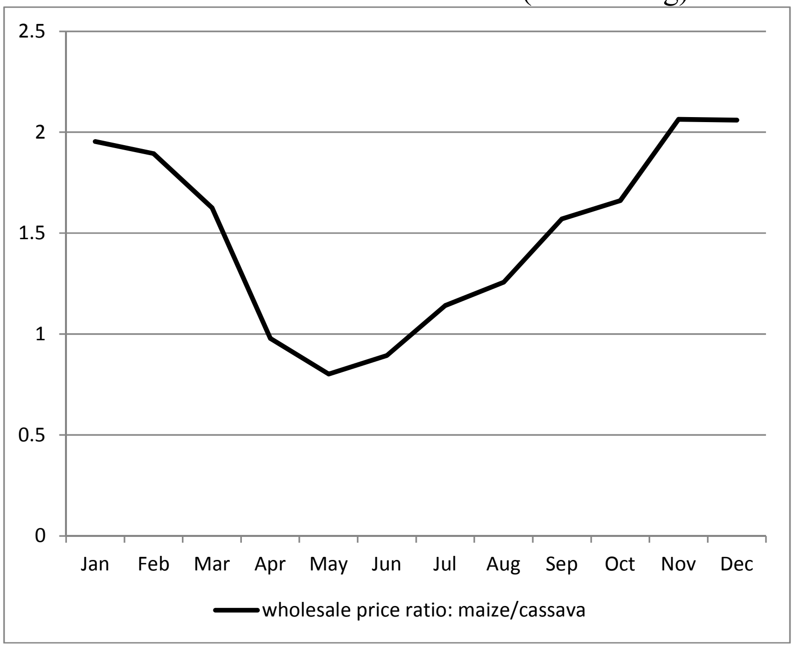
over 40% of households harvesting
20 to 40% of households harvesting
Source: TIA Survey 2005.

Analysis of the database of the Agricultural Marketing Information System database (SIMA 2011) demonstrates that cassava prices peak during the lean season months of April and May, just before the cereal harvest when maize availability is lowest and hunger becomes more acute (Figure 13a). During these months, on farm stocks of dried cassava become scarce and drying impossible due to the rains. Maize prices exhibit different seasonality as well as more pronounced seasonal price movements (Figure 13a). As a result, relative prices vary substantially over the year. During the maize harvesting months of months of May and June, when maize prices bottom out, wholesale maize grain becomes slightly cheaper than dried cassava. However, as maize prices rise during the dry season, the wholesale maize prices increases to 50% and ultimately 100% higher than the wholesale dried cassava price (Figure 13b). This motivates seasonal food substitution by consumers (Table 10).

Figure 13. Real Wholesale Price Seasonality, Nampula Mozambique 1999-2010 Averages



a. Dried Cassava and Maize Grain Prices (Meticals/kg)



b. Price Ratio

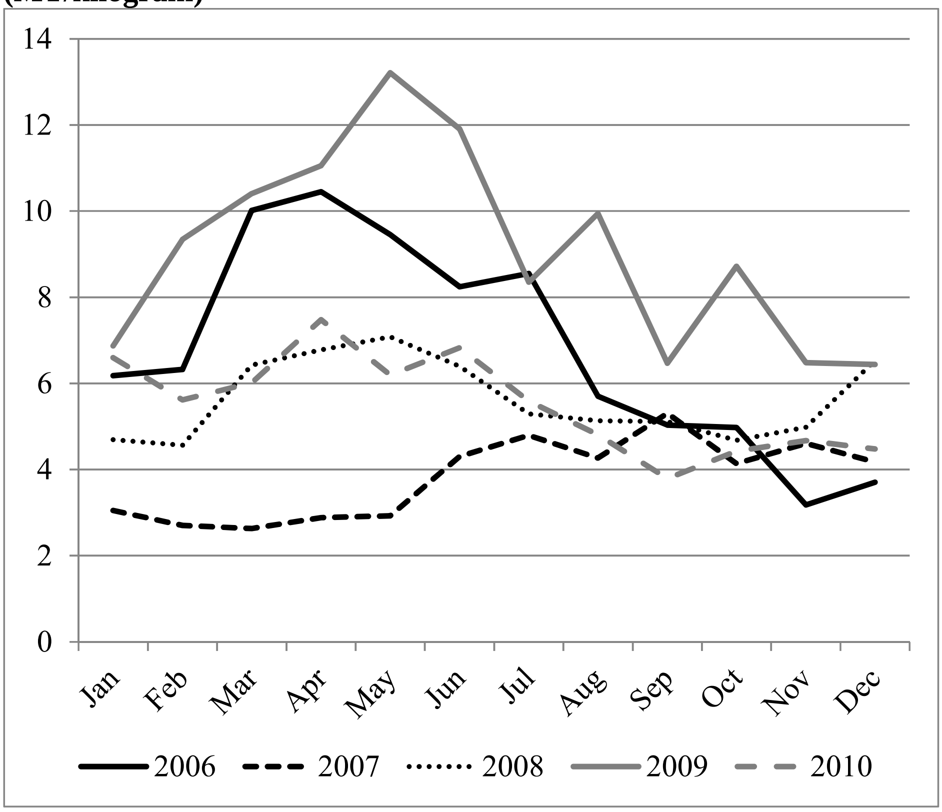
Source: SIMA 2011. Base Period: December 2010.

Comparing across years, cassava prices follow the price of major food substitutes, particularly maize. When maize prices spike during drought years, cassava prices also rise sharply. Following the Mozambican drought of 2005, for example, cassava (and maize) prices spiked in 2006. Similarly, during the world food crisis of 2008/09, cassava prices in northern Mozambique ratcheted sharply upwards as competition among food staples triggered notable increases in the domestic cassava price (Figure 14). Conversely, following the first of Malawi's major fertilizer subsidy programs, in 2005/06, Malawi's then-record maize harvest of 2006 contributed to a fall in maize and cassava prices in northern Mozambique in 2007.

4.2.4. Performance

Cassava trades in competitive markets with low barriers to entry and large numbers of traders. Low barriers to entry enable rapid entry and exit. As a result, small-scale traders with modest working capital dominate the short-term trade. Often young and male, they rely on rapid turnover of small volumes to earn small margins through spatial arbitrage. They repeat cycles of purchases in surplus zones followed by delivery and quick sale in regional wholesale markets.

Figure 14. Price Seasonality, Real Wholesale Price of Dried Cassava in Nampula (MT/kilogram)



Source: SIMA 2011. Base Period: December 2010.

Wholesale cassava markets feature clusters of many small to medium-sized traders operating in distinct clusters at assembly and terminal markets. This structure contrasts with more oligopolistic maize markets in which two to three large wholesalers account for a majority of marketed volumes throughout most of northern and central Mozambique. However, looking forward to the possible arrival of a handful of large industrial cassava buyers, the structure of cassava markets may well become more concentrated in coming years.

The majority of cassava traders in northern Mozambique engage in spatial price arbitrage. They move cassava, particularly dried cassava, from low-cost zones to high price markets in the coastal cities. Because dried cassava transits long distances, transport costs drive a spatial wedge in prices. Traders regularly monitor these price spreads in determining where to sell their dried cassava. Assembly traders in surplus cassava zone around Morrupula, for example, can ship their dried cassava north to Nampula or south to Quelimane. During our field visits in February 2010, a bag of dried cassava chips wholesaled for 200 MT/bag in Morrupula. Because of the longer distance from Morrupula to Quelimane (400 km) than to Nampula (70 km), a 50-kilogram bag of dried chips sold in Quelimane at 450 MT/bag while the same bag from Morrupula sold for 300 MT/bag in Nampula. By regularly monitoring prices, north and south, by cell phone, traders identify the most profitable market destinations. In doing so, they contribute to spatial price arbitrage.

Seasonal price arbitrage also occurs. A network of probably 50 to 100 medium-sized traders and large cassava millers store dried cassava chips for four to eight months in order to profit from seasonal price swings of roughly 100%. This segment of the dried cassava market requires considerable working capital as well as secure storage facilities, thus limiting entry to a restricted cohort of traders.

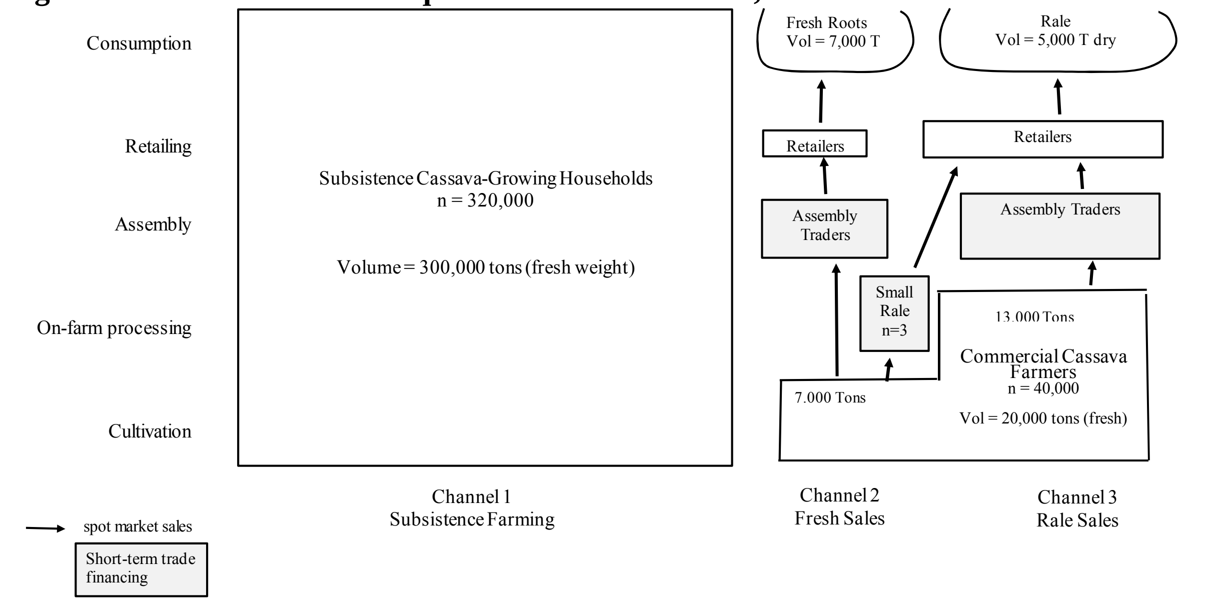
Over longer periods, in-ground storage offers the cheapest and most secure means of storing cassava. Given the flexibility in cassava planting and harvesting calendars, farmers in northern Mozambique can harvest cassava over a 12 to 30 month period. This enables them to store mature cassava in their fields for up to 18 months. Traders and farmers agree that this flexibility enables commercial cassava farmers to adjust the quantity of cassava they harvest and sell in any particular month in order to compensate for fluctuations in maize availability and price. The discussion below, in section 5, explores the magnitude of this intra-year buffering made possible by the flexibility of in-ground cassava storage on farms.

4.3. Southern Mozambique Cassava Value Chain

Cassava commercialization in southern Mozambique differs from the north in several ways. Volumes marketed are much smaller – only about 3% to 6% of total production compared to 12% to 13% in the north (Table 6). The composition of products sold differs as well. Rale and fresh roots dominate in the south, while dried cassava dominates in the north. Finally, the supply chains in the south are much shorter, both geographically and functionally (Figure 15).

Fresh cassava sales account for about one-third of marketed volumes in southern Mozambique (Figure 15, Channel 2). As elsewhere, itinerant assembly traders (primarily men) gather up transportable loads from farmers for transport to nearby markets. Retailers (primarily women) purchase bags and retail in small lots in urban markets.

Figure 15. Southern Mozambique Cassava Value Chain, 2010



Source: Mudema, Tomo, and Donovan (2011).

Southerners prefer consuming dried cassava as rale rather than as porridge. The fermentation and toasting of rale confers a distinctive taste on the final product. Rale processing likewise extends the shelf life to about six months. Most rale processing takes place on farms (Figure 6, Column 1). Women dominate the production of rale. In addition to preparing rale for household consumption, the 40,000 commercial small farmers in southern Mozambique make surplus rale for sale. These women market their rale in local assembly markets along transport arteries, generally in 20-liter plastic buckets. Assembly traders who visit these assembly points purchase rale from multiplier suppliers in order to put together marketable loads, which they then transport to nearby urban markets by truck or bus (Figure 15, Channel 3).

A handful of small factories, perhaps half a dozen, produce rale using semi-industrial methods. They grate using mechanical graters, large fermenting tanks, mechanical screw presses, and large banks of wood-fired stoves to toast the rale. Unlike the home producers, these artisanal factories typically package their rale in 1-kilogram bags for retail shops in the urban centers (Figure 6, Column 2). As previously noted, spatially, most rale production remains concentrated in Inharrime District of Inhambane Province. From there, marketed volumes flow south to the major cities of southern Mozambique.

The seasonality of cassava production and marketing also differs slightly in the south. Because of the large share of fresh cassava consumed, harvesting continues year-round, at a small level, on one-quarter of southern cassava-farming households. Peak harvest and selling months spread over a longer interval than in the north, with a majority of cassava-growing households harvesting cassava over a seven-month period running from April to October (Table 11).

4.4. Gender Dimensions of Cassava Commercialization

In the cassava belt of northern Mozambique, female-headed households produce more cassava and less maize than male-headed households do. However, they sell less of both. On average, female-headed households sell half as much of their cassava as male-headed households (Table 12). Cassava's zero input costs, drought tolerance and flexible planting and harvesting calendar make it attractive to cash- and labor-constrained rural households, many of whom are female-headed. Women dominate on-farm processing (peeling, fermenting, drying, rale production) and market retailing functions.

In contrast, assembly trade, wholesaling, storage, and milling remain primarily the province of men. Given the heavy bags in which fresh and dried cassava are marketed and given the mobility required, young men largely dominate the assembly trade. In our field investigations, women accounted for less than 10% of itinerant traders. Only in the rale trade do women surface in appreciable numbers as market intermediaries. Men overwhelming populate the long- and short-term cassava storage depots as well as cassava mills.

In general, women predominate in the labor-intensive, low-returns segments of the cassava value chain – the manual processing and retailing. Meanwhile, the most lucrative niches, in long-term storage and milling, remain largely dominated by male entrepreneurs with large blocks of working capital, secure storage facilities, and access to transport services.

Table 12. Gender Dimensions of Staple Crop Production and Marketing in Mozambique, 2008

	Cassava Production and Sales (per capita)				Maize Production and Sales (per capita)			
Household	Planted (ha)	Production (kg)	Sales (kg)	Share Sold (%)	Planted (ha)	Production (kg)	Sales (kg)	Share Sold (%)
North								
male head	0.09	382	50	13.2%	0.10	63	14	21.7%
female head	0.12	425	29	6.7%	0.08	47	3	7.2%
Center								
male head	0.01	64	2	2.9%	0.18	126	25	20.0%
female head	0.01	35	0	0.6%	0.20	108	17	15.7%
South								
male head	0.05	108	7	6.4%	0.11	41	3	6.9%
female head	0.07	126	4	3.6%	0.16	42	1	2.7%
National								
male head	0.07	263	32	12.1%	0.12	76	15	19.8%
female head	0.08	262	16	6.2%	0.12	59	6	9.6%

Source: TIA 2008.

4.5. Dynamics

Seasonal and spatial price arbitrage in dried cassava roots currently offer the most profitable commercial niches in Mozambique's cassava value chain. Approximately one hundred traders buy dried cassava in bulk and store it over the four to eight month trading season in strategically located depots across northern Mozambique. From these vantage points, they monitor price spreads in coastal cassava markets and maize prices in southern Malawi to determine when and where to release their stocks of dried cassava chips and flour. Given continued rainfall volatility in the region, and close maize marketing links with southern Malawi, these trading opportunities offer sustained prospects for commercial profitability in coming decades.

Over the long term, Mozambique's growing urban areas offer the country's most rapidly growing markets for commercialized foods. Over the past five decades, urban population has grown at 7.3% per year, compared to 1.2% in rural areas. These trends are expected to accelerate in coming decades, with Mozambique becoming majority urban by 2025 (United Nations 2007). Regionally, the coastal cities of northern Mozambique provide large centers of cassava-preferring consumers. In urban markets throughout Mozambique, fresh cassava roots find growing seasonal markets, while flour and rale (particularly in the south) offer prospects for low-cost urban convenience foods. Cassava offers a strong cost advantage over other staple foods.

In the north, cassava flour sells for 55% the cost of wheat flour and 60% the cost of maize flour.[4] In order for cassava-based products to compete with other urban staples – such as wheat, rice, maize – investments will be required in processing technologies and experimentation with composite and substitute convenience foods. Work has already begun on composite flour breads. Imported convenience foods such as cassava cheese bread will require technology transfer (from Brazil) and development of local brands for these and other prepared cassava-based foods.

Technology development will be required in several key areas. Manual peeling currently poses a major constraint to scaling up cassava commercialization. Indeed, investors in the Mocuba ethanol plant consider hand peeling the largest single constraint to large-scale cassava processing.

In addition, technical work on the biochemistry of cassava fermentation, food safety, and food quality remain critical to the scaling up of cassava processing industries. Early work at Eduardo Mondlane University has identified two fungal molds as the key fermentation agents governing cassava heap fermentation and hydrogen cyanide reduction during processing. This initial work suggests that inoculation with pure cultures of these fungi can reduce processing time and improve product quality and safety (Tivana et al. 2007). Given the small scale of most Mozambican food processors and the consequent externalities and spillovers from technology development, the required biochemical research is a public good.

[4] These percentages represent 11-year averages, from 1999 to 2010. Because relative prices vary seasonally and across years, the price ratio in any given year or month will differ from this long-term average. In 2010, for example, the price of cassava to maize flour averaged about 70% while the cassava to wheat price ratio averaged 60%.

5. FOOD SECURITY DIMENSIONS OF CASSAVA COMMERCIALIZATION

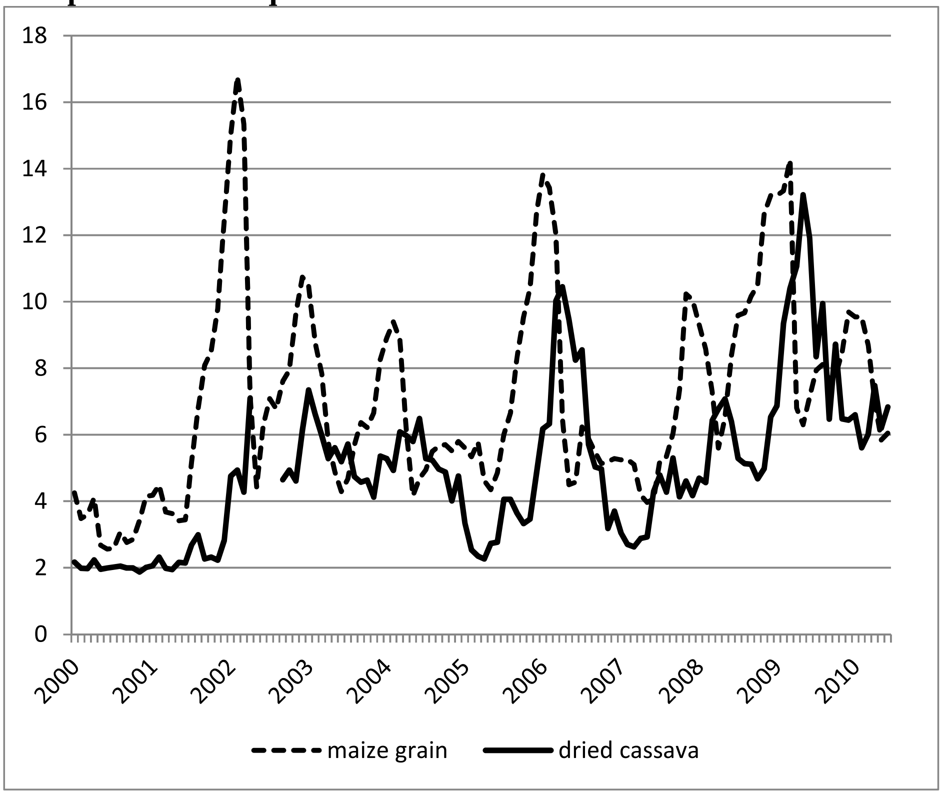
5.1. Consumer Substitution among Food Staples

The cassava belt of northern Mozambique houses the country's largest breadbasket. In addition to 85% of national cassava production, this fertile, land-surplus zone produces 45% of national maize output. In terms of sales, the north looms even larger, accounting for 50% of total national maize commercialized by domestic farms (Table 7).

The region's consumers, 50% of the country's population, consume both cassava and maize in shifting proportions throughout the year. During the lean season, late in the rainy season before the maize harvest when maize prices peak, they consume large quantities of fresh cassava, the only staple food they can harvest during this period. After the maize harvest, when stocks and plentiful and maize prices low, maize flour accounts for a large proportion of the porridge they consume. As the dry season proceeds, cassava flour becomes increasingly prevalent in regional diets (Table 10).

This consumer substitution between cassava and maize leads to a close tracking of cassava and maize prices. Across seasons and years, cassava prices typically follow maize prices upwards and down, with a lag (Figure 16).

Figure 16. Monthly Real Wholesale Prices for Dried Cassava and Maize Grain, Nampula Mozambique



Source: SIMA 2011. Base Period: December 2010.

Substitution also occurs elsewhere, though on a more limited scale. In central and southern Mozambique, as in the north, fresh cassava sales supplement diets during the lean season. Current experimentation by bakeries with composite flour breads offers potentially significant substitution for wheat flour, while growing poultry and animal feed industry holds potential for cassava substitution for maize as a carbohydrate source in feeds. At the present time, however, the greatest source of foods substitution between cassava and other staples occurs between cassava and maize in the country's northern cassava belt.

5.2. Flexibility of Cropping and Sales Calendars

The flexibility of the cassava-cropping calendar allows farmers considerable latitude in the timing of labor allocations for planting and harvesting. They can harvest throughout the year, though processing requirements (particularly sun drying) lead most to favor dry season months for harvest and preparation of dried chips (Table 11). This harvesting flexibility, coupled with short-term storage of dried chips, enables seasonal substitution of cassava for other staple foods.

In addition, because cassava is a perennial, rather than an annual plant, farmers can harvest it over multiple years. Indeed, typical cassava-cropping cycles in Mozambique span 12 to 30 months (Table 2). As a result, farmers can adjust harvested quantities across years as well as across seasons. During years of moisture stress, when maize yields and production fall sharply, many farmers elect to harvest more cassava than normal. Market price signals and household consumption needs both promote this counter-cyclical cassava harvesting. In contrast, in years of abundant maize harvest, cassava farmers can elect to let their cassava plots remain unharvested, effectively storing reserve stocks of cassava in the ground in unharvested or partially harvested plots. Most farmers who leave their in-ground cassava plots to mature over multiple seasons prune (ratoon) their cassava at the beginning of its second rainy season in order to avoid shading among intercropped plants and to spur vegetative growth, which they claim, extends in-ground storage time. Cassava's capacity for multiple-year, in-ground storage enables farmers to use it as a food security buffer during drought years.

5.3. Cassava as a Regional Food Security Buffer

During low-rainfall years, traders from northern Mozambique supply maize to deficit markets across the border in drought-sensitive southern Malawi (Whiteside 2003). As a result, the cassava belt of northern Mozambique also serves as a regional basket. Given fertile soil, surplus land, and favorable growing conditions, northern Mozambique produces regular food surpluses as well as an array of cash crops.

During drought years, such as 2005, maize production falls, as do the volumes of maize marketed. In normal rainfall years, such as 2008, maize production and marketing increases. In contrast, cassava production and sales move in the opposite direction. In a good rainfall year, when the maize harvest is normal, cassava production and sales both diminish. However, during a drought year, when maize production and marketed volumes fall, cassava farmers increase the volume of cassava they harvest and sell.

In an effort to quantify this counter-cyclical cassava response, Table 13 compares per capita production and sales during a normal (2008) and drought year (2005). During the drought year, maize production per household falls 7% below normal in northern Mozambique. Given more erratic rains in the center and south, maize production falls steeply in these zones, lowering national maize production by 14%, twice as much as in the north. In response to the maize deficit, farmers harvest 9% more cassava in the north and 32% more cassava nationally. While maize sales *fall* by 25% nationally and 17% in the north, cassava sales *increase* by 34% and 26%, respectively.

Large traders of dried cassava in northern Mozambique confirm the counter-cyclical role of cassava sales. When asked about year-to-year differences in volumes of dried cassava marketed, they indicate that years of maize shortfall result in their largest sales of dried cassava. For this reason, Mozambique's large cassava traders monitor domestic as well as regional maize markets. During a season when pending maize shortages threatened southern Malawi, one large cassava depot owner smiled and confided, "That means we will have a very good year in the cassava trade."

Table 13. Changes in Cassava and Maize Availability during Drought (2005) and Normal (2008) Rainfall Years

	Drought year (2005) minus normal year (2008)			
	Harvest		Sales	
	cassava	maize	cassava	maize
Quantities (kg/household)				
North	53	-19	17	-8
Center	93	-22	6	-29
South	313	-84	3	-3
National	122	-45	14	-15
Percentage change ([2005-2008]/2008)				
North	9%	-7%	26%	-17%
Center	83%	-4%	207%	-25%
South	183%	-43%	24%	-33%
National	32%	-14%	34%	-25%

Sources: TIA 2005 2008.

6. POLICIES AFFECTING CASSAVA COMMERCIALIZATION

Unlike other governments in the region, which lavish large-scale subsidies on maize producers while largely ignoring cassava production, Mozambique treats cassava producers more equitably. IIAM has conducted ongoing cassava research on a small scale since independence. These efforts increased with the emergence of serious disease threats in the 1990's. Breeding work at IIAM has focused on improved yield and, since the early 1990's, on disease tolerance to cassava brown streak disease and the cassava mosaic virus. In collaboration with a variety of NGOs and donor programs, IIAM has helped to make clean planting material available and to disseminate these improved varieties throughout the cassava production range. Most recently, in late 2011, IIAM expects to release two new cassava varieties with resistance to mosaic virus and adapted to low altitude zones.

Applied research at Eduardo Mondlane University has focused on several areas of cassava processing aimed at raising productivity further up the cassava value chain. Work on mechanical cassava graters and presses aims at raising labor productivity in rale production. Related work on food biochemistry and food safety explores the biochemistry of cassava fermentations and the microbiology of spoilage microorganisms. These efforts aim to the identify practices required to effectively remove cyanogenic glucosides and ensure food safety of cassava-based foods.

A consortium including IIAM, the Nampula Province Directorate of Commerce and Industry (DPIC) and the regional science and technology delegation (Cuambe et al. 2008) has investigated composite flours. Working with local bakeries, they conducted a series of test products and consumer acceptability trials (see Figure 7). Despite significant health and food safety issues, Mozambique has not yet instituted official standards for fresh cassava, cassava flour or other cassava-based products (Agro.GES 2007).

From a policy maker's perspective, cassava remains largely a food security crop in Mozambique (Agro.GES 2007). Nonetheless, over the past 5 to 10 years, Mozambique's Ministry of Commerce has launched a series of studies and task forces aimed at exploring prospects for cassava commercialization. In 2004, the Ministry's National Department of Trade (DNC) initiated a task force to explore regional export market for Mozambican cassava to be used in South African starch plants (External Market Task Force 2004). In 2006 and 2007, the ministry commissioned a strategic cassava subsector review aimed at identifying prospects for commercial development of cassava-based products (Agro.GES 2007). Although private sector uptake has remained cautious, these two efforts have succeeded in raising awareness of the medium-term potential for cassava commercialization in prepared foods, feeds and in starch and biofuel industries. As a result, several large, privately financed industrial ventures are currently experimenting with cassava-based ethanol and beer production.

7. CONCLUSIONS

7.1. Cassava Commercialization

Commercial opportunities in Mozambique's cassava value chain derive from cassava's large production base and the large number of people habituated to consuming cassava. Over time, rapid urbanization is leading to growing markets for all food staples, particularly processed, convenience foods. Given cassava's high productivity per unit of land and labor, cassava prices in Mozambique's northern cassava belt average about 55% of the cost of wheat and 60% of the cost of maize. This cost advantage underpins considerable commercial opportunities for cassava-based foods, feeds, and starches.

Current trade in cassava focuses on human foods, particularly dried flour in the north and the pre-cooked convenience food, rale, in the south. In addition, throughout Mozambique fresh cassava provides a low-cost seasonal food supplement during the peak lean season.

Efforts to develop new cassava-based commercial products include recent work on composite flours. These focus mostly blending cassava and wheat flour for use in bread and other baked goods. In addition, several large private firms are experimenting with cassava-based industrial products. Two firms have established distilleries for processing cassava (and tropical sugar beets) into distilled alcohol, ethanol, kerosene, and fuel gel. In addition, the country's major brewery is piloting a cassava-based bottled clear beer. Underexplored areas with clear competitive potential include cassava-based animal feeds, industrial starches, and convenience foods.

In order for cassava processors and traders to take advantage of Mozambique's considerable market potential, they will require access to industrial research in two key areas. First, scaling up production of cassava-based products from artisanal to industrial scales will hinge the mechanization of labor-intensive production bottlenecks in peeling, grating and pressing. This, in turn, will require the development and marketing of low-cost mechanical processing equipment. Second, research on the biochemistry of cassava fermentations and on the food safety of alternate processing technologies will be necessary to enable industrial firms to market healthy, safe cassava-based food products. As with basic agricultural research, public research on food processing technology will need to include an active extension component as well as active interaction with private processors in defining, designing, and conducting this applied research. In the meantime, scientific research on food biochemistry, curriculum development, teaching, and food technology student internships will go hand in hand with the modernization and expansion of cassava-based processed foods.

7.2. Food Security

Cassava has historically served as Mozambique's key food security crop. Its drought tolerance, high productivity, low input costs, and flexible harvesting and planting calendar enable even households of modest means to ensure food security through cassava production, both seasonally and across years.

Commercialization affects cassava production and distribution in ways that promote and at the same time hinder the food security potential of cassava. On the negative side of the ledger, commercialization tends to favor adoption of high-yielding, rapidly maturing cassava varieties. Though profitable for commercial farmers in normal years, these early bulking varieties typically breed out longevity and thus reduce farm households' ability to retain and manage in-ground cassava storage over multiple seasons.

On the plus side of the ledger, cassava commercialization strengthens the mechanisms through which cassava production and marketing can help to buffer seasonal, regional, and inter-annual food shocks emanating from localized failures in maize production. Northern Mozambique currently plays a key role in ensuring regional and seasonal food security. Large numbers of farm households consume both cassava and maize. Because they have the flexibility to harvest cassava over a 12 to 30 month period, their in-ground cassava stocks serve as a regional shock absorber. When maize production falters – in southern Malawi, Zimbabwe or southern Mozambique – cassava farmers in northern Mozambique reduce their own maize consumption and increase harvest and consumption of cassava. They also release additional cassava for sale on the market during drought years, thus permitting urban households in the dual-staple zone to substitute cassava for maize flour in the same manner. This consumer substitution in the dual-staple zones releases additional maize for sale in deficit maize-consuming areas. Clusters of traders store dried cassava at strategic crossroads in order to deliver dried cassava to the locations and times where price (and need) is highest. Long-term on farm cassava storage in the ground provides a reserve to complement the medium-term storage of dried cassava roots by private traders.

To protect this food security buffer provided by cassava farmers, consumers and traders in dual-staple zones of Mozambique, researchers will need to focus on in-ground storage properties of improved cassava varieties. Disease resistance and long-term in-ground storage properties remain critical for reinforcing the food safety net provided by Mozambique's cassava farmers and traders.

The role of cassava leaves in Mozambican diets likewise remains underappreciated and imperfectly understood. Available data suggest that cassava leaves offer an important source of green vegetables, in both rural and urban areas, particularly among low-income households. Commercial processing and trade merit further exploration given the high protein and vitamin content of cassava leaves, urban marketing, and the nutritional implications of various forms of leaf preparation.

ANNEX A. INTERVIEW GUIDES FOR FIELD INTERVIEWS

Guia Entrevistas nos Mercado e com Comerciantes

1. Apresentação

• quem somos?

2. Perfil da pessoa

• Papel (rol) : do armazém, gerente, comprador, etc.
• # de anos a trabalhar nisto
• fontes de produto
  - De onde vem o produto? De qual lugar compra a maior quantidade?
  - De quem foi comprado o produto (vender a quem? comprador principal)
  - Quem compra o produto dele (ou do armazém)?

3. Perfil da empresa

• quais funções (comercio ambulante; armazém (tipo A) aluguer de espaço para armazenagem, armazém (tipo b) para manter "stocks" para longo duração (tipo B); moagem (tipo A), moagem com armazém para guardar os seus "stocks" (tipo B)

• quantos outros agentes operam no mesmo lugar:
  - Ambulantes
  - Armazéns tipo A
  - Armazéns tipo B
  - Moagens tipo A
  - Moagens tipo B

4. Sazonalidade

	Meses											
	J	F	M	A	M	J	J	A	S	O	N	D
Quantidade maior (+) menor (~)												
Preço du mes hoje max (que meses?) min (que meses?)												

5. Anos boas, anos más

• o ano de maior vendas desde que começou a trabalhar com o produto
  - Qual ano foi?
  - Por quê houve maior vendas naquele ano?

• impacto do preço do milho
  - em que ano o preço do milho foi elevado?
  - que foi o impacto sobre as suas actividades com mandioca ?

Entrevistas com produtores e extensionistas

1. Alimentação

a. quais são as comidas básicas mais importantes?

i.

ii.

iii.

b. utilização da mandioca (qual percentagem para cada produto?)

fresca	______
farinha	______
oteca	______
exportação	______
total	100%

2. Gestão da mandioca

a. # de machambas _______

b. calendário de cada machamba

Machambas de mandioca	Area (ha)	Meses/ano de plantar	Meses/ano de podar	Meses/ano de colheitar
1				
2				
3				

c. como gerir uma seca?

Si a produção de milho esta baixa, que fazem famílias produtoras para garantir a sua segurança alimentar?

d. género

rol de cada	homens	mulheres
produção	______	_______
vender	______	_______

3. Processamento de mandioca ates de secagem?

4. Utilização das folhas de mandioca?

5. Comercialização

comerciantes ambulantes
De aqui ________ ________
Estrangeiros ________ ________
armazéns de mandioca
Tipo A (alugar o espaço para armazenar) ________ ________
Tipo B (manter um "stock" próprio) ________ _________
moagens
Tipo A (prestação de serviço só) ________ ________
Tipo B (moer os próprios stocks ________ _________
Direcção dos fluxos principais?

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