PN-ABJ-608
74121

ASPAP/DAI Report No. 155

The Role of Sweet Potato in Rwanda's Food System:

The Transition from Subsistence Orientation to Market Orientation

Prepared for the Agricultural Surveys and Policy Analysis Project in Rwanda, under A.I.D. contract number 696-0126-C-00-7777-02

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April 1991

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GLOSSARY

AE	Adult equivalent. A conversion measure used to discount the calorie requirements of the very young and the very old.
ARE	100 square meters; 100 ares = 1 hectare.
Agronome de Préfecture	Prefecture agriculture officer, usually responsible for compiling agriculture data.
BNR	Banque Nationale du Rwanda; Rwanda's Central Bank.
Bulker-Shipper	Retailer/wholesalers operating the long-distance trade in sweet potatoes and cassava, usually selling retail, but also selling, less frequently, wholesale.
Bulk-breaking	Reducing larger units (wholesale units) to smaller units for retail sales.
Bulking	Combining smaller units into larger units that are more efficiently shipped and handled. Usually occurs where merchants must travel some distance for supplies.
Catch crop	A relatively quick-maturing crop often planted to insure against the eventuality of crop failure of more seasonally important crops.
Commune	Third administrative subdivision of Rwanda, after Prefecture and Sous-Prefecture. Smallest administrative entity with some self-financing capability. Administered by Bourgmestre.
ENBC	Enquête Nationale sur le Budget et la Consommation des Ménages, Budget and Consumption Survey conducted by the Ministry of Planning.
ENQPAT	Enquête Patate Douce, Survey of Production, Marketing and Consumption of Sweet Potatoes, conducted by Tardif-Douglin in conjunction with the Ministry of Agriculture's Statistical Service (SESA)
Grain equivalent	A conversion ratio applied to nongrain foods that converts weight to grain equivalent calorie content; a conversion that allows direct comparison of energy content of different foods.
GRENERWA	Greniers du Rwanda. A parastatal firm dedicated to buying, selling, and storage of grains.

Hectare/year	A ratio used to discount yields by the amount of time (percent of one year) to maturity.
Intake quintile	Twentieth percentile of all households within a certain food intake (usually calories) range.
Local/rural markets	Markets having local (close proximity) demand zones and supplying rural customers. Differs functionally from local/urban markets by the lack of retailers.
Local/urban markets	Markets having local (close proximity) demand zones and supplying urban customers. Differ functionally from local/rural markets by the existence of retailers
Minagri	Ministry of Agriculture, Livestock, and Forests.
Miniplan	Ministry of Planning.
Minifineco	Ministry of Finance, Economy, and Commerce.
Moniteurs Agricole	Agriculture agents operating at the commune (or lower) level. Traditionally responsible for collection of agriculture production statistics.
OPROVIA	A parastatal firm dedicated to buying and selling perishables and other food products.
PAP	Projet Agro Pastoral de Nyabisindu; a regional agriculture development project funded by the German government.
Petty retailer	Small-scale retailer rarely operating at a distance greater than a 30-minute walk from his/her home market. Locally supplied, local sales.
Prefecture	Rwanda's first administrative subdivision, roughly equivalent to an American state. Rwanda is made up of 10 prefectures. Each prefecture is administered by a Prefet partially elected by the electorate of the prefecture.
Secteur	Fourth administrative subdivision of Rwanda, after commune. Administered by a council.
SESA/DSA	Service des Statistiques Agricoles (Division des Statistiques Agricoles as of 1990). The statistics division of the Ministry of Agriculture.
Sous-Préfecture	Second administrative subdivision of Rwanda. Of little significance in planning. Relatively anachronistic.

Terminal market	The market, within the long-distance trade, in which transactions are almost exclusively between merchants and consumers.
UOP profit	Unit Output Price profit. Profit divided by unit output price.
Wholesale market	The market, within the long-distance trade, in which transactions are almost exclusively between producers and merchants.

EXECUTIVE SUMMARY

The sweet potato is a highly important source of calories in the cool humid climates of the highlands of the Western Branch of the Great Rift Valley. Since its introduction in the early 18th century, the sweet potato has come to be cultivated by nearly all farm households in this rugged region of dense population and high elevation.

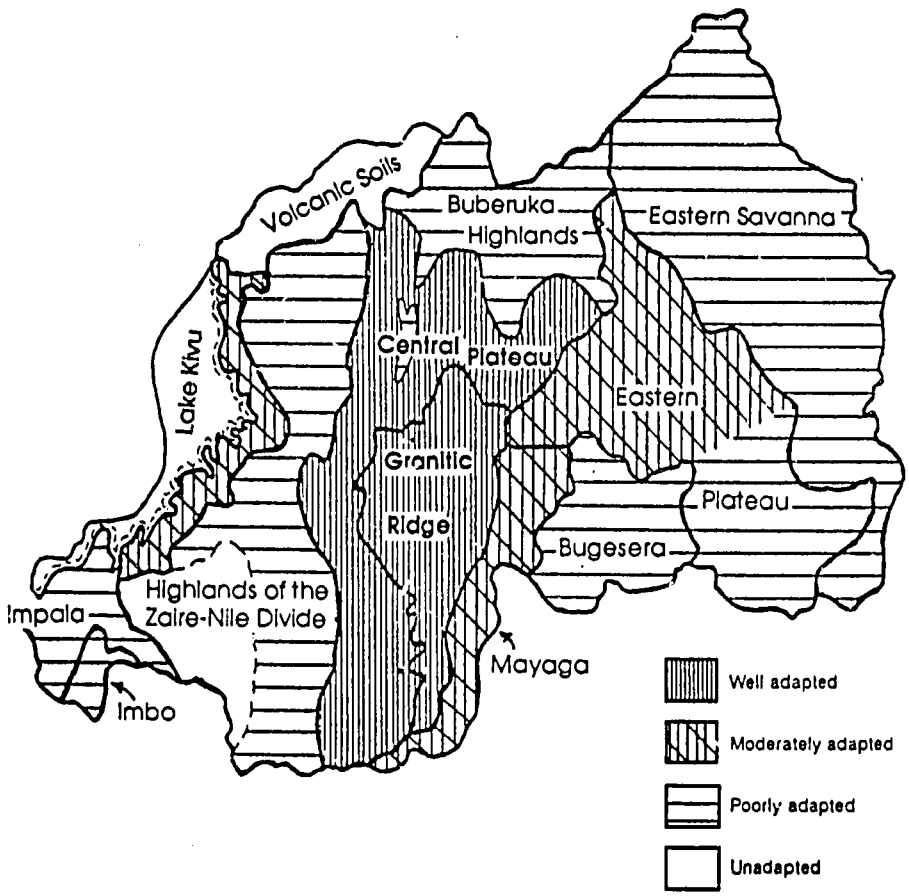
The popularity of sweet potato in the countryside, among semisubsistence farms, does not seem to extend to the rapidly expanding urban population. Urban households consume about half the amount of sweet potatoes as rural households. The principal reason for this difference is related to marketing problems. The sweet potato market has not developed the linkages and economies necessary for it to provide sweet potatoes to distant urban markets inexpensively and reliably.

To provide information about this little-studied market, a series of surveys of producers, merchants, transporters, and consumers was conducted during 14 months of field work. Prices were also regularly recorded. The results permit a detailed description of the market — of its strengths, weaknesses, and potential for improvement.

Two types of regression analysis applied to primary and secondary price data show that the sweet potato market is poorly integrated and that its development has been retarded relative to the cassava market. To determine the source of market inefficiency, a profit equation was fitted to data from 29 merchants. It was found that smaller-scale merchants, of whom there are many, are relatively less economic-efficient than their larger-scale counterparts.

Suggestions for improvement address the key problems of bulkiness and perishability as well as the need for many merchants to expand size of operations. If sweet potatoes are to play a more important role in urban diets, the market must address the bulkiness and perishability characteristics of the sweet potato. Until they are addressed, certain measures can be encouraged; among the most important are expanding size of operations, changing the system of taxation, and improving product handling.

THE ADAPTABILITY OF SWEET POTATO
TO THE AGRO-CLIMATIC REGIONS OF RWANDA



Source: Pfeiffer, H. "Evaluation du Programme de Recherche sur la Patate Douce a l'ISAR," ISAR, Rwanda, 1988.

CHAPTER ONE

SUMMARY AND INTRODUCTION

Sweet potato is the single most important provider of calories in the Rwandese diet and has been a key contributor to Rwanda's self-sufficiency in food. Sweet potato is unparalleled in its ability to rapidly provide large quantities of calories as well as ensure year-round availability of food. As a consequence, the relative importance of sweet potato growing is increasing as population pressure forces ever greater agricultural intensification. Without sweet potatoes, it is unlikely that the exceptionally high population density throughout much of Rwanda could have been supported, especially on the steep slopes typical of so much of the country's farmland.

Sweet potatoes have become important and widespread in Rwanda in a remarkably short period. They were introduced from Uganda in the early 18th century and are grown by virtually all rural households. Their importance in the diet, however, has been limited primarily to the countryside, where they are extremely well suited to the agronomic conditions. Only a small amount of sweet potatoes is marketed, usually to local exchanges. A very small amount is exported from local markets to more distant markets, such as urban Kigali.

The critical importance of developing the market for sweet potatoes is evident, however, when the urban growth rate is considered. The rapid rate of growth of Rwanda's urban population (which is twice the national rate) is beginning to place great stress on the food marketing system. Although Rwanda's population has remained relatively unurbanized, as a direct result of the highly dispersed pattern of settlement in the countryside, extremely high population pressure on agricultural resources is forcing ever more rapid migration from the countryside to urban areas. The rate of urbanization will continue to accelerate in the foreseeable future as the offspring of farmers, who already have insufficient land, are forced off the land and obliged to seek their livelihood elsewhere. As the urban population grows, a large demand for inexpensive staple foods will also develop.

This demand might be met in many ways. In the face of high internal marketing costs, imports could become an important source of food for urban areas; wheat, rice, and maize could be imported (possibly on concessionary terms) to meet the urban demand for inexpensive food. Alternatively, import-substituting foods such as rice and wheat might increasingly be promoted and grown around the country, primarily to supply the urban market. A third possibility is that foods traditionally produced in the hinterlands would be shipped in greater quantities to deficit urban areas. Bananas, sweet potatoes, and cassava are the most likely candidates, given declining trends in the production of the other traditional staple foods such as sorghum, millet, and maize.

As urban areas grow, however, it is unclear whether the sweet potato market will be able to develop to enable farmers to take advantage of increased demand. The market for sweet potatoes, while large, is primarily local and poorly developed. Urban consumers eat less than half the quantity of sweet potatoes that their rural counterparts eat. This paper demonstrates that the sweet potato market is poorly integrated and remains so, in contrast to the steadily developing market for cassava. Cassava serves the same role in the diet (that of readily available and inexpensive starch) but, because of the more rapid development of its market, seems poised to become an important source of revenue for farmers in the future.

Reasons for the sweet potato market's relatively poor development have to do with its natural bulkiness and perishability, which do not necessarily pose serious barriers to marketing, but which have seriously limited market development to date. If the market for sweet potatoes is to develop, processing techniques that can be applied at the farm or local market level will ultimately have to be developed.

The cassava market provides a model for such development; it is through innovation in processing that cassava's inherent bulkiness and perishability problems have been surmounted. Another key marketing problem, especially pertinent from a policy perspective, is the disincentive effect of volume-based taxation on bulky, low-value products such as sweet potato. Sweet potato merchants pay twice as much in taxes, as a percentage of the value of their produce, as do cassava merchants.

The dividend from improving the marketing of sweet potatoes in Rwanda could be great. Not only could urban areas be assured of relatively inexpensive (and steady) sources of food, but farmers, one-third of whom sell some of their harvest regularly, might receive more remunerative prices. Furthermore, with improved integration, the regional specialization that policy makers have been promoting for years could become a reality, allowing agroclimatic regions to specialize in crops in which they have comparative advantage (potatoes rather than sweet potatoes in Gisenyi; cassava rather than sweet potatoes in Kibungo; and sweet potatoes rather than bananas, cassava, or potatoes in Gitarama, Butare, and Gikongoro). This specialization would foster increased inter-regional trade and greater efficiency. A further bonus of market development would be the freeing up of land that is otherwise used for in-ground storage of sweet potatoes, the opportunity cost of which will continue to grow with the intensification of agriculture.

This paper describes and evaluates the economics of the system in which sweet potatoes move to market in Rwanda, in order to assess the sweet potato market's potential role in providing food to rapidly growing urban areas and its ability to strengthen the much-needed linkage between urban and rural development. The study on which this paper is based had as a guiding principle that, while some market development takes place naturally in response to pressures favoring increased specialization and integration, market development (especially where other economic institutions are also weak) is imperfect and can be improved through analysis and planning. The findings are of direct relevance to Rwanda's food security, but are also of general relevance to other highland regions of humid tropical Africa where sweet potato production is an important contributor to the diet.

METHOD OF DATA COLLECTION

Because little information existed about Rwanda's sweet potato sector — aside from estimates of production and marketing levels and limited price data — it was necessary to conduct extensive primary data collection. Much of the data used in this study were collected in 14 months of fieldwork, conducted from October 1987 to November 1988. Four types of data collection methods were used — questionnaires, market entry records, business accounts, and price records.

Questionnaires were administered primarily to procure data for descriptive purposes. Market informants, usually individuals having formal responsibility for a market, were asked about the sweet potato trade in general as well as specifics about their own market. Their responses enabled the author to make estimates of the types (and number) of participants in various types of market. Producers were asked an extensive set of questions to determine the extent of their market orientation and the effect of prices on their production and marketing decisions, as well as the importance of in-ground storage. Local

retailers were questioned about amounts of sweet potatoes sold, profit margins, and factors likely to influence both. Larger-volume retailers engaged in long-distance trade were also surveyed to develop a picture of the functions performed by other intermediaries in the long-distance trade, namely bulker-shippers and truckers. Consumers were surveyed about their buying and consumption habits, and on their perception of the services provided by the market.

Extensive records were kept of sweet potato and cassava shipments into six urban Kigali markets. Recording was repeated during the first week of each month for 11 months, and the results extrapolated to provide an estimate of annual shipments to Kigali markets, and to determine the sources and flows of sweet potatoes into Kigali and the size of Kigali's market supply zone. Similar studies were conducted on a more limited scale to determine supply zones of other key markets.

To calculate the cost and profitability of marketing sweet potatoes, all transactions of a sample of the two principal types of intermediaries in the sweet potato market (local retailers and bulker-shippers) were recorded for one month. The resultant data were used in an analysis of relative efficiency of types of merchants and systems of marketing.

Prices recorded on a weekly basis by the author were used to complement monthly prices collected by the Ministry of Planning in analyses of price correlation and market integration. Hourly price movements were recorded to find out how variable prices were throughout the day, and to assess the degree to which spot prices, the kind generally reported in Rwanda, are representative of the range of prices actually observed.

ORGANIZATION OF PAPER

The findings of these surveys, market tallies, business accounts, and price records suggest inefficiencies as well as potential for improvement. This paper presents these findings to promote a better understanding of the market, especially the inefficiencies, their extent, the ramifications for market development, and ways the inefficiencies might be surmounted.

Chapter Two, based in large part on the results of the producer survey, describes Rwanda's food system, emphasizing the role, importance, and suitability of the sweet potato. This is followed in Chapter Three by an in-depth description of how the market operates; this description is presented, to the extent possible, in a structure-conduct-performance (S-C-P) framework, and is based on data from the market master, merchant, trucker, and consumer surveys.

Quantification of overall marketing efficiency, using correlation measures of market integration, is done in Chapter Four. The analysis begins with monthly prices furnished by Miniplan and is tested with other price series, including the weekly prices collected by the author. From these, a picture of a relatively poorly integrated and inefficient market begins to emerge. In Chapter Five, after identifying the key marketing costs, derived from the one-month business accounts, an attempt is made to specify which contribute most to inefficiency, and to classify merchants according to their relative efficiency. Conclusions and recommendations for improving marketing efficiency are presented in Chapter Six, which includes an assessment of the probable regional food security benefits to be derived from these modifications.

CHAPTER TWO

THE SWEET POTATO IN RWANDA

This chapter provides an overview of the sweet potato sector, focusing on how, where, and why sweet potatoes are grown, their importance and placement in production systems, the extent and nature of demand for them, and how they are marketed.

The sweet potato is suited to Rwanda and has gained an increasingly important place in its food system. With the exception of the northwest, production is high and well distributed throughout the country. Levels of consumption are high both absolutely and relative to other starchy staples in rural areas. Demand among the urban poor would presumably continue to grow if sweet potatoes could reach them in reasonable condition and at reasonable prices.

THE IMPORTANCE OF SWEET POTATO

Sweet potato production has grown faster than the other important crops (banana, beans, and sorghum) and as fast as potato, which has benefitted from a much more intensive and well-funded research program.

Figure 2.1.A shows the average production of principal food crops in 1984-86, ranked according to the amount of calories they supply. Sweet potato follows banana in gross production of calories and provides roughly the same amount as beans. On less than 13 percent of total cultivated area it produces 16 percent of total gross food energy coming from crop agriculture. Sweet potato ranks fourth in area, but third in gross calorie production. Although banana provides more calories, because bananas are usually consumed as wine, up to one-half of their calories are lost to human consumption (*1*, pp. 151-153).[1] The wine-making process results in calorie losses. Consequently, sweet potato is considered Rwanda's principal source of dietary energy (2, p. 44).

The sweet potato has had one of the fastest rates of growth in production between 1966 and 1985. This is shown in Figure 2.1.B, which is drawn on a semi-logarithmic scale to facilitate direct comparison of rates of growth. The growth of sweet potato, cassava, beans, and banana production are shown separately; important cereals — sorghum, millet, and maize — are grouped. Rates of growth are contrasted with population growth over the same period (measured on the right-hand axis). Most crops have grown at roughly the same rate as population, but a few have grown faster. Sweet potato production has grown at an average annual rate of 7 percent, within the same general level as potato, but substantially greater than that for beans, cassava, banana, and the cereals.

Most of the increase has come from extensification rather than intensification of production; cultivated area has increased by 6 percent annually, yields, by only 2 percent (*3*). As increasingly marginal land is brought into cultivation yields can be expected to decline. This is not to say that all the

[1] Arabic numbers and pages in parentheses refer to citations listed at the end of each chapter.

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FIGURE 2.1: THE SWEET POTATO IN RWANDA

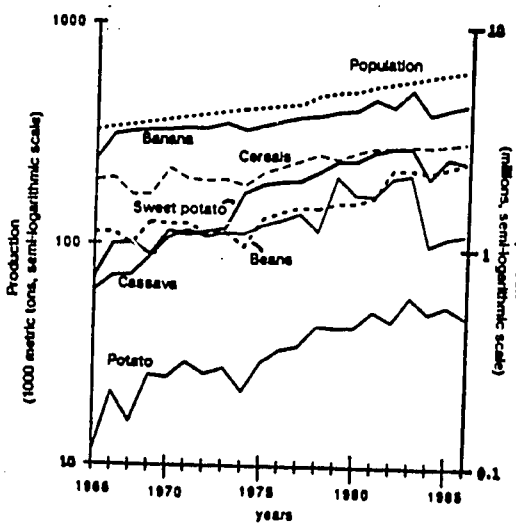
IT IS AN IMPORTANT ENERGY SOURCE:

A. Area, Yields, and Production of Key Food Crops of Rwanda, 1984-86

	Area (1000 ha)	Yields (tons/ha)	Production (1000 tons)	Production grain equivalents (1000 tons)	Food energy (bil. Kcal)	Percent food energy
Banana	249	9.0	2247	449	1571.5	31
SWEET POTATO	129	7.0	895	248	868.0	17
Beans	321	0.8	271	232	812.0	16
Sorghum/millet	175	1.2	202	202	707.5	14
Cassava	32	10.2	326	163	570.5	11
Maize	82	1.2	97	97	339.5	7
White potato	42	6.9	289	58	203.0	4
Total principal crops	1050	. .	. .	1449	5072.0	100

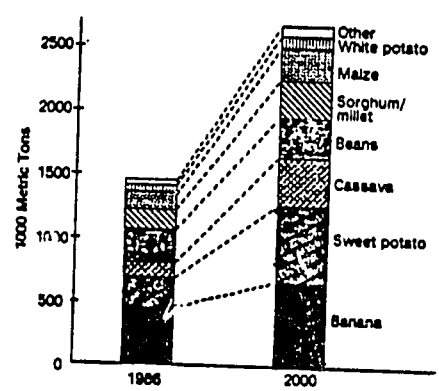
ITS PRODUCTION HAS GROWN RAPIDLY:

B. Rate of Growth of Production of Key Crops, 1966-85



AND IT IS EXPECTED TO BECOME EVEN MORE IMPORTANT:

C. Projected Change in Production and Composition of Production, 1986-2000



Sources: A and B: Rwanda, Ministry of Agriculture, *Annual Reports*. C: Rwanda, Ministry of Planning, *Strategie Alimentaire au Rwanda: objectifs chiffres et programmes d'actions*, no. 3, 1983, from Scott, Gregory J. *Potatoes in Central Africa: A Study of Burundi, Rwanda and Zaire* (International Potato Center, Lima, 1988).

additional land brought into sweet potato cultivation has been previously uncultivated or uncultivatable. The data also indicate shifts away from cereals and grain legumes in favor of the higher-yielding staples, banana, cassava, potato, and sweet potato.

The rapid growth in sweet potato production has helped keep per capita calorie availability steady throughout the 1970s and 1980s, in spite of the demands placed on the food system by a rapidly growing population. Since 1965 population has grown at an average annual rate of 3.3 percent, reaching 6 million in 1987, and an expected 10 million by the year 2000 (*4*, p. 269). During the 1970s and 1980s, agricultural production grew at an average annual rate of 5 percent, slowing down towards the end of that period, but remaining three times as rapid as the rate of growth for Sub-Saharan Africa (*4*, p. 222). Consequently, agricultural production per capita has grown at an annual rate of a little over 1 percent, slowing down somewhat in more recent years. Daily per capita calorie availability remains fairly steady, around 1,800 to 2,000 Kcal.[2] (*1*, p. 276).

The sweet potato's adaptability to Rwanda and its ability to meet the food energy requirements of a large and rapidly growing population have been incorporated into long-term planning. The extent to which this is so is evident from Figure 2.1.C, which is derived from projections made in Rwanda's 1986 Five Year Plan, "Plan Quinquennal." Production levels in the figure have been converted to grain equivalents, a measure of their food energy content, which allows for direct comparison and aggregation. If population grows by 4 million between 1986 and 2000, as is expected, the production level, in grain equivalents, will have to grow by 1.3 million MT over the same period. Projected increases in root and tuber crops, specifically sweet potato and cassava, would make up the bulk (50 percent) of the necessary increase. Sweet potato production is projected to nearly triple between 1984/86 and 2000, most of the increase coming from intensification. Yields are expected to nearly double while area is expected to increase by less than one-fifth. The only other important crops where yield improvements are being counted on so heavily are potato, sorghum, and, to a lesser degree, cassava

PRODUCTION

The sweet potato is considered a famine-reserve or a catch crop to be cultivated when land and labor allocated to crops having more demanding planting and harvesting schedules are freed up.[3] Consequently, minimal labor is expended on it. Its primary advantage, from the point of view of producers, is its ability to be left in the ground to be harvested as needed. Only a small part of annual production is placed on the market, and that is usually for local trade.

Nine out of 10 farm households cultivate sweet potatoes. This varies, in some cases greatly, by region (*5*, p. 199). In the middle elevation zone, all households grow some sweet potato. In the high elevation zone, only a little more than two-thirds do. Sweet potato cultivation is considered women's work, although men are often responsible for field preparation and help decide when and where the crop

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[2] In Sub-Saharan Africa, excluding Nigeria, population growth rate has averaged 2.5 percent between 1965 and 1987 while agricultural production has grown by only 1.3 percent per annum. Consequently, production per capita has actually fallen by about 1 percent annually.

[3] A catch crop is one that is relatively quick-maturing and is often planted to insure against the eventuality of crop failure of the more seasonally important crops.

should be grown (*5*, p. 37). The small proportion of farm households that do not cultivate sweet potato are the richest in land, cattle, and other indicators of wealth.

Placement in the Agricultural Calendar

Sweet potato cultivation can be fit into the agricultural calendar as other crops permit, even if sometimes somewhat haphazardly, because the timing of harvest and, consequently, of planting is relatively flexible (*7*, p. 13). Figure 2.2 portrays the agricultural calendar for sweet potato and some key seasonal crops in the Central Plateau.

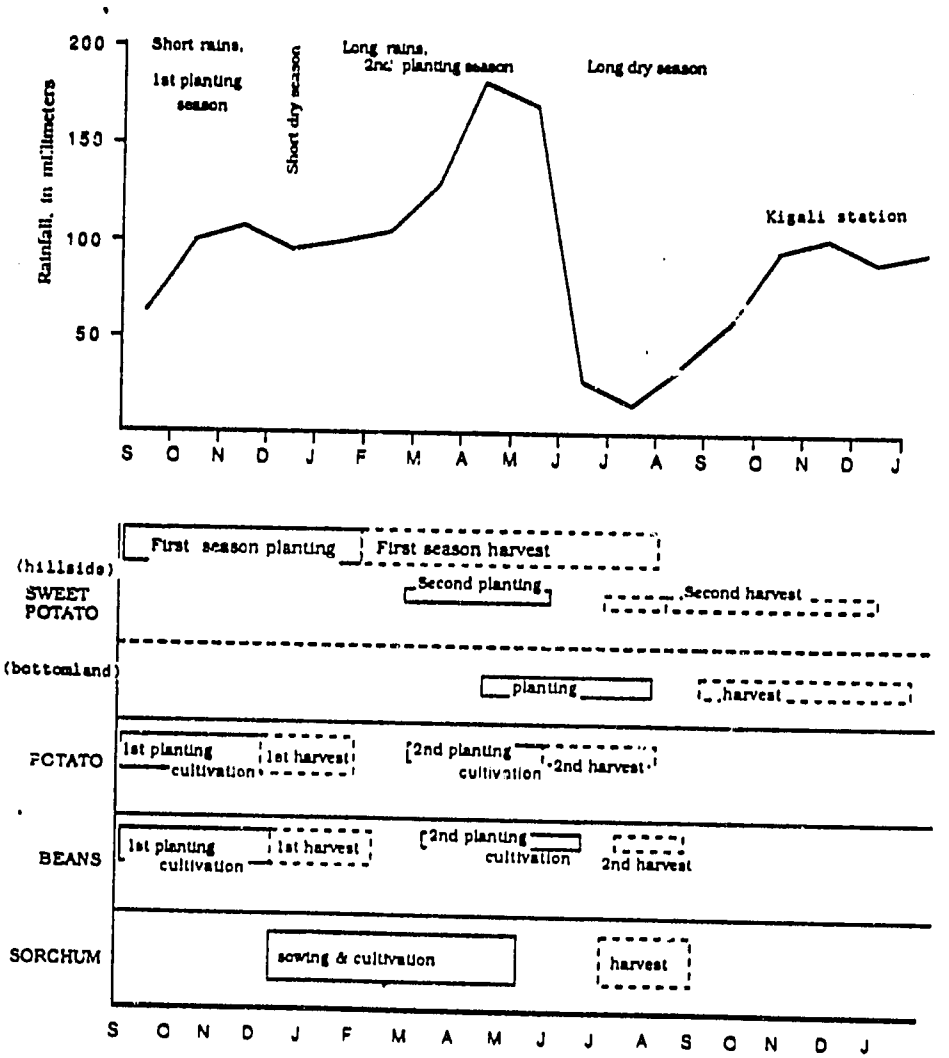
The cropping year begins in September with the onset of the short rains, which usually last until the end of November. In most parts of the country this is the season when the first and most important crops of beans and maize are planted (*5*, pp. 96 and 103). During the subsequent, short dry period, which normally lasts a little over one month, first season crops are harvested. For all seasonal crops except sorghum this is the most important harvest. The long rains follow. The crop most strictly associated with this period is sorghum, which takes too long to mature to be grown in the first season. The second crop of maize and beans, and other minor cereal and legume crops, are also sown then. The agricultural calendar ends with the long dry season, which is the principal harvest period for sorghum, and the second, and secondary, period for beans and maize.

The sweet potato is usually planted and harvested throughout the year, with little seasonal differentiation or specificity. First season planting is most frequently done on hillside fields between September and January, and second season planting is usually done between February and May, which permits harvesting throughout most of the year. Households that have access to bottomland fields in addition to hillside fields can plant from May to July, and thereby ensure a year-round supply of sweet potatoes (*6*, p. 32).

Sweet potatoes are usually planted in pure stands, but there is some seasonal variation in cropping. During the first season, two-thirds of the area under sweet potato cultivation is pure-cropped. Only one-half is pure-cropped in the second season when more of the bottomlands are used and there is more pressure to get a variety of crops sown. Sweet potatoes are mixed-cropped with beans and maize in the first season, and with beans, sorghum, and cassava in the second. When they are mixed with other crops, sweet potatoes are generally of secondary importance (*5*, pp. 158-176). What is considered mixed cropping may really be part of a strategy to maintain a seedstock reserve of sweet potato vines for later planting. Other times, sweet potatoes are planted in an established field of beans, sorghum, or maize, with the intention of harvesting the established crop first and then continuing with the cultivation of the sweet potato field as a pure crop — a procedure more analogous to relay cropping or planting and harvesting a series of crops overlapped on the same field.

In the rare event that crop rotation is practiced, sweet potato cultivation usually follows a brief period of fallow, sometimes no longer than one season. Usually, however, a field is replanted immediately after the preceding crop of sweet potatoes has been harvested. This procedure, a consequence of land shortage, has been blamed for low yields and the pest and disease problems that are discussed below (*7*, p. 12).

FIGURE 2.2: RELATIONSHIP BETWEEN RAINFALL PATTERN AND CROPPING CALENDAR FOR SWEET POTATO AND SEASONAL CROPS IN THE CENTRAL PLATEAU OF RWANDA



Source: Rwanda, "Plan interimaire d'urgence," 1970.

The three principal factors determining when mature sweet potatoes will be harvested are:

- The availability of labor for the preparation of cuttings, the preparation of new fields, and planting;
- The availability of land upon which to plant the vines from the harvested field; and
- Household and, to a limited extent, market demand.

All three must be meshed by individual households if losses are to be avoided or reduced. For most farmers the cycle of planting, harvesting, and preparing new fields for planting involves the carefully coordinated use of hillside and bottomland fields.

According to the producer survey (hereafter, ENQPAT) the author conducted with the assistance of the Ministry of Agriculture, farmers appear to use both kinds of fields for sweet potato cultivation. Nearly two-thirds of all households use both bottomland and hillside fields, one-third rely on bottomland fields alone, and a small minority cultivate only hillside fields; the vast majority would prefer to use only bottomlands for sweet potato cultivation but most are forced to use hillside fields as well (*9*, p. 45):

	Hillside only	Bottomland only	Both
	(percent)		
Cultivate	3	38	60
Prefer	25	71	4

The adverse effects of not having both of the complementary types of fields include having to buy cuttings as "seedstock," especially after the long dry season when the harvest from bottomland fields would be expected to provide cultivators with planting material for the first hillside crop. The disadvantages of possessing only one type of field may also include having to buy food seasonally to carry over until hillside or bottomland fields are ready for harvest.

Sweet potato cultivation is usually given a relatively small amount and percentage of household farmland. Farms are small, averaging a little over one hectare, broken into five fields averaging 24 ares each (*5*, p. 156). Average farm size varies between 0.9 and 2.0 ha, number of fields, between two and seven, and average field size, between 14 and 96 ares, depending primarily on the level of population density in the region. Since sweet potato production is most associated with the more densely populated areas, sweet potatoes are more likely to be found on farms no larger than one ha. A survey by Rwanda's agriculture research institute, Institut des Sciences Agronomiques du Rwanda (ISAR), of 72 farmers in 8 of the 12 agroclimatic regions found that, on average, 0.12 ha were used for sweet potato cultivation, and that the range in size was from 0.01 to 0.63 ha (*8*, p. 211). Elsewhere it has been estimated that 0.1 to 0.3 ha are used (*2*, p. 38). The results of the National Agriculture Survey (ENA) conducted by the Ministry of Agriculture in 1984 were that average annual household production of sweet potatoes was 725 kilograms, and per hectare yields were between seven and eight metric tons. These suggest that the typical household uses 0.1 ha for sweet potato cultivation.

Methods of Cultivation

Sweet potatoes are propagated vegetatively. The seedstock is vines that usually come from other, just-harvested fields owned and cultivated by the household. Careful planning is necessary for a household to ensure that proper balance and coordination is maintained between harvesting and planting, so to minimize loss of expensive planting material. Cuttings have a high value, especially at time of planting, and there is a thin but high price market for them.[4] Shortfalls in production have been attributed as frequently to insufficient planting material as to pest infestations or diseases. Seedstock is often in short supply because most farmers plant at very high densities as a crop insurance strategy (*6*, p. 32 and *7*, p. 13). The results of the ENQPAT study suggest that most households acquire their seedstock from their own fields, although a sizeable minority must either buy or receive cuttings as gifts (*9*, p. 47):

Source of seedstock	Percentage of households for whom primary source
Own fields (hillsides)	52
Own fields (bottomlands)	34
Gifts	9
Purchases	5

Sweet potatoes cultivated on the bottomlands are grown on large raised beds built primarily for drainage. They are planted with vines usually coming from the previous hillside crop. Hillside fields are generally flat, sometimes terraced. Vines are planted at a very dense 17 per square meter (*6*, p. 32), and usually come from reserve fields, from thinning out other unharvested fields, or from harvested bottomland fields, depending on when the crop is being planted.

Once planted, relatively little attention is given to the sweet potato crop. Almost no farmers apply fertilizer; fewer than one-third weed their fields, and then only once (*6*, p. 32). This probably constitutes a rational use of household labor, but it also reduces sweet potato yields and production. Sweet potato fields are left to produce with little intervention.

Major Diseases and Pests

Limited intervention extends to pest and disease control. Other than choosing varieties that are most resistant, farmers do little to actively combat disease and pest infestations, in spite of the extensive damage caused by them. The virus complex (sweet potato virus disease) and alternaria are the two most important sweet potato diseases; sweet potato weevils and defoliating caterpillars the most serious pests. George Ndamage, the head of root and tuber research at ISAR, has conducted research on the extent of disease and pest infestation. He reports that a 1984 study by ISAR found that an estimated two-thirds of all sweet potato fields were affected by alternaria, one-half by the virus complex. Pest damage also appeared to be widespread, caterpillar damage being found on nearly half the fields, and weevils infesting one-third of them (*6*, p. 34). Actual rates of infestation may be higher; symptoms are often masked where soils and other growing conditions are good.

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[4] There are no records of prices paid for cuttings, but the author was told on numerous occasions that, by weight, cuttings are equivalent in price to tubers.

Market Orientation of Producers

The amount of sweet potatoes entering the market is influenced by farmers' perceptions about when, how, and how much of their crop to harvest and by their in-ground storage practices. Sweet potato sales represent a small part of production in aggregate as well as for the average producer. The ENQPAT survey suggests that only about one-third of producing households sell any of their crop.

Households most likely to sell sweet potatoes are those that seem, by certain criteria, to be the poorest. These criteria are low area-to-household-size ratio, and thatch rather than tin or tile roofs on their houses. The vast majority of households (80 percent) that do not sell sweet potatoes simply have no excess production to sell. A sizeable minority (13 percent) could sell but choose not to because they have other sources of income, and only 5 percent are deterred from selling by low prices (*9*, p. 49).

Sweet potato sales by producers do not tend to be responsive to the market. Most sales are made, instead, when households have a pressing need for cash for school fees or medical bills rather than when prices are favorable. Most households (75 percent) appear never to take market conditions into consideration when making their production plans. One-third of all households that sell admit to having their harvest schedules and amounts influenced by market price. Of these, however, only half base their harvest decisions directly on prevailing market prices. Where price has no apparent influence on harvesting or marketing, harvest decisions are based primarily on food and cash needs rather than on crop maturity (*9*, p. 49):

Reason for harvest	Percentage of households for whom it is the primary reason
Food needs	50
Cash needs	15
Crop maturity	32
Other reasons	3

Finally, that nearly three quarters of all selling households sell their sweet potatoes regardless of the prevailing price shows that market price is not yet an important determinant of sweet potato sales.

CONSUMPTION OF SWEET POTATO

The sweet potato is a highly important component of the diet in rural areas but is substantially less important in the diet in urban areas, where it seems to be eaten primarily by people of modest or poor means. Sweet potato consumption represents 13 percent of the value of food consumed by rural households, but only 4 percent of the value of food consumed by their urban counterparts (*10* and *1*). Nationally, levels of consumption are high, the contribution to caloric intake great, but importance declines with increases in income. While levels differ, patterns of consumption differ little between rural and urban consumers. Methods of procurement, however, differ as do degrees of responsiveness to prices. Rural households eat sweet potatoes primarily from their own fields. Urban households buy nearly half of what they consume (*1*, p. 3). From the perspective of market analysis, it is the evolution of urban demand and consumption that is most challenging and interesting.

Levels of Consumption

The two most important foods in traditional rural diets are beans (for protein) and sweet potato (for calories). The typical meal in the countryside usually includes both. Sweet potatoes are prepared very simply for the average meal, usually the unpeeled tuber is boiled and served directly with beans. In some cases the tuber is peeled and mashed prior to being served, and in still others it is grilled and eaten as a snack. Consumers prefer their sweet potatoes starchy (floury) and sweet (*9*, p. 50):

Sweet potato characteristics	Percentage of households preferring each characteristic
Starchiness/flouriness	44
Sweetness	27
White fleshed	5
Blandness	4
Yellow fleshed	1

Between 1982 and 1986, Rwanda's Ministry of Planning conducted a budget and consumption survey (ENBC) of rural households (November 1982-December 1983) and urban households (October 1984-January 1986). Most of the consumption data used in this thesis come from the ENBC study. Unfortunately the urban segment had not been completed at the time of writing, and hence the lack of clear estimates of urban demand elasticities, among others.

For the rural part of the survey the base sample was 1,170 households, 13 from each of 90 *secteurs* selected from 90 rural communes. From a subsample of 270 households, three each from the 90 communes, it was estimated that annual consumption was 203 kilograms (556 Kcal per day) per adult equivalent (hereafter AE),[5] and that it varied from 300 kilograms (821 Kcal/day) in the north-central part of the country, where it reached as much as 400 kilograms (1096 Kcal/day) for one-fourth of the households, to 130 in the east and northwest, where nearly half the households consumed less than 100 kilograms (274 Kcal/day) (*1*, pp. 46 and 74).[6] Although these results are from a study of rural households, they provide reasonable estimates of national averages because the urban population is so small that it does not substantially alter aggregate or average levels. Average annual consumption of sweet potatoes for all households was estimated at 865 kilograms; for households actually consuming sweet potatoes the estimate was 895 kilograms. Ndamage suggests that overall per capita consumption (not just adult equivalent) is roughly 120 kilograms nationally, which would convert to 600 kilograms per household (*6*, p. 32).

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[5] The expression adult equivalent (AE) is used to discount the calorie requirements of the very young and the very old. At the time of the survey in question the adult equivalent population was roughly 4.5 million, or three quarters of the total population of 6 million.

[6] North-central, east, and northwest are three of the five geographical zones by which the country is divided. They have little relation to agroclimatic regions, and the only reason they are used here is because they are the regions for which the Miniplan data we have cited have been disaggregated. The north-central zone corresponds roughly with middle elevation, although it also includes some of the high-altitude Buberuka Highlands. East is synonymous with low elevation, high temperatures, and low rainfall, and northwest with high elevation, low temperatures, and high rainfall.

The ENBC study estimated that in 1983 sweet potato accounted for 17 percent of the average household's calorie intake, making it, after beans which provided 32 percent, the second most important source of calories. Sweet potato was a distant second, after beans, in the provision of protein, providing 8 percent versus 65 percent of the protein in the average diet (*1*, p. 43):

Percentage of calories and protein supplied by each crop in the typical diet

	Calories	Protein
Beans	32	65
Sweet potato	17	8
Cassava	12	5
Sorghum beer	9	4
Cooking banana	8	1
Banana wine	5	na
Maize	4	4
Potato	9	3
Other	4	10

In addition to regional differences, there are some important demographic and socioeconomic factors affecting the level and relative importance of sweet potato consumption. One factor that seems to have an important effect on the amount of sweet potato in the diet is profession or employment of the head of household. Households in which the head of household is a craftsman (artisan), for example, consume about half as much sweet potato per capita as those engaging entirely in farming. Since women are the principal agriculturalists in Rwanda, what is implied when the male head of household has a profession or employment other than farming is that there is a greater source of cash income. Households with greater cash income tend to switch to cassava, much of which is probably purchased, and their sweet potato calories decline to about one-half the average level. (*10*, p. 108).

Households with more farmland (another indicator of well-being) also tend to rely somewhat less on sweet potato than do their counterparts with less area. This suggests that it is the poorest who rely most heavily on sweet potato. There is also an apparent positive relationship between the extent to which households consume only what they produce, and the relative importance of sweet potato in the diet. The ENBC study classified households according to the share of their diet that came from purchased foods, and found that households that bought only one-fourth to one-sixth of the food they ate relied twice as much on sweet potatoes as their counterparts that bought nearly half of their food. (*10*, p. 113).

Effect of Income on Consumption Level

Although it is only at the highest income levels that sweet potato consumption actually declines, its relative importance in the diet diminishes as income grows. Sweet potatoes are most important in the diets of people of modest or poor means. The ENBC study of rural households analyzed the structure of food purchases, sales, and consumption as a function of household calorie intake, a proxy for nutritional status (and, equally, income/wealth levels). Average daily calorie intake per adult equivalent in each household was broken down into five categories or quintiles (*10*, p. 90):

Calorie intake quintile	Range (Kcal/AE/day)
First	Less than 1,706
Second	1,706 - 2,105
Third	2,106 - 2,510
Fourth	2,511 - 3,050
Fifth	Greater than 3,050

The importance of sweet potato as a source of calories for the first intake quintile (25 percent of all calories) was found to be more than twice what it was in the fifth quintile (12 percent) (*11*, p. 115).

The same study found that the average rural household consumes what amounts to the equivalent of 60 U.S. dollars worth of sweet potato each year, most of that coming from the household's own production (*11*, p. 24):[7] [8]

Source	Value in Rwanda francs	Percent
Own production	5,071	92
Purchases	272	5
Gifts	166	3
Barter	24	<1
ALL SOURCES	5,533	100

If only those households actually making sweet potato purchases are considered, the results are somewhat different. According to ENBC, one-third of all households purchase sweet potatoes, spending on average the equivalent of 10 U.S. dollars (*10*, p. 31). The results of the ENQPAT survey indicate that half of all rural households buy sweet potatoes, but that purchasing rates vary by prefecture, being highest where there are fewest producers (Ruhengeri and Gisenyi) and lowest where households rely most heavily on sweet potato (Gikongoro) (*9*, p. 54):

[7] Here and in subsequent computations conversion from Rwanda francs to U.S. dollars has been made at the rate of 90 francs to 1 U.S. dollar.

[8] Since most sweet potatoes never enter the market, there are some problems with valuing their consumption at the prevailing market price. By so doing, more is assumed than is warranted about the state of supply and demand.

Prefecture	Households buying sweet potato (percent)
Gisenyi	64
Ruhengeri	60
Byumba	53
Gitarama	51
Kibungo	46
Butare	44
Cyangugu	43
Kibuye	43
Gikongoro	26
Kigali	28
RWANDA	46

The ENBC study analyzed demand for different goods as a function of the value of per capita consumption of all products, by household, and other household characteristics (*11* pp. 11 and 113-121). The independent variable used to estimate demand elasticities was the annual value of per capita consumption of all products by household (a proxy for income or household well-being). The dependent variable was the percent of the household budget allocated to particular consumption categories (food, sweet potatoes, and so forth). From the demand and consumption relationship were computed demand elasticities similar to the commonly used income elasticities of demand. The rationale for using value of total consumption rather than the more commonly used income level was that the value of consumption can be more precisely measured than income, and that consumption levels in developing countries tend to be more stable from season to season than is income (*11*, p. 114). Rather than be considered as normal income elasticities, the elasticities derived by the study are, more strictly, expenditure elasticities, since the dependent variable is a monetary value rather than a physical quantity. The elasticities differ from expenditure elasticities, however, in that the values of total consumption as well as the consumption of specific goods include the value of goods purchased as well as those produced by the household itself.

The study found that as the value of total consumption increases, the value of sweet potato declines in importance, and there tends to be a shift away from sweet potatoes and other low cost foods, towards more expensive sources of calories. The relatively low (0.14) income elasticity of demand of rural households for sweet potatoes suggests that while total consumption increases with income, because demand is elastic, albeit only slightly, sweet potato's share of the food bill becomes smaller. A 1-percent increase in overall household consumption results in only a 0.14 percent increase in sweet potato consumption. The table below, also from ENBC, lists the income elasticities of sweet potato and key competing starchy staples in descending order (*11*, p. 120):

Food	Elasticity
Potato	1.45
Banana	0.77
Sorghum	0.67
Beans	0.63
Cassava	0.42
SWEET POTATO	0.14
Processed foods	1.85
All food	0.85

The relatively high elasticities of demand for potato and banana suggest that consumption of them will increase nearly proportionally with overall household consumption (or income), and if consumption levels increase, the share of potato and banana will grow at the expense of products with lower elasticity. The extremely high demand elasticity for potato reflects its status as a luxury food among rural households. Potatoes have come to be viewed, perhaps because their consumption was associated with Belgian colonialists, as part of the sophisticated diet of the well-to-do. As value of consumption (income) grows, more potatoes tend to be bought and consumed.

Sweet potato consumption does not increase proportionately with increases in personal income (total consumption). This has two ramifications:

- Sweet potato represents an especially important component of the diet for primarily the poor, or for those with low levels of value of consumption overall.

But this brings up a difficulty with the measurement used. Values rather than actual quantity consumed have been used to determine income elasticities, and it is not completely clear whether households that are better off in terms of higher value of food consumed eat less sweet potato or whether because their food bill is larger, as a result of eating more expensive items, a similar amount simply represents a smaller share of total consumption.

- The other implication is that the relative importance of sweet potato in the average diet is not much affected by total consumption or income. The sweet potato is truly a Rwandan staple.

Although no price elasticities of demand are available for rural or urban consumers, general estimates can be derived from income elasticities. They must, however, be interpreted with caution. Estimates of income elasticity set the lower limit on price elasticity. Consequently, the absolute value of price elasticity can be placed at no less than $|-0.14|$, and because of the existence of substitutes such as cassava, banana, potato and other root crops, it is probably higher. Nonetheless, demand for sweet potato, is almost certainly inelastic with respect to its own price. A 1-percent drop in price will result in a 0.14 to, perhaps, 0.20 percent increase in consumption for the average household. Richer households would have lower price elasticities, poorer households, somewhat higher price elasticities of demand.

It is as difficult to ascribe meaning to price elasticities as to income elasticities in the rural semisubsistence setting that characterizes most of Rwanda. Income elasticities are computed on the basis of imputed values of consumption because most food, especially the sweet potato, does not enter the market. Overall low market orientation poses problems for the interpretation of estimates of price elasticity. If a household does not get any of its sweet potatoes on the market, prices do not influence consumption directly, but indirectly through sales or substitution decisions. Nonetheless, the seemingly low price elasticity suggests that the key to promoting sales and demand for sweet potato and sweet potato products is to process them into a product that has advantages such as high value and easy storage and preparation — values normally associated with processed foods. It is worth noting that the income elasticity of demand for processed foods (principally locally processed) has been estimated at 1.85.

Growth in Urban Demand and Consumption

The consumption and demand patterns of urban consumers differ from those of rural consumers. There is a greater selection of foods from which to choose, and consumption is more directly tied to cash

income and product prices. Because average urban income is higher it is likely that the income elasticity of demand of urban households for sweet potato is generally lower than that of their rural counterparts. There are, nonetheless, two primary reasons urban demand for sweet potato is likely to increase in the future:

- Population increases are rapid as Rwanda begins to urbanize in earnest; and
- At least half, probably more, of the sweet potatoes eaten in urban households will have to come from the market.

According to the urban component of ENBC, conducted between 1984 and 1986, food consumption represents just under half the average urban household's total annual consumption of all goods and services (*10*, p. 2). Most of that is purchased. Since the households are urban and, by definition, have limited access to land, it is remarkable that a little over one-tenth of households' food needs are produced by the households themselves.

Sweet potato ranks fifth, along with banana, in value of starchy staples consumed by the average urban household. It represents 4 percent of the value of all food consumed, a little under one-tenth the value of starchy staples, including beans and peas, and about one-sixth of all roots, tubers, and bananas consumed. Roughly half the sweet potatoes consumed are bought (*10*, p. 1):

Source of sweet potatoes	Average annual value of urban household consumption FRw	Percent
Own production	1,762	51
Purchases	1,692	49
Barter	11	<1
ALL SOURCES	3,465	100

More than 90 percent of all households eat sweet potato, and an only somewhat smaller proportion (85 percent) buy them.

Based on the value of annual sweet potato consumption among urban households (3,465 francs versus 5,533 francs for their rural counterparts), and on an estimated per kilogram price of 11 francs, we have estimated that urban households consume on average 315 kilograms of sweet potatoes annually. They consume a little less than half the quantity of sweet potatoes eaten by rural households, but they purchase greater amounts than their rural counterparts. Urban households purchase 49 percent of what they consume, spending on average 1,700 francs for 150 kgs, while rural households spend on average 290 francs for them annually (*10*, p. 3, and *11*, p. 30). Among households actually buying sweet potatoes, urban households spend 2,000 francs each year, while rural households spend only 930 francs.

The rapid growth in the urban population, and the likely ramifications of that growth, has been treated above. Income elasticities are assumed to be smaller among urban households than among rural households. Price elasticities, on the other hand may be larger in spite of the normal association between price and income elasticities, because of the availability of a wide range of substitutes for sweet potatoes in urban markets. Substitutability between the root and tuber crops and bananas is high (field notes).

The homogeneity condition suggests that own-price elasticity is likely to be high since income elasticity is low and cross price elasticities appear to be high.[9]

Nearly half the sweet potatoes consumed by urban households are supplied through the market. Rwanda's urban population was estimated at 420,000 in 1988 (*4*, p. 278). If urban households are indeed eating 315 kilograms of sweet potato each year, of which 150 kilograms are bought, then roughly 13,250 metric tons must be brought into urban markets. The average annual rate of urbanization between 1980 and 1987 has been 8 percent, which means that for the sweet potato to retain its position in the urban diet, the amounts brought into urban markets will have to increase by 6,200 metric tons, an increase of roughly 50 percent, over the next five years.

With increased urbanization there will be less space on which to grow the kitchen gardens that have heretofore enabled urban consumers to supply up to half of the sweet potatoes they consume. More of what is consumed in the cities will have to come from the outside via the market. If, for example, the self-sufficiency ratio of urban consumers falls from 50 percent to 25 percent, the additional amount of sweet potatoes that will be needed on the market within five year's time will be roughly 10,000 tons. The organization and performance of the sweet potato market is studied here to provide information necessary to ensure its optimal performance in meeting the rapidly growing demand for inexpensive sources of food especially among the nonagricultural population.

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[9] The homogeneity condition is based on the observation that the sum of income elasticity, own price elasticity, and cross price elasticities is zero.

CITATIONS

1. Rwanda, Ministry of Planning, "Consommation alimentaire en milieu rural," *Enquête Nationale sur le Budget et la Consommation des Ménages*, Vol. 4, December 1988.

2. Ndamage, "Développement et amélioration de la production de la patate douce au Rwanda," in *Séminaire atelier sur la production, la conservation, la transformation et l'utilisation des racines et tubercules*, UNICEF-IWACU, February 8-12, 1988, Kigali.

3. Rwanda, Ministry of Agriculture, *Annual Reports*.

4. The World Bank, *Sub-Saharan Africa: From Crisis to Sustainable Growth* (Washington, D.C., 1989).

5. Rwanda, Ministry of Agriculture, "Résultats de l'enquête nationale agricole 1984," Report 1, Volume 1, September 1985.

6. Ndamage, G., "Développement et amélioration de la production de la patate douce au Rwanda," *Bulletin Agricole du Rwanda*, 21e year, January 1988, pp. 31-39.

7. Pfeiffer, H., "Evaluation du programme de recherche sur la patate douce à l'ISAR," Rapport de mission, Institut des Sciences Agronomiques du Rwanda (ISAR), Butare, June 1988.

8. Alvarez, M.N., and G. Ndamage, "La patate douce au Rwanda, situation actuelle," *Bulletin Agricole du Rwanda*, 18th year, October 1985.

9. Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions" (unpublished dissertation, Cornell University, 1991).

10. Rwanda, Ministry of Planning, "Consommation finale des ménages urbains," *Enquête Nationale sur le Budget et la Consommation des Ménages* (Kigali, 1985?).

11. Rwanda, Ministry of Planning, "Consommation et sources de revenus des ménages ruraux," *Enquête Nationale sur le Budget et la Consommation des Ménages*, Volume 3, May 1988.

CHAPTER THREE

ORGANIZATION OF THE SWEET POTATO MARKET

As a prerequisite to analysis of marketing efficiency in the sweet potato subsector, it is necessary to develop a clear understanding of the functions performed by the market, its structure, and the channels through which sweet potatoes are transferred from producers to consumers. Only then will subsequent observations about efficiency have practical significance. This chapter identifies market functions, the types and number of economic agents performing them, and the regulations, restrictions, and financial or legal obligations faced by participants at different levels of the market. Emphasis is placed on in-depth description of the performance of these functions, and comparison with the performance of markets for competing crops such as cassava and potatoes.

MARKET ORIENTATION OF SWEET POTATO PRODUCERS

Most sweet potato producers are marginally market oriented; what they grow is almost exclusively for consumption on the farm. Consequently, only a small part of each year's national harvest is marketed, which holds for most crops in Rwanda. It is not clear what percentage of production is marketed, although, because most sweet potatoes are grown for home consumption, the percentage should be quite low. There are widely differing estimates on percentage marketed, the most commonly reported being those made by the Ministry of Agriculture, and apparently based on little more than the educated guesses of agriculture agents. Table 3.1 presents ministry estimates of percentage of sweet potato, cassava, and potato production marketed, as well as estimates of percentage of all households selling those crops. It is estimated that one-third of the annual sweet potato crop is sold. This is probably not significantly different from the percent of cassava and potatoes placed on the market.

The ENBC study of the Ministry of Planning, and a study by ISAR have very different estimates of the percentage of sweet potato production that is marketed. The ENBC study estimated from 1982-83 data that only 6 percent of the sweet potato crop was sold. The percentage of the cassava and potato crops sold during the same period was estimated at 15 and 25 percent (*1*, p. 58). The ISAR study of sweet potato growers estimated that the marketing ratio was 12 percent (*2*, p. 52), but this study seemed not to include exchanges occurring in local/rural markets. Certainly only a small amount of what is grown is sold. This is further suggested by the relatively small proportion of growers that sell any of their sweet potatoes.

Nine out of 10 farmers grow sweet potatoes, but only about one-third of those cultivating them sell any (*3* and *4*, p. 76). They account for all the marketed surplus, which in 1984-86 would be, depending on the estimate of marketing ratio, between 269,000 and 54,000 metric tons out of total production of 895,000 metric tons (*1*, *5*, and *6*):

TABLE 3.1: RWANDA: PERCENT OF HOUSEHOLDS SELLING SWEET POTATOES AND OTHER CROPS, AND PERCENT OF PRODUCTION MARKETED, BY PREFECTURE, FOR SELECTED YEARS

Prefecture	Percent Households Selling[1]			Percent Crop Marketed[2]			
	Sweet potato (1984)	Cassava (1984)	Potato (1984)	Sweet potato (1978-79)	Sweet potato (1981)	Cassava (1978-1979)	Potato (1978-1979)
Butare	34	30	3	30	30	60	45
Byumba	31	8	9	25	32	40	38
Cyangugu	13	31	2	30	30	35	30
Gikongoro	39	21	7	23	23	40	35
Gisenyi	21	23	39	29	35	12	43
Gitarama	29	34	3	43	34	50	38
Kibungo	18	29	3	50	20	50	60
Kibuye	39	15	9	38	40	20	38
Kigali	29	35	5	30	40	33	20
Ruhengeri	31	3	24	30	30	35	48
National average	29	23	11	32	31	38	40
National average (1982-1983)	25	28	14	NA	NA	NA	NA
ENBC, Rwanda[3] (1982-1983)	NA	NA	NA	6	NA	15	25

Sources: [1] Rwanda, Ministry of Agriculture, *Resultats de l'Enquete Nationale Agricole*, Report 1, Volume 3, p. 122, May 1986; [2] Rwanda, Ministry of Agriculture, *Annual Reports*; [3] Rwanda, Ministry of Planning, "Consommation et Sources de Revenues des Menages Ruraux," *Enquete Nationale sur le Budget et la Consommation*, Volume 3, pp. 58 and 62, May, 1988.

Note: Percent of all households, producers and non-producers.

Source of estimate[1]	Percent marketed	Estimated amount placed on market (1000 MT)
Minagri (1986)	30	269
ISAR (1987)	12	107
ENBC (82/83)	6	54

The ENBC estimate is the lowest in part because it is based on a survey that distinguished between cash sales, barter, and sweet potatoes given away as gifts. Combining these three categories, we find that an estimated 9 percent of total production was marketable surplus — sweet potatoes that could have been placed on the market. When estimates of urban purchases are included, the ENBC data indicate that 11 percent of total production is transferred from producers to consumers annually.

The true percentage that is placed on the market probably lies between 10 and 15 percent of total production in an average year. The Ministry of Agriculture estimate of 30 percent seems too high since it implies that average sweet potato purchases per household in 1983 were 260 kilograms and average purchases per household actually buying sweet potatoes were 925 kilograms, whereas ENBC found corresponding figures to be 45 kilograms and 155 kilograms (*1*, p. 30). Percentages smaller than 10 to 15 percent do not seem reasonable either, in light of the author's market entry survey results, which suggest that between 5,000 and 8,000 MT entered urban Kigali markets during a 12-month period in 1987-1988.

Although relatively few households sell any sweet potatoes, a relatively large proportion buy them. Results from the ENQPAT survey indicated that nearly half of all rural households buy sweet potatoes, and of those households growing sweet potatoes, 41 percent buy from time to time. The ENBC study of rural households found that nearly one-third of all households consuming sweet potatoes were buyers (*1*, p. 30). In spite of increases in production, and rapid increases in the nonfarm population in Rwanda, the percent are of sweet potato production that is marketed has not changed much over the years. Table 3.2 shows marketing ratios of selected important crops for the years 1974 through 1979 (and 1981, for cassava and sweet potatoes). For the reasons stated above, these figures should be used with caution. The Ministry of Agriculture's percentages might be considered to overstate true percentages by a factor of two. We have used them for lack of any other multiple-year figures on levels of marketing. Comparing figures for 1974 through 1979 shows that growth in the share of sweet potatoes put on the market has been relatively slow — for example, half that for bananas. The marketing ratios of cassava and potato have doubled and increased by 20 percent, respectively, over the same period. Adding 1981 data, it is apparent that between 1974/75 and 1979/81 the marketing ratio for cassava grew four times as fast as that for sweet potato.

[1] The Ministry of Agriculture estimates are reported in the 1986 *Annual Report*; Ministry of Planning estimates are from the budget and consumption survey conducted in 1982/83; ISAR estimates were made by George Ndamage, the Institute's principal root and tuber researcher, in 1987.

TABLE 3.2: RWANDA: PERCENT OF ANNUAL PRODUCTION MARKETED FOR KEY CROPS, 1974-1981.

Crop	1974	1975	1976	1977	1978	1979	AVG[1]	1981
Bananas	28	30	30	40	53	54	39	NA
Beans	23	25	27	30	30	30	28	NA
Maize	18	22	27	28	30	28	26	NA
Cassava	16	20	34	36	37	39	30	40
Potato	35	36	40	38	40	45	39	NA
Rice	70	75	75	80	88	80	78	NA
Sorghum	30	33	37	36	35	35	34	NA
Sweet potato	21	24	32	33	33	30	29	30

Source: Rwanda, Ministry of Agriculture, *Annual Reports*, 1974-1979; Rwanda, Ministry of Agriculture, "Colloque sur la commercialisation des produits vivrieres," April, 1984.

[1] Average, 1974-1979.

STRUCTURE AND ORGANIZATION OF THE MARKET

Sweet potato markets are classified into three principal types depending on the overlapping of three criteria: the location (rural or urban) of the marketplace, its proximity to the supply area (local or long-distance), and the extent to which producers and consumers are separated and intermediaries required.[2] The first two, local/rural and local/urban, are with few exceptions exclusively retail markets, and refer to individual markets. The third type, the long-distance market, involves a network of wholesale/supply markets and urban retail markets. The author departs from normal marketing usage in referring to the urban retail markets as "terminal" markets to emphasize their relation to the wholesale/supply markets from which sweet potato shipments originate.

Local/Rural Markets

Most sweet potato sales are between farmers in local/rural markets, classified as local or *petit* by the Ministry of Agriculture (*7*). Because nearly all rural households produce some sweet potatoes, it is reasonable to assume that these markets are activated on one side by farmers with temporary or regular surpluses to dispose of, and on the other by farm households having temporary or chronic shortages in the production of sweet potatoes or substitutes.

Although the large majority of sales take place in the marketplace (80 percent of household sales), periodically entire unharvested fields will be sold. This occurs primarily when one household anticipates a large shortfall in its own production. Since the purchaser must provide the labor for harvesting and transporting to the household, the per unit price is usually lower than it would be in the market. Even less frequently, surplus producers will sell from their homes or from shops outside the local marketplace.

Local/rural markets are the most important in terms of number of markets and, consequently, number of buyers and sellers and volume of trade. Table 3.3 incorporates data from a Ministry of Agriculture list of markets with data the author collected from surveys. It shows that local/rural markets represent the vast majority of markets (89 percent) and, consequently, the majority of buyers and sellers. While volume of trade has not been quantified according to different market channels, this type certainly represents the vast majority of sales, probably around 80 percent (*3*, p. 68). This would mean that local/rural markets handled between 72,000 and 107,000 metric tons annually in 1984-86. Local/rural markets tend to draw from a relatively circumscribed market supply area usually having a radius of 5-10 kilometers. Map 3.1 shows potential market supply zones, based on the distances from which sellers were observed to travel to market. The largest zone is associated with Kigali terminal markets, which are part of the long-distance trade, the smallest is associated with local/rural markets.

Figure 3.1 shows the market flows typical of each of the sweet potato market types. A key characteristic of the local/rural market is the absence of middlemen and the presence, often, of as many or more sellers as buyers.

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[2] These are not categories of markets handling only sweet potatoes, but are classifications of the sweet potato sections of larger markets.

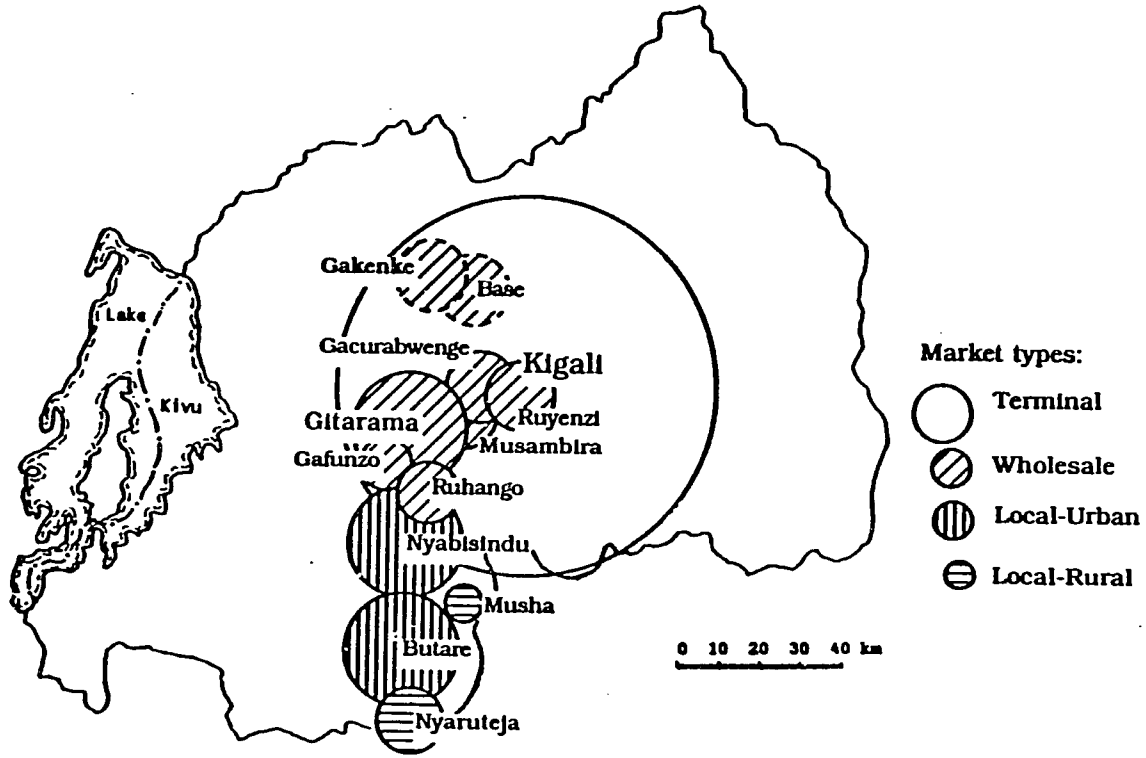
TABLE 3.3: 1987/88 SURVEY RESULTS: NUMBER OF MARKETS, AND OTHER CHARACTERISTICS OF THE PRINCIPAL TYPES OF SWEET POTATO MARKET IN RWANDA

CHARACTERISTIC	LOCAL/RURAL	LOCAL/URBAN	LONG-DISTANCE MARKET	
			WHOLESALE	TERMINAL
Number of markets in each category (%)	389 (89)	20 (5)	15 (3)	10 (2)
Average number of producers bringing produceto market in one day.[2]	50	50 - 100	100 - 400	10 - 20
Average number of consumers buying sweet potatoes in one week.	100-200	>200	NA	>500
Market participants (See Figure 3.1)	Producer, Consumer	Producer, Retailer, and Consumer	Producer, Bulker-Shipper, Bagger/Loader, Trucker, and Consumer	Bulker-Shipper, Retailer, Off-Loader, and Consumer
Radius of market supply zone (kms)[1]	5 - 10	10 - 15	10 - 20	~60
Units of sale	Exclusively by the basket.	Primarily by the basket, some mounds	Baskets, high quality.	Mounds of varying sizes.
Standardization and uniformity of product	Not uniform.	Uniformity of size and quantity for price.	Uniformity of basket size.	Standard relation size/price.
Quality: Sorting and Grading	Low quality: no sorting or grading.	Higher quality: sorting and grading by size.	Mix of quality: irregular sorting.	Higher quality: sorting by size, color and quality.
Selling strategies of producers	Passive, await buyers.	Passive, attract buyers with displays.	Aggresive promotion of sales.	Passive

Sources: Rwanda Ministry of Agriculture, "Nationwide List of Markets," 1987; Tardif-Douglin, D., Field Notes, 1987-88.

Notes: [1]Taken to be the distance to the furthest Secteur (administrative sub-division of the Commune) from which supplies come.

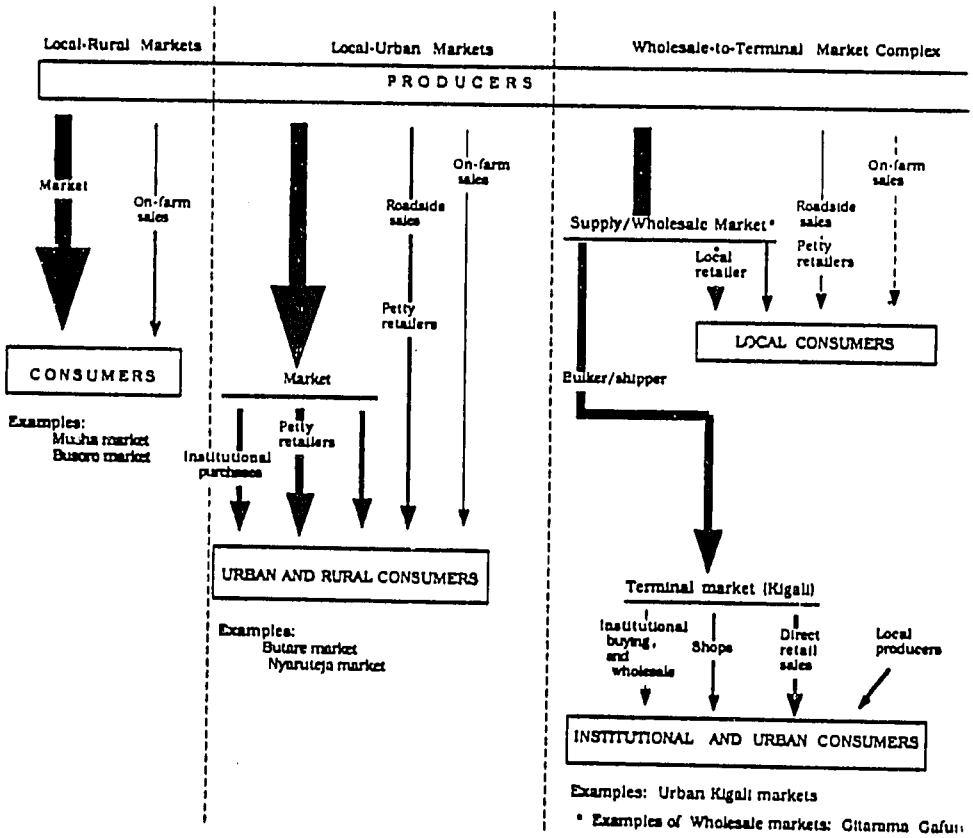
MAP 3.1: 1987/88 MARKET ENTRY SURVEY: MARKET SUPPLY AREAS FOR KIGALI AND OTHER SWEET POTATO MARKETS IN RWANDA



Source: Tardif-Douglin, D., Field Notes, 1987-1988.

Notes: The radius of each market supply area is taken to be the distance to the furthest Secteur from which supplies come.

FIGURE 3.1: DIAGRAM OF MAPKET FLOWS TYPICAL OF THE THREE MAJOR SUB-CATEGORIES OF THE RWANDAN SWEET POTATO MARKET



Source: Tardif-Douglin, D., Field Notes, 1987-1988.

Notes: Within each market type, line thickness is representative of each channel's relative importance. Lines that are not labeled signify direct sales by producer.

A typical market day begins as farmers, mostly women, each balancing a basket of sweet potatoes on her head, begin arriving in the marketplace early in the morning.[3] As they arrive they assemble in a section of the market reserved for produce, deposit their baskets on the ground, and sit in a group to await customers. There is no bulk-breaking, the only unit of sales being the basket, sometimes baskets of different dimensions (see Table 3.3). If requested to sell less than a basketful, most producers will comply, albeit reluctantly, fearing they will have difficulty selling the remainder.

The services of bulk-breaking and risk transference, usually associated with intermediaries, are not provided in these markets. The profits to be made by providing these services are apparently insufficient to induce would-be retailers, and producers see no gain in breaking the standard sales unit of one basket into smaller, less expensive units.

Specific examples of local/rural markets include the Musha and Busoro markets of Butare Prefecture, the former shown with its market supply radius in Map 3.1.

Local/Urban Markets

Local/urban markets are characterized by the presence of retailers (see Table 3.3 and Figure 3.1). Most would be classified by the MINAGRI as *moyen, grand*, or in some cases *très grand* (*7*). They range in size from tens to hundreds of participants. The presence of a much greater concentration of civil servants (these markets are usually in administrative centers), shopkeepers, and nonfarm laborers probably explains the need for the bulk-breaking services provided by retailers. Furthermore, because these markets draw from a marginally larger and more distant supply area (radius of 15 kilometers, according to Map 3.1) producers are less willing to spend time in the market waiting for customers. They prefer to sell to retailers for somewhat less than they could make in direct sales.

The volume of sweet potatoes entering these markets is unknown. The author has estimated that 15 percent of all marketed sweet potatoes pass through them, which would mean that between 1984-1986 they handled between 13,000 and 20,000 MT annually.

Local/urban markets are held more frequently than local/rural markets. When producers arrive with their baskets of sweet potatoes they congregate in a section of the market set aside for direct sales, removed from the stalls used by retailers. Retailers come by to make their purchases, which they take back to their stalls, break into smaller units, usually mounds of one to two kilograms, and sell.[4] Consequently, what is often seen in this type of market is what appears to be a hybrid of rural and urban markets. Retailers break bulk for customers who prefer to buy small quantities, while producers sometimes sell directly to consumers who need greater quantities. Invariably there are producers who remain in the market waiting for a price higher than that offered by retailers. By so doing they provide greater choice to customers.

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[3] The sweet potatoes brought to market will have been harvested very early that same morning or, more frequently, the evening before. They will have been cleaned and, in some cases, sorted before being placed in baskets to be taken to market. The baskets weigh between 10 and 20 kilograms, the Gitarama average being 16 kilograms (*1*). Two-thirds of those producers who market some of their sweet potatoes sell in one market only, the one closest to them.

[4] Almost no sweet potato merchants sell by the kilogram.

The prices producers receive in these markets are usually higher than those received in the local/rural markets, but not enough to substantially alter the way produce is brought to market, or to greatly widen the supply area (*3*, p. 74).[5] It is not clear what the price threshold is above which is triggered the use of alternative methods of transportation (bicycle, taxi-bus, or pick-up truck) to the head load. The price differentials between Kigali and wholesale supply markets, as will be shown below, provide estimates of the price levels necessary to attract vehicles permitting longer-distance trading than is possible with the headload.

The existence of intermediaries differentiates this type of market from the smaller local/rural market. The lack of more than one level of intermediary and other forms of transport distinguish it from long-distance markets. The local/urban market includes most marketplaces in prefecture capitals and in the larger towns throughout Rwanda. Specific examples, whose supply zones can be seen in Map 3.1, are Butare, Nyabisindu, and Nyaruteja.

Long-distance Market

The long-distance market includes wholesale/supply markets that differ from local/rural markets primarily in that transactions tend to be between producers and intermediaries rather than consumers (see Table 3.3). It also includes retail/terminal markets, primarily in urban Kigali, to which sweet potatoes are regularly transported and sold.

The typical wholesale market in the long-distance trade looks much like a local/rural market in that there are many women entering the market with carefully loaded baskets full of sweet potatoes. There is, however, much more activity and a much greater sense of trading as merchants and producers dicker over price, quantity, and quality. What is often apparent in wholesale markets is the greater care with which sweet potatoes are cleaned, packed, sorted and presented (see Table 3.3), and the relative uniformity in basket size and weight. The terminal market resembles a well-developed local/urban market with the difference that producers are more likely to be absent or peripheral, and most sales are made by large-volume retailers.

The few markets involved in the long-distance trade are dominated by relatively large-volume merchants (hereafter referred to as bulker-shippers to emphasize the dual nature of their activity) who assemble sweet potatoes in wholesale markets, ship them to terminal/retail markets where they sell them directly or through other intermediaries. The author has already estimated the amount of sweet potatoes moving through the local (rural and urban) markets at 95 percent of all that is placed on the market. This leaves an estimated 5 percent placed on the long-distance market. The annual amount of sweet potatoes entering these markets in 1984-86 averaged between 5,000 and 7,000 metric tons. Another way to estimate the quantity placed on these markets is to work backward from the number of persons living in Kigali (300,000), ENBC estimates of household consumption and percentage of consumption that is purchased, and estimates of household size.[6] There are roughly 60,000 households in Kigali, consuming on average 315 kilograms of sweet potatoes annually of which about 150 kilograms are purchased. This

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[5] The survey of weekly prices was conducted in five markets, only four of which had relatively complete data.

[6] The average household is composed of five persons.

suggests that urban Kigali purchases in 1984-86 were on average 9,000 metric tons. The vast majority of sweet potatoes placed on Kigali markets comes from outside greater Kigali (*3*, p. 75).

The small number of this type of market and the relatively small amount of produce passing through its channels are made up for by its complexity. Furthermore, the long-distance market provides a wealth of information about the development of distribution networks for perishable products, which will become increasingly important in the future.

As can be seen from Map 3.1, the long-distance trade represents the largest single overlapping of supply and demand zones for sweet potatoes. It comprises the six largest urban Kigali markets, Nyarugenge, Nyamirambo, Nyabugogo, Remera, Gikondo, and Kicukiro, as the terminal markets, and numerous Gitarama, Kigali, and Ruhengeri prefecture markets (the two most important being in the towns of Gitarama and Gakenke) as the wholesale or supply markets. Regional flows are presented in Map 3.2, which is derived from the author's market entry surveys, principally those conducted in wholesale markets. It shows that most sweet potatoes entering urban Kigali come from producers in the Central Plateau and the Granite Ridge. The vast majority of sweet potatoes come from the market in the town of Gitarama. Our estimate is that three-quarters comes from Gitarama, 20 percent from southeastern Ruhengeri (Base and Gakenke), and another 5 percent from east of Kigali (*3*, p. 76).

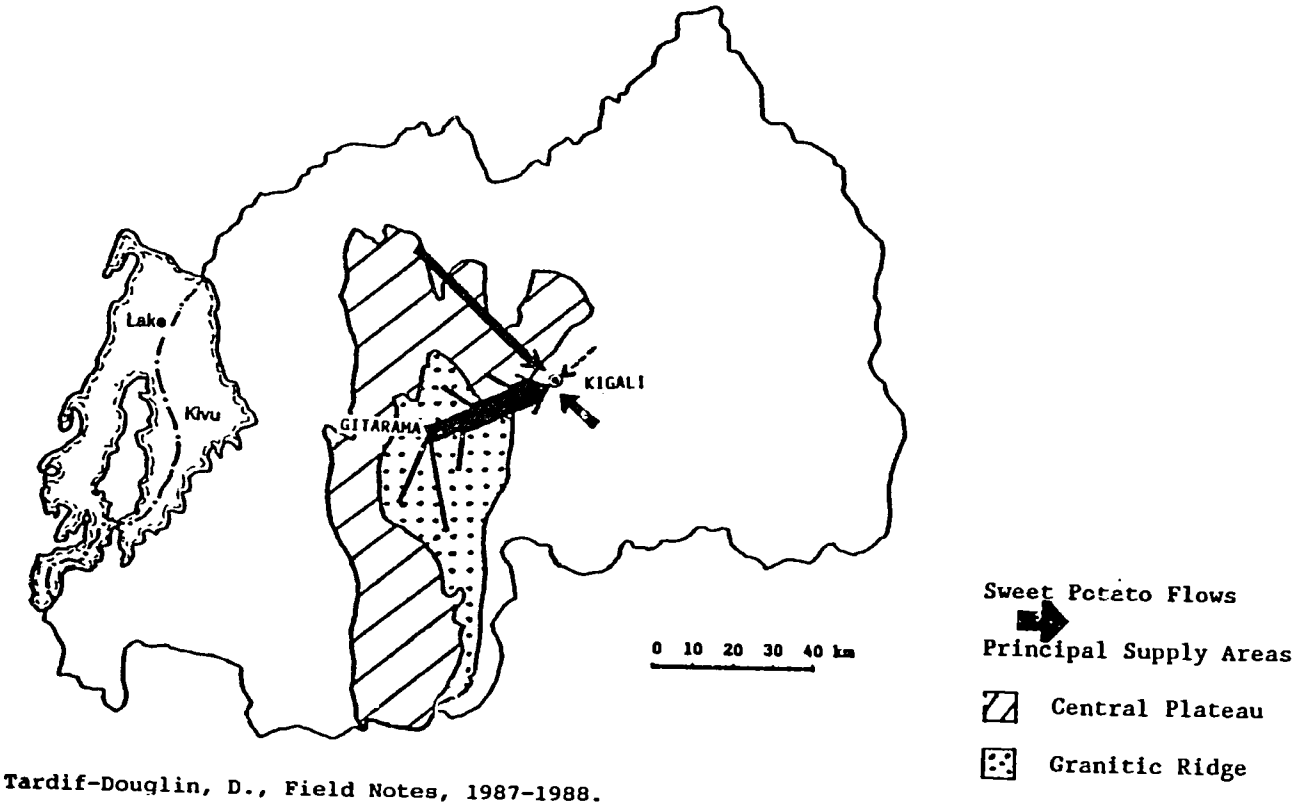
Findings from our market surveys (see Map 3.1 and Table 3.3) indicate that the supply radius for the long-distance market is 70-80 kilometers. Other competing foods are transported much greater distances. Bananas and cassava are transported from as far away as Kibungo, 110 kilometers away. The supply zone for potatoes extends to a point between Ruhengeri and Gisenyi, from 90-150 kilometers from Kigali.

Most sales in the limited number of wholesale markets are from producers to bulker-shippers coming up from urban Kigali markets. Transactions are made relatively quickly because both sides appear to have information about current prices on a given day and for a given tuber quality. Additionally, bulker-shippers are usually competing to get back to the terminal market with the first shipment of fresh tubers. Whoever first returns with fresh tubers is ensured rapid turnover of their stock and a price premium over the inventory of sweet potatoes remaining in the market from the last trip to market, three to four days past.

The process by which buyers and sellers come to agreement on prices and gain price information is shown schematically in Figure 3.2. The opening price quoted by the seller is based on knowledge she has gained about the market from previous experience and from the experience of friends and neighbors. It is also influenced by cash needs and cost of production. The buyer makes a counter offer whose amount is influenced by his past experience, cash needs, information from other participants, expected sales price (if the buyer is an intermediary), and an assessment of the willingness of the producer to bargain. Then begins the process of price discovery wherein each side applies pressure to bring the price as close as possible to their opening position. Whichever side can apply most pressure while resisting opposing pressure is likely to succeed in pulling the final price closer to his or her initial position. It would be this side that would seem to have the balance of bargaining or market power.

Contrary to conventional wisdom, farmers do not universally consider buyers to exert excessive market power. This conclusion is based on responses to one of the questions in ENQPAT, which asked producers whether the final price for their sweet potatoes was closer to their own opening price or the opening price of buyers (*3*, p.80):

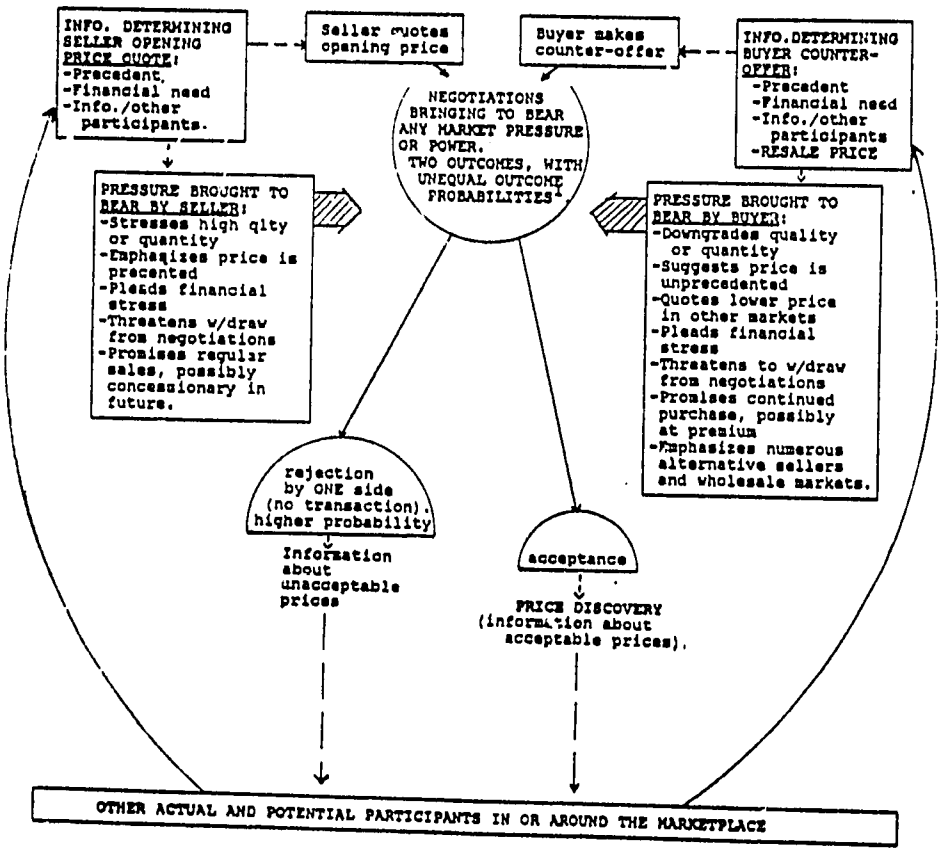
MAP 3.2: MARKET ENTRY SURVEY, 1987/88: FLOWS OF SWEET POTATOES FROM WHOLESALE MARKETS TO TERMINAL MARKETS IN KIGALI



Source: Tardif-Douglin, D., Field Notes, 1987-1988.

Notes: Thickness of arrow is related to relative importance of supply area. The arrow coming from north-east of Kigali has a broken line to show the uncertainty and irregularity of supplies from that region.

FIGURE 3.2: DIAGRAM MODEL OF THE PROCESS OF PRICE FORMATION AND DISCOVERY, AND THE DISSEMINATION OF PRICE INFORMATION IN RWANDA'S SWEET POTATO MARKET



Source: Tardif-Douglin, D., Field Notes, 1987/88.

Notes: Rejection on one side is all that is needed for trade not to occur; acceptance by both sides is necessary for it to occur. Hence, most price information that is disseminated is about prices that were unacceptable.

	Closer to Producer	Closer to Buyer	Neither, or don't know
		(percent households)	
Full sample	47	44	9
Gitarama	38	56	6

That the transaction price may be closer to the producer's initial price than to the buyer's price does not necessarily mean the buyer has not exerted market power. Producers' opening price may be highly conditioned on past experience with buyers and knowledge of what buyers have been willing to pay in the past. Hence, buyers may exert market power through a built-up influence on price expectations rather than through individual, isolated dickering with producers. But it is similarly likely that buyers will tend to price according to what they expect producers will accept. In the absence of historical market power on one side or the other, observing how prices are formed in each transaction can give clues as to the balance of market power. Respondents were about equally divided between those who considered buyers or producers to have the greater effect on prices (*3*, p.80). This approximate parity in power did not seem to hold between producers and bulker-shippers. In Gitarama prefecture, for example, where more than four important markets cater to urban Kigali demand, 56 percent of the farmers believed buyers had more influence on the transaction price.

Usually bulker-shippers have information on price movements in the markets where they sell as well as in one or more other wholesale markets. Consequently, their negotiating tactic of emphasizing that prices are lower in other comparable markets carries weight, probably tilting transactional power in their favor. That there are far fewer merchants than producers probably adds to the former's market power (oligopsony); they have greater opportunity to collude on prices. This power is reduced, however, by the option most producers have of removing their sweet potatoes from the market if prices are not acceptable. The ENQPAT survey suggests that one-third of all producers use this option rather than sell at unacceptable prices.

The predominant type of transaction observed in the urban terminal markets is retail sales of sweet potatoes that have been imported from outside of greater Kigali.[7] Some wholesale transactions occur between bulker-shippers and institutional buyers — restaurants, schools — but it is relatively infrequent. It is rare to see producers selling directly to consumers, although it does occur in the more peripheral urban markets. More frequently, producers desiring to sell their sweet potatoes will arrange to sell through retailers, probably preferring to accept a lower price in exchange for reducing the opportunity cost of waiting for customers.

The organization of the long-distance trade in sweet potatoes appears sophisticated in comparison with the more local markets. When contrasted with the markets for cassava and potatoes, however, it seems undeveloped and limited. The potato subsector has a marketing channel that has reached all but the very smallest and most localized markets in the country, and is operated by numerous intermediaries (*8*, pp. 79 and 82). The cassava market derives its advantage over the sweet potato market from household-level processing. By soaking and drying their cassava, producers have produced a highly transportable, high-value product that is not nearly as perishable as it would be unprocessed.

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[7] By greater Kigali is meant urban Kigali and the surrounding supply and demand areas that are accessible by foot. Sweet potatoes coming from greater Kigali do not represent the bulk of sales in the larger markets of the city.

Consequently a product whose market is no older than that for sweet potatoes has become substantially more active and developed.

PERFORMANCE COMPARISONS

A market can be considered to be functioning well to the extent that it performs well in providing utility or benefits to producers and consumers, and conveys accurate and timely information about supply and demand conditions. This section is devoted to describing and assessing the functioning of the sweet potato market, comparing it to the performance of markets for cassava and potatoes where possible, and to the idealized market performance of a perfectly competitive market. Table 3.4 lists the general functions a market is expected to perform and contrasts the extent to which the sweet potato, cassava, and potato markets perform them. Ideally, markets must provide producers and consumers with time, place, and form utility. Prices should, additionally, provide clear information about the state of supply and demand in the market and in connected markets. The sweet potato market does not appear to be providing these market utilities as well as the markets for competing crops such as cassava, potato, and banana.

Provision of Time Utility

Time utility is satisfied when a mechanism exists whereby consumers can gain access to sweet potatoes when they need them, and producers can unload surplus production when necessary and profitable. Because, with few exceptions, sweet potatoes can only be bought on market days, both producers and consumers may not be able to achieve time utility as well as they can in other markets. This is less of a problem in urban markets, which are normally open three to six days of the week. But it can be an important problem for rural households, which often have access to markets only once a week.

The potato and cassava markets are better able to provide day-to-day time utility. Dried cassava can be found in local shops relatively easily even when the market is closed. Potatoes can be bought any day of the week from local shopkeepers, local traders, and cooperative outlets (*8*, pp. 83-85).

Restricting the hours during which transactions may take place in the market, to the extent restrictions are enforced, also introduces inconveniences for producers and consumers. In the principal urban Gitarama market, for example, the market must close by 3:30 in the afternoon. This regulation is enforced by communal market policemen who will forcibly remove remaining producers from the marketplace after that time. That producers will often remain until that time is evidence that there is an unmet demand on the part of producers for additional selling time.

Because storage for periods longer than one or two days is virtually unknown, the sweet potato market provides little time utility through storage. There are a few producers who will place their tubers in the sun for a few hours before setting them aside for a few days before they are needed. They are an extremely small minority. Furthermore, the difference in storability is on the order of days, not the weeks or months that are possible using techniques currently unknown to producers. Many farmers do have knowledge about the relative postharvest perishability of the varieties available to them, and to some extent use perishability as a choice criterion. The form of storage most prevalent at this stage of the development of the market is farmer-supplied in-ground storage, where sweet potatoes are kept in the

TABLE 3.4: THE PROVISION OF PLACE, TIME AND FORM UTILITY IN SWEET POTATO, CASSAVA, AND POTATO MARKETS IN RWANDA

FUNCTION	SWEET POTATO MARKET	CASSAVA MARKET	POTATO MARKET
Provision of PLACE UTILITY			
-Assembling	Only marketplace assembling	Shopkeeper and market-place assembling	Rural trader, shopkeeper and marketplace assembling
-Transport	Transportation, usually by headload	Greater use of vehicles for transportation	Greatest use of trucks, often large trucks
-Wholesaling, retailing	Very few intermediaries # participants ≤ 3	Somewhat more intermediaries # participants ≤ 4	Numerous intermediaries # participants ≤ 6
Provision of TIME UTILITY			
-Storage	Storage is extremely rare	Storage of dry tubers is practised regularly	Greater short term storage than with sweet potatoes
-Frequency & duration of availability	Stable availability throughout the year	Stable availability throughout the year	Seasonal peaks and troughs in availability
Provision of FORM UTILITY	No processing Limited grading	Processing well developed Greater grading	Little processing Some grading
Dissemination of MARKET INFORMATION	Narrow and inaccurate	Wider, more accurate	Widest, most accurate

Sources: Durr, Georg, "Potato Production and Utilization in Rwanda," (Working Paper 1983-1, Social Sciences Department, International Potato Center, Lima, 1983); Scott, Gregory, J., *Potatoes in Central Africa: A Survey of Burundi, Rwanda, and Zaire.* (International Potato Center, Lima, 1988); Tardif-Douglin, D., Field Notes, 1987-1988; Appendix Tables B.1 through L.9.

ground past some optimal maturity to ensure access at a later date. It is unlikely, however, that this is converted in any appreciable way to time utility at other levels of the market.

The cassava market provides better time utility through storage of dry tubers and cassava flour. Both products are regularly produced and stored throughout the marketing chain. When combined with on-farm storage of cassava similar to that for sweet potatoes, storage throughout the market ensures relatively uninterrupted stocks. The availability of dried cassava has a relatively minor seasonal component; during the wet season drying is more difficult, supply is marginally reduced, and quality is often diminished. The potato market provides time utility through substantial short-term warehousing throughout its distribution system (*8*, pp. 83 and 84).

Place Utility

The provision of place utility ensures that sweet potatoes are transferred from producers that most need (and want) to liquidate surplus production to consumers that most need (and are able) to buy them, and that the product actually gets from one place to another. For most local/rural markets and urban markets the location of the market is crucial. It must be within walking distance of both sides of the market, buyers and sellers. If the market is too far away, potential participants will not be served, their place utility unrealized.

Sweet potato producers rarely travel more than 10-15 kilometers to market. They must carry a heavy, relatively low-value product at what the World Bank considers to be the very high per-kilogram cost of head load transport — 340 francs per ton/kilometer, which translates to roughly 50 francs for the average 16 kilogram basketful of sweet potatoes brought about 10 kilometers (*9*, p. 32). Cassava producers, however, because they practice on-farm processing, have a lighter, less perishable, and higher-value product to transport. They will normally travel a greater distance to market, up to 20 kilometers. Potato producers regularly walk up to 20 kilometers to market. The potato market is better able to provide place utility because it has a higher market value.

Another contributor to place utility is assembling, combining small amounts into large enough stocks to interest potential traders. Other than the rudimentary assembling that takes place at marketplaces on market day, none occurs for sweet potatoes. This contrasts with the assembling of small stocks of dried cassava by local traders for resale to bulker-shippers in wholesale markets. Rural potato traders also do substantial assembling. According to Scott they regularly collect and stockpile several tons of potatoes in their homes and shops for resale to trucker/traders (*8*, p. 83).[8]

The availability of transportation is an important determinant of the ability of a market to achieve place utility. For sweet potatoes the transportation system remains rudimentary and unorganized; most produce enters the marketplace by headload. The other forms of transportation — bicycles, minivans, and small trucks — are used for relatively small amounts. This is in sharp contrast to the organization of the potato market where 25 percent (compared to 2 percent for sweet potatoes) of production is exported to nonlocal marketplaces. Using larger trucks, of 5-10 ton capacity, reduces per unit transport cost in the potato market, and contributes to the different levels of attainment of place utility.

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[8] Gregory Scott is an agricultural economist working with the International Potato Center in Peru. He conducted a study of potato marketing in Central Africa, including Rwanda.

Furthermore, potential sweet potato supply markets remain underdeveloped for lack of reliable availability of transport services. These undeveloped markets provide examples of poor attainment of place utility. That a demand exists for the produce that could be exported from these markets is evident from the sporadic trips merchants make to buy and export from them. There is also a demand on the part of local producers for the outlet that these markets represent; that they bring their sweet potatoes to market is proof. Transport services to these markets are unreliable, making bulker-shippers understandably reluctant to buy large quantities (*3*, p. 87). Two examples of markets suffering from particularly unreliable transport services are the Gakenke market, on the main road between Kigali and Ruhengeri, and the Gafunzo market, in rural Butare.

Price Discovery and Formation, and the Dissemination of Information

A third function of the market is to facilitate price discovery and formation, and the accompanying dissemination of information about supply and demand (see Figure 3.2). Within local market supply areas information is well disseminated. Participants appear to have reasonably accurate knowledge of prevailing prices. The relative infrequency of trading, however (in most local markets there is only one day of activity each week), results in a discontinuous flow of market and price information. New supply and demand conditions can not easily be transmitted to potential suppliers until market day, thereby creating a lag between the new state of supply and demand and knowledge of it within the market. Market conditions for potato and cassava are more readily transmitted because potato and cassava sales are not as closely tied to market days.

Market information and price conditions of the typical local market are rarely disseminated beyond the limited confines of the local market supply areas, usually the distance producers are willing to travel with headloads of sweet potatoes. Very few producers are aware of prices in markets other than the single one they frequent. Such a limited flow of price information makes arbitrage problematic and infrequent. Very low correlation of price series across regional sweet potato markets, discussed in greater detail in chapter four, attests to the difficulty potential arbitragers have had in the market.

The lack of uniform weights and standard measures exacerbates the problem the market has of communicating (signalling) information. Sales are denominated in baskets or mounds that are often of various capacities and sizes. Without uniformity, the information that is disseminated tends to be unclear and inaccurate.

In the cassava market, by contrast, all sales, down to the most local of markets, are made by kilogram (*3*, p. 88). Because of greater uniformity and greater frequency of trades (sales in shops as well as in weekly markets) the cassava market provides faster and more accurate information about market conditions and prices. The higher correlation of prices between cassava markets, as will be shown below, suggests a better flow of information.

The potato market has the highest price correlation figure of the three considered. This apparently superior performance in the dissemination of price and market information is in keeping with what is known about the potato trade. It has the most extensive marketing channels and the largest market supply area. It is not surprising that it communicates information farther and faster than the sweet potato market. The correlation of price series from different markets is considered in greater depth in the next chapter.

Provision of Form Utility

Producing sweet potatoes in the form desired by consumers that sweet potato producers are willing to put on the market, at minimum cost to consumers and maximum return to producers, is the function of form utility.[9] It is normally thought of as processing only, but should also include any handling, sorting, and bulk-breaking (or bulking) that changes the form of the product, from what is bought by the intermediary (a basketload, for example), to what the consumer purchases (a mound).

Few of the procedures normally associated with form utility are provided by the sweet potato market. There is no processing. Some amount of grading is done in some markets, allowing customers to buy, within narrow limits, their preferred size and quality (or variety) of tuber. This does not take place in local/rural markets. The bulk-breaking practiced in local/urban and terminal markets provides customers with some form utility by allowing them to buy, again within limits, the amount needed. Instead of buying an entire basketful or bagful, consumers can buy a fraction of either. This usually means access to 1-kg or 1.5-kg mounds of sorted sweet potatoes, formed by retailers, but in some markets also includes baskets and mounds of various sizes. This is most developed in urban Kigali markets, especially the central marketplace.

The cassava and potato markets provide more types of form utility. Processing has been the principal factor contributing to greater form utility in the cassava market. It is not clear when farmers began to process cassava, although it is probable that soaking, peeling, and drying of bitter cassava varieties began with the relatively recent introduction of cassava.[10] As a result, however, consumers now have a considerable range of choice in cassava products, from fresh tubers, to tubers dried under a number of different techniques resulting in different products, and cassava flour. The potato market provides form utility in part through standard size, prepacked containers of potatoes of the size most desired by consumers. This is most likely a practice recently adopted from the neighboring Zairian market.

The cassava and potato markets appear to be performing the idealized functions of product markets better than is the sweet potato market. This is suggested from the information presented above, by smaller margins between excess supply and excess demand regions (discussed below), and by higher interregional correlation of prices (also discussed below).

LEGAL, POLITICAL, AND CONTRACTUAL ENVIRONMENT

The legal, political, and contractual environment can either advance or hinder a market's operation and development. It affects the market's ability to perform the basic functions of bringing producers and consumers together, enabling them to reach agreements on price and product quality that allow trade to proceed. Weakly developed legal and contractual arrangements have hindered the development and expansion of a low-cost market. Lack of certainty about supplies and the availability

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[9] Producers are here defined relatively broadly to include all intermediaries adding value to the final product purchased by the consumer.

[10] Cassava was not apparently known in Rwanda until around the time of the famine of 1945, when it was introduced by the Belgians in the hope that its cultivation would reduce the recurrence of famines.

of marketing services such as transportation have especially retarded the development of a smooth flow of produce from surplus to deficit areas. Furthermore, regulations seem to have a mixed impact. Price policy, which aims to place a floor under producer prices would have a distorting effect to the extent it is effectively enforced.

Market Regulations

Market regulations that have an impact on the sweet potato market are imposed at different levels of government. Probably the most important restriction is on when and where markets may meet — days, hours, and locations of sales. Although cultural and traditional factors influence the days markets are held, local authorities, usually at the commune level, determine when they may be held (*3*, p. 95). Most markets are open once a week, others from twice to three or four times a week, and the largest urban and regional markets may be open every day of the week.

It appears that concern over the ill effects often associated with market days in the past, namely drunkenness, loitering, and general lack of productivity, has led officials to reduce as much as possible the number of days markets meet (*3*, p. 95). There is some evidence, however, that with the increasing market orientation of the population in general has come a need for more market days. In the Gitarama market, for example, Wednesdays and Saturdays have traditionally been the only market days. In mid-1988, as a result of local pressure, Mondays became officially sanctioned market days as well.[11] Restricting when markets may be held might hinder market development. This holds for all products, but is especially a problem for perishables like sweet potatoes.

In most markets the hours during which trading may take place are also restricted. Usually trading takes place between 8:00 am and 3:00 pm, rarely beginning before 7:00 and only in special cases (Ruhango) going past 5:00 o'clock. Forcing participants to adhere to these restrictions allows market officials to control the market for reasons of taxation, sanitation, and general market orderliness. These objectives certainly have merit and value to the development of the market. In some markets, however, opening and closing hours are overly strictly observed with no apparent rationale other than the convenience of officials (for example, Gitarama, where market police will physically disrupt sales, overturning vendors' baskets if the latter remain on the market grounds after 3:30 pm).

An important problem with maintaining such strict limits on when trading activity may take place is that the resultant price fluctuations (usually declines) toward the end of trading can be very large as a percentage of the prevailing price.[12] The producer who is left in the market near the end of trading faces the dilemma of either reducing the price sharply and quickly or not making the sale at all.

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[11] It appears that the local pressure resulted from the perception, on the part of local consumers, that wholesale trade dominated transactions on Wednesdays and Saturdays to the detriment of retail activity. The Monday market was to be held primarily for local retail transactions. Interestingly, however, on the very first Monday the market was held Kigali bulker-shippers were there.

[12] Restrictions on the period during which trading may take place is not new or unique to Rwanda. More sophisticated markets, commodities markets in the United States, for example, have official opening and closing times. The difference is that the latter deal with contracts as opposed to physical perishable goods.

One regulation that improves the dissemination of market information within individual markets is the requirement that specific product groups like tubers and grains be traded in proximity to one another. Each crop is also expected to be bought and sold in the same general area. Thus in the Gitarama market there is a long row of sellers and buyers just in from the principal road. Behind it are producers awaiting better prices. Next to the section where sweet potatoes are being sold is a section for cassava. As negotiations proceed and sales are made buyers and sellers of neighboring products gain price information that can help guide their marketing mix.

In the more sophisticated and specialized urban markets there is further separation. Within the same crop, producers who are considered to be selling wholesale congregate in one part of the market and retailers are generally segregated from them. Within each group, vendors adjust their price expectations as a function of the prices they see their neighbors receiving. In the absence of grouping this might otherwise not occur, or might happen relatively slowly.

Whether this segregation by type of participant creates discontinuities in the flow of information is unclear. If it were not for the periodic purchase by retailers of baskets of sweet potatoes from producers who have come to market, it is conceivable that these groups could remain relatively disconnected, their prices being formed independently.

Price Policy

Although it espouses, and generally adheres to, the principle that prices should be determined by supply and demand, the Rwandan government retains the right, established under a 1967 law, to control prices. The stated objectives of the government's price policy are to assure remunerative prices to producer (and intermediaries) without overpricing products to consumers, and to diminish seasonal price variability for food crops, thereby reducing speculative hoarding (*10*, pp. 90-93).

The government has used a series of controls to achieve these objectives, generally with little success. The most important of the controls include minimum producer prices, maximum margins for middlemen, maximum transport tariffs, regulation of commerce sector by licensing and separating wholesale and retail business, intervention in the market through parastatal marketing institutions, restriction of trade with neighboring countries — import limits, and the promotion of farmers' associations or cooperatives. A World Bank study of food marketing has evaluated each and found that, almost without exception, the controls have either been ineffective (minimum prices, transport tariffs, margin limits, parastatal marketing institutions) or counterproductive (regulation through licensing and import limits) (*9*, pp. 15-32).

It was not until four years after the law authorizing government intervention in price formation that any attempts were made to fix prices. Minimum prices were set first for bananas, in 1975, then for beans in 1976, potatoes in 1977, wheat in 1984, and all major food crops in 1986. All official minimum prices were revised in 1988 (*9*, p. 16).

Official prices have had almost no effect on prices of food crops traded in marketplaces. While the government has had the authorization to fix prices it has not had the power to do so. Market prices have generally been below the official minimum price, and no government agency has had the ability to enter the market and purchase sufficient amounts of any food to raise prices. Price policy has largely been irrelevant for the vast majority of market activity, especially smaller-volume trade, which would include most sweet potato marketing. It is true, nonetheless, that, "Its continued formal existence, even

though presently not enforced, creates a risk of legal prosecution for producers, cooperatives and merchants who buy and sell food crops and thus an uncertainty that hinders market development." (*9*, p. 19). Having official minimum prices contributes to another problem. It is often not clear whether the prices reported by various branches of the government reflect official prices or true market prices. Although they are supposed to reflect the latter, there is likely to be substantial pressure to report official prices as "proof" of the policy's effectiveness.

Public Services and Infrastructure

In addition to regulations and restrictions imposed on markets, governments at different administrative levels provide services and infrastructure aimed at facilitating trade and the development of markets. Clearly these must be paid for; user fees and general taxes are levied to provide the funds needed to operate marketplaces. It is useful to understand how the services and infrastructure, and, at least in part, the means by which they are funded affect the organization of the market and marketing decisions of actual or potential participants.

One service provided in even the simplest of local/rural markets is security. At minimum, a commune-level official combining the roles of tax assessor/collector and market manager is present on each market day (*3*, p. 99). In addition to collecting taxes he is responsible for ensuring that market regulations are observed. He is often accompanied by the head of the local police who assists in resolving trading and other disputes within the market, and ensures traders an environment relatively free of petty thievery. Sweet potato vendors do not explicitly bear the cost of this service; in strictly local/rural markets producers bringing their produce to market are not taxed, nor are consumers. The provision of an officially sanctioned place, the market grounds, is the other service (a type of infrastructure) provided even in the most rudimentary market.

With increasing sophistication and size, services and infrastructure such as market stalls, roofs, garbage disposal, and other marketplace infrastructure are provided to facilitate trading. Along with improved market infrastructure and services come higher levels of user fees. Fees in the most sophisticated and well-furnished markets are as high as 50 francs per stall per day, in addition to 1,000 Rwanda francs per stall per month (*3*, p. 100). Since neither taxes nor market fees are levied on producers as long as they are selling as wholesalers (that is, as long as they do not engage in bulk-breaking), it is the retailers and other intermediaries who bear the brunt of the cost of these services and infrastructure.

The market also provides, through the offices of the market master, an informal mechanism or forum for resolution of disputes over trade. In the Gitarama market, for example, a bulker-shipper upset at having been sold the contents of a basket with a false bottom refused to pay the amount initially agreed upon. He insisted on paying only half that amount. The market master was called in to determine who was at fault and to find a way to resolve the dispute. He found that the basket did have a false bottom, but he decided that since the excess weight was substantially less than half the weight of the produce, the bulker-shipper should pay more than half the price agreed upon prior to the dispute. In this informal but effective way, disputes are dealt with that could otherwise seriously impede trade. Whether the disputes tend to be resolved to the greater advantage of buyer or seller is difficult to say. Because it is revenue from merchants that to some extent supports the persons responsible for maintaining order, the tendency will be to favor merchants so they are not lost to other wholesale or terminal markets.

Contractual Arrangements

Contractual arrangements, to the extent they are enforceable, facilitate trade by ensuring that buyers and sellers (as well as other participants in the market) have access to, or outlets for, their produce. Contracts are risk management tools, whose role in the sweet potato market will be treated in Chapter Five. None exist between buyers and sellers at any level in the market (*3*, p. 101). They would hardly be expected in direct sales from producers to consumers at this early stage in the development of the market, but one might expect contracts to develop between retailers and their suppliers or, even more likely, between bulker-shippers or institutional buyers and their suppliers. As the risk of not succeeding to make planned purchases increases, so does the utility of, and demand for, contracts. Perhaps there lies the explanation for the lack of contracts between buyers and sellers; the utility of contracts is less for producers than for buyers because the risk to the former is less than to the latter.

Where the risks may be similar, as between bulker-shipper and transporter, there is some evidence of contract-like arrangements, some attempt to maintain a clientele or a service. They do not represent the norm, for contracts are practically nonexistent there too, but there are some examples of truckers providing credit arrangements to their bulker-shipper clients (*3*, p. 101). These usually take the form of agreements whereby the bulker-shipper is provided transport services without being required to pay until the end of the month. The merchant is thereby allowed greater liquidity for larger purchases during the month, and the transporter is assured a client and a profitable shipment. In the absence of contractual arrangements the majority of bulker-shippers and transporters face uncertainty and risk each time they go to market. This is likely to be hedged by caution and timidity in purchases and the supply of transport services.

The legal and contractual arrangements in the cassava market are unlikely to be significantly different from those that have been listed above for the sweet potato market. The potato market, described by Scott as having no written contracts, has better-developed informal, precontract arrangements. He mentions, for example, that "most urban wholesalers have a regular set of trucker suppliers . . . ," and later, that "wholesalers will advance potatoes to retailers in the morning and receive payment at the end of the day" (*8*, p. 85). These are indicators of developing trust and working relationships between participants at different levels in the market. Few if any analogs existed in the sweet potato market during the author's research.

CITATIONS

1. Rwanda, Ministry of Planning, "Consommation et sources de revenus des ménages ruraux," *Enquête Nationale sur le Budget et la Consommation des Ménages*, Volume 3, May 1988.

2. Ndamage, "Développement et amélioration de la production de la patate douce au Rwanda," in *Séminaire atelier sur la production, la conservation, la transformation et l'utilisation des racines et tubercules* (UNICEF-IWACU), February 8-12, 1988, Kigali.

3. Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991.

4. Rwanda, Ministry of Agriculture, "Tableaux sur les données saisonnières," *Résultats de l'enquête nationale agricole*, Rapport 1, Volume 3, May 1986.

5. Rwanda, Ministry of Agriculture, *Annual Report, 1986.*

6. Ndamage, G., "Développement et amélioration de la production de la patate douce au Rwanda," *Bulletin Agricole du Rwanda*, 21st year, Jan. 1988.

7. Rwanda, Ministry of Agriculture, List of Markets by Secteur, Commune and Prefecture (date unknown).

8. Scott, Gregory J. *Potatoes in Central Africa: A Survey of Burundi, Rwanda and Zaire* (Lima: International Potato Center, 1988).

9. World Bank, *Rwanda Agricultural Sector Memorandum: Working Paper, Food Crop Marketing* (Washington, D.C., 1990).

10. Rwanda, Ministry of Planning, *Stratégle Allmentaire au Rwanda, Objectifs, Chiffres et Programmes d'Actions*, Document no. 3, March 1983.

CHAPTER FOUR

AGGREGATE MEASURES OF MARKET EFFICIENCY AND INTEGRATION

PRICE CO-VARIANCE AS AN INDICATION OF EFFICIENCY AND INTEGRATION

Underlying most studies of the efficiency of marketing systems is the theoretical relationship between co-variation of price series and degree of pricing efficiency. In a perfectly competitive market, where there is room for arbitrage profits, these opportunities will be exploited so that the price differentials between two regions will be no more than the costs of transfer, of getting the product from one point to the other.[1]

As potential arbitragers compete for the business of transferring the product from one marketplace to another, the price of providing that service to the market will decline until it approximates the costs of transfer (transport, handling, storage, and other costs). If, as theory suggests and empirical studies have shown, prices in two connected submarkets differ by approximately the cost of transfer, they should move together. A change in price in one market should be reflected by a similar change in the other, lagged by the delay with which price information is communicated from one to the other.

Studies of price co-variation are useful in the analysis of two principal components of market integration, spatial and temporal, and have been used for both. For spatial integration it is assumed that transport and associated fees should ultimately approximate real costs of transfer. To the extent that they do, and as long as the costs of transfer remain relatively stable, the theoretical link between spatial marketing efficiency and similar movements of prices between marketplaces should hold. It is this spatial integration of markets that is measured by correlation coefficients of pairs of price series.

The argument for tests of temporal integration proceeds similarly: to the extent that warehousing and associated fees approximate the real costs of storage, seasonal price differentials should be uniform from year to year. Seasonal integration of markets can be measured by testing the degree of price correlation across seasons rather than markets.

Co-variation of price series has been used to determine the speed with which prices formed in terminal markets are transmitted to supply markets. The faster the transmission, the more efficient and integrated the system. Emphasis in studies of this sort done in developed countries has been on the mechanism of transmission, with lag structures considered extremely important. These studies have relied on highly accurate weekly price information with which to test market integration. One area where price correlation and price transmission analyses have been particularly important has been in studies of commodity futures markets.

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[1] A perfectly competitive market is by definition efficient in this sense, because competition will drive excess profits down to zero, driving out inefficient firms in the process.

TESTS OF THE EFFICIENCY OF RWANDA'S SWEET POTATO MARKET

Problems of Price Data in Africa

There are two categories of problems with price data in Africa. The first is accuracy in collection and reporting. The low overall level of accuracy is most attributable to inadequately supplied and trained staff, who often lack an appreciation of the role of market prices in signalling production and consumption mixes, and the lack of coordinated procedures for the collection, transmission and reporting of prices.

The other has to do with completeness and consistency, the existence and extent of missing or dissimilar observations. Poor infrastructure and insufficient budgets for data collection are important contributors to this problem. Completeness and consistency largely determine the degree to which data are useful for analysis. Incomplete price series, for example, make it very difficult for the price analyst to find enough observations to carry out analyses without running into degrees of freedom problems. Inconsistent data mean that what are supposed to be the same type of data from period to period, or between regions, may be dissimilar, rendering any price analysis exceedingly difficult or impossible.

Although, as is shown below, its data collection mechanism has faults and duplication, Rwanda probably has among the most accurate and consistent price data in Africa. Reasons for this include Rwanda's relatively well-developed and extensive infrastructure, which enables statisticians to procure and transmit data quickly, and official reliance upon free market forces for price formation. Reliance on market forces promotes an awareness of the importance of prices, which tends to be absent where arbitrary prices are imposed on markets, as occurs in much of Africa.

Price Data Used in Correlation Analysis

For the purposes of this study the price series generated by Rwanda's Ministry of Planning (MINIPLAN) were chosen. They constitute the most complete and standardized set of monthly data collected at the prefectoral level. Prices are collected between one and three times each month, usually at the beginning, after two weeks, and at the end of the month (*1*, p. 3).

There is some intra- and inter-market consistency in the prices that are being reported. Gitarama prices are purportedly collected between 9 a.m and 10 a.m. in the morning at the Wednesday market. To the extent that this schedule is adhered to, reported prices can usefully be compared across time. Additionally, and like other price series collected in other prefectures, each of the three monthly prices used to determine the monthly average are in turn based upon a sample of three prices. Each reported price is based on nine sampled prices in the market.

In Kigali, prices are normally collected between 8:30 and 12 noon, and in Kibungo, at 10 am. In some prefectures the statistical service has not collected its own data, relying instead on other services. An example is Cyangugu, where price series sent to the central Miniplan office have come from Minifineco reports, which in turn come from reports generated by each commune's mayor.

Some series represent wholesale and others retail prices. Although this is a problem for comparison of prices across prefecture, it does not pose serious problems for this study, because wholesale and retail prices would be expected to move together. It should, however, be realized as a

shortcoming of the price series. The lack of standardization diminishes the usefulness of prices as carriers of information about production and marketing conditions throughout the country. Wholesale prices and retail prices tend to be formed very differently, the former often less standardized and highly dependent on bargaining skills, and the latter increasingly uniform. It is true that there is less of a clear-cut distinction between producer, wholesale, and retail prices, especially for products that have a relatively thin and usually local market.

The extent of variability in the types of prices reported even within the Ministry of Planning is evident from the following review of collection methods used in different prefectures. In Gitarama, price information is collected from consumers exiting the market after having made a purchase. The price is noted and normally the purchase is weighed. These are actual, as opposed to asking, retail prices paid for particular commodities. In Kibungo, the statistician either buys the product to be priced or follows a procedure similar to that employed in Gitarama. By buying, the statistician has an exact price, but that price may not adequately reflect what most consumers are paying.

All series are collected in the markets nearest the Miniplan office, sometimes, but not always the most important market in the prefecture. The Miniplan prices are generally reflective of conditions in the morning, and the degree to which they are representative of the price prevailing throughout any one day of trading depends on the extent to which the commodity in question is perishable. The less perishable a crop the more accurately an early morning price will represent prices prevailing throughout the day, other things the same.

This brings up the issue of comparability — to the extent to which any conclusions can be made about relative prices. Sweet potato prices can, and do, fluctuate sometimes sharply throughout the course of the day. To determine what sort of hourly fluctuations there might be in sweet potato prices on an average day, the author conducted a survey of prices, hour by hour, for two to six days, in four markets (2, p. 123).[2] Average hourly prices are shown in Figure 4.1. Prices prevailing at any point in the day varied by as much as 25-30 percent of the daily average in some markets. They generally fell as the day progressed, a trend more regular in the more rural markets, Nyaruteja and Gitarama, where the ratio of vendors to consumers (buyers) is relatively high (Figure 4.1 b and c) In these markets prices began 4-6 percent above the daily average and fell throughout the day. Figures a and d show fluctuations in the more urban markets of Remera (Kigali) and Butare, where there was much less of a pattern of high early morning prices followed by subsequent declines, but also sharper price fluctuations. In Butare, prices opened slightly above the day's average and did not drop heavily until later in the day. Prices in the Remera market began 10 percent lower than the day's average and rose for the next three hours.

Because Miniplan prices are not averages, it is not clear how adequately they measure prevailing prices for perishable crops like the sweet potato. They are probably more accurate for more storable crops such as beans, sorghum, cassava (dried), and even potatoes (which are less perishable than sweet potatoes). Generally, prices reflective of conditions existing in the morning overstate the price of perishables such as sweet potatoes. The degree to which the price is overstated must be inversely related to the extent to which storage facilities are available and used.

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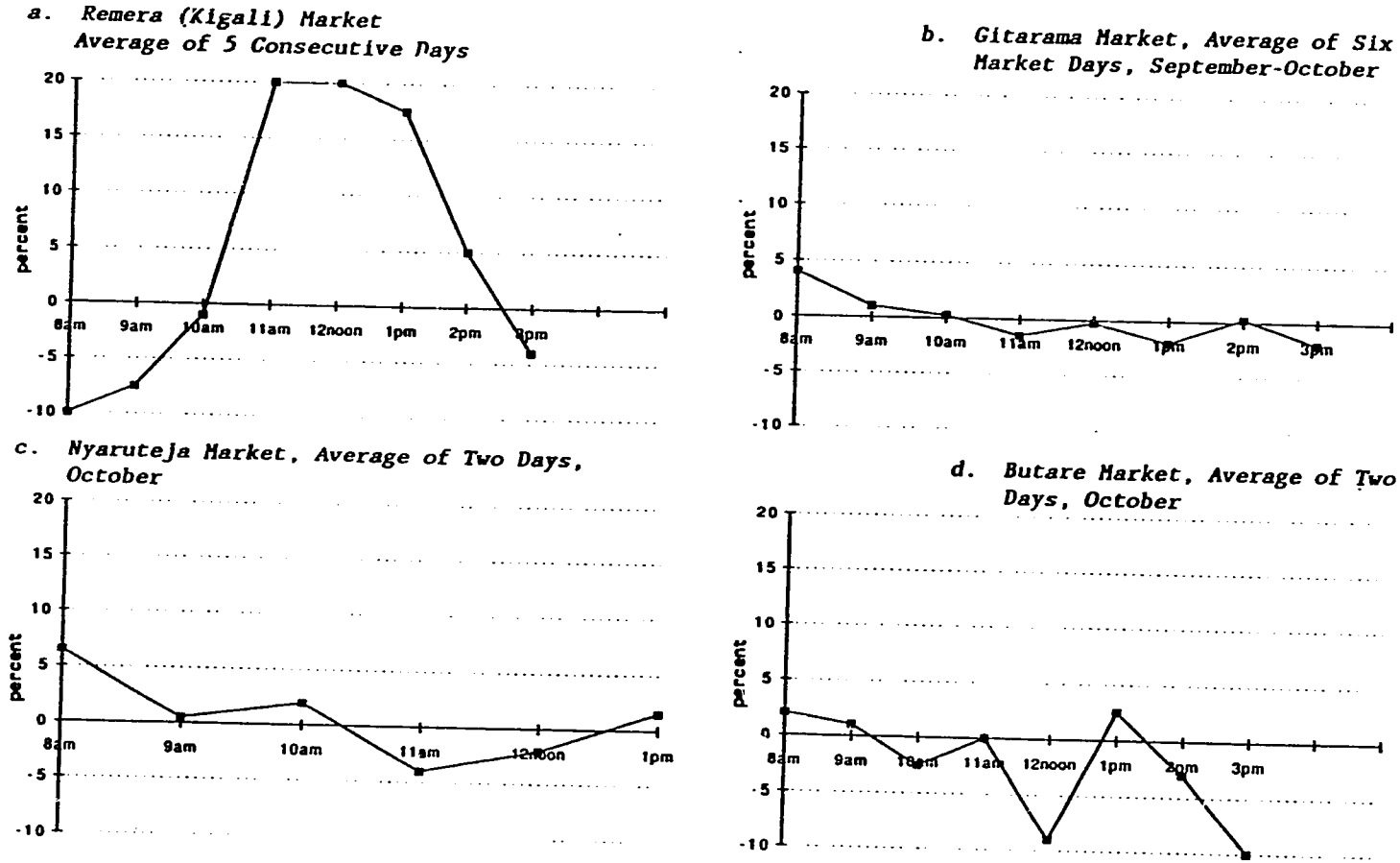
[2] Each price reported from the survey of hourly prices is the average of three sampled prices. Price data were collected by asking producers or retailers the price of the unit they sold, as or immediately after sales were made. Units were weighed to facilitate conversion to per-kilogram prices.

FIGURE 4.1: RWANDA: HOURLY FLUCTUATIONS IN SWEET POTATO PRICES IN FOUR MARKETS, IN PERCENT OF DAILY AVERAGE, SEPTEMBER-OCTOBER 1988



Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991.

The findings based on Miniplan monthly price series were tested by using weekly price data the author collected in four markets in Butare, Gitarama, and Kigali prefectures (*2*, p. 125). Monthly price data collected in 1981-1984 by the staff of an agriculture project, Projet Agro-Pastoral de Nyabisindu (PAP), were also used. These data were from regionally important markets in northern Butare and southern Gitarama prefectures (two years of data for two markets, one year for four markets) (*3*).

The weekly price series are shown in Figure 4.2; they were collected from December 1987 through September 1988. There are two reasons for using these series to test the validity of findings that were based on the Miniplan series. First, we have greater confidence in the meaning and accuracy of the prices we collected. Only two commodities were priced, dry cassava and sweet potatoes, and the timing of data collection was standardized. Prices were collected within the first three hours of trading by hired enumerators under our supervision. When a transaction was being made the price were recorded, classified as a retail or a wholesale transaction, and the unit weighed. For each week's price three transactions were recorded.

Second, because the price series generated are weekly, one should expect, other things the same, the degree of price correlation to be lower. Since market integration, which is what price correlation is intended to measure, is improved by information, one should expect it to improve, up to a point, with time. Price correlation between two markets should be greater after one month than after only one week. Unfortunately the author's price series were relatively limited and we were unable to test the correlation coefficients of more than a few market combinations. They were supplemented by coefficients from the German project mentioned above.

Application of the Simple Correlation Model in Rwanda

Before presenting our analysis and its results, we review a similar study by the Ministry of Agriculture's statistical service (SESA). It is presented to show how analysis of market efficiency has been done in Rwanda and to specify their classification scheme, which we have used. The SESA study was made using monthly Miniplan price data, and was made on the premise that "a weak integration of prices may suggest that there is a weak flow of information between markets or that the distribution systems are inefficient due to physical and/or political barriers." (*4*, p. 1) It was also assumed that the higher the correlation of prices the better is the information suppliers have of prices prevailing in regions other than those in which they normally operate.

SESA emphasis was on the bean market, but they also tested the other major food crop markets, including potatoes, cassava, and sweet potatoes. The model used was little different from the simple static correlation model described above. They used a simple univariate regression model of the form $P_a = c + xP_b$, P_a being the price in one market, P_b the price in the other market, of a pair, c being the constant (average) difference in price between the two markets, and x being the coefficient indicating the extent to which both price series move covariantly.[3]

The R^2 values were arbitrarily classified into three market integration categories: values between 0.80 and 1.0 (the maximum possible) indicated highly integrated pairs of markets, 0.60 to 0.79 suggested

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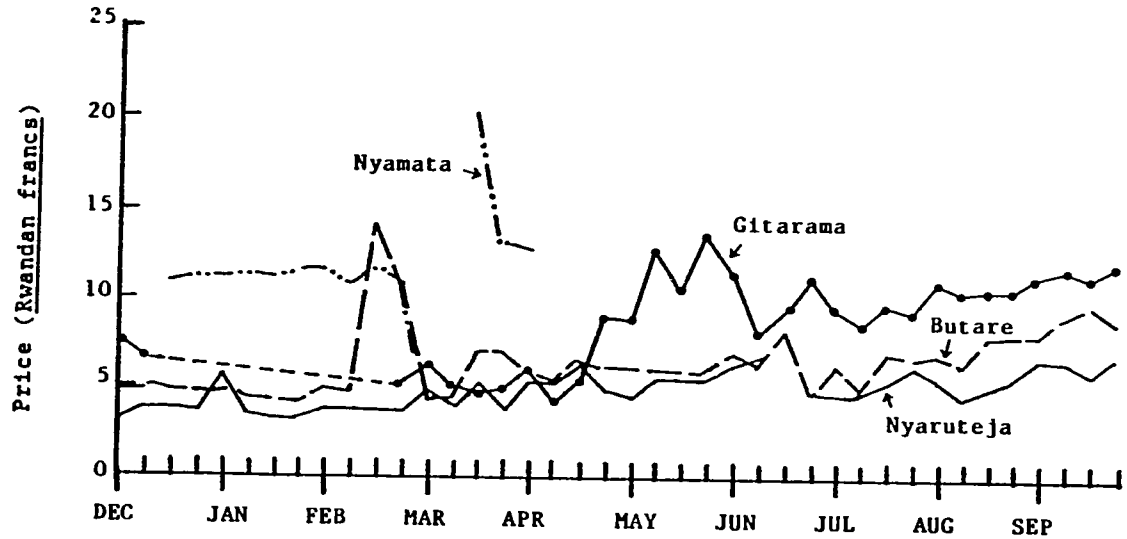
[3] The only difference between this model and the correlation model is the use of coefficients of determination, R^2 rather than correlation coefficients, r, the square root of the coefficient of determination, to measure the degree of integration.

FIGURE 4. 2: RWANDA: WEEKLY SWEET POTATO PRICES IN FOUR MARKETS (BUTARE, GITARAMA, NYAMATA, AND NYARUTEJA), FROM DECEMBER 1987 TO SEPTEMBER 1988



Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991.

average or medium integration, and values from zero to 0.59 were indicative of poor integration. The R-squares used by SESA are defined somewhat differently from the more frequently used r. The former, the coefficient of determination, predicts the amount of variation in one variable (the dependent variable) that can be predicted by another variable (the independent or explanatory variable). An R-square of .50 means that 50 percent of the variation of the dependent variable can be explained by variation in the explanatory, or independent, variable. R's simply measure the degree of linear association between two variables. To compare SESA results with other correlation studies the square root of the R^2 values must be taken.[4]

SESA findings about market integration were consistent with a priori expectation. None of the markets was particularly well integrated when compared to results from other regions having more developed marketing systems. Expected patterns were, nonetheless, upheld by the data. Less perishable crops (beans) tended to have higher correlation coefficients than more perishable crops (sweet potatoes) because increased storability stimulates trading activity. Also, crops that were known to be traded more extensively (potatoes) had higher correlation coefficients than less traded crops (sweet potatoes), a finding that reinforces the premise that greater trading leads to increased information flow.

Tests of Market Integration in the Sweet Potato Market

As a beginning point, and so the author's results can be compared with the earlier SESA findings, we used a simple univariate regression model, with data unaltered except for the use of moving averages to fill in holes in some series, and the deletion of severe outliers. As a test on the simple regression test (essentially the simple static correlation model), I applied the same data as per Ravallion/Timmer. This approach has been taken to avoid the criticism that intermarket correlation can be explained away by general inflation, or seasonal factors, both of which can be dealt with under the Ravallion/Timmer model.

Results of Univariate Regression

The SESA study used adjusted coefficients of determination rather than the simpler but similar correlation coefficients to analyze and compare market integration. The use of an adjusted measure such as the adjusted R^2 (hereafter adj-R^2) seemed warranted because of the variability in the size of price series (potentially 194 observations for Miniplan series, only 40 for Weekly series, and a maximum of 24 for PAP series), and because of differing degrees of completeness within each series.

Analysis of Miniplan Data

Regression equations of the form: $P_a = c + \beta P_b + e$[5] were run on Miniplan monthly price series for six commodities in 10 different markets. Prices in each market were regressed individually against all other markets, for a total of 45 separate equations. The adjusted coefficients of determination,

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[4] Using r rather than R_2 the categories above would be: correlation values between 0.89 and 1.0 indicate highly integrated markets; those from 0.77 to 0.88 suggest moderate integration; and values from zero to 0.76 are indicative of poorly integrated markets.

[5] Where P_a is the price in one market, P_b the price in the other market, of a pair.

adj-R^2's, were extracted from each equation. Coefficients of determination give the standard "goodness of fit" measure of regression equations; the value of the coefficient expresses the degree to which variation in one variable "explains" change in the other. Since they are often highly influenced by the size of the sample or series, R^2's are often adjusted, to account for differences in degrees of freedom among series or samples of different sizes.

The adjusted coefficients of determination were then classified according to SESA categories presented above and in Table 4.1: well integrated, moderately integrated, and poorly integrated.[6] Within each category gradations were added because without them there was insufficient sensitivity, especially between similarly integrated markets.

Because the SESA study chose to use adj-R^2's rather than r's, it is the percentage of the former falling into each integration category and subcategory that is presented in Table 4.1. The corresponding r's, assuming adjustment, are presented so the reader used to correlation coefficient measures of market integration can quickly make the necessary conversions.

It is immediately obvious from the table that for the base period the sweet potato and cassava markets were poorly integrated relative to markets for beans, sorghum, bananas, and potatoes.[7] None of the pairs of markets for sweet potatoes were considered well integrated; only 5.6 percent of the pairs of cassava markets fell into that category. On the other hand, 17.6, 15.5, and 33.3 percent of the bean, sorghum, and potato markets were well integrated. Conversely, more than two-thirds of the pairs of sweet potato and cassava markets were either poorly integrated or completely unconnected (having zero or negative coefficients of determination). Only 4.4 percent of the pairs of bean markets were in that category; 24.3, 42.2 and 53.3 percent of the banana, sorghum, and potato market pairs were poorly integrated.

The relatively long period over which the base period regression adj-R^2's are derived tends to mask changes in integration that may occur over time. The SESA study demonstrated the usefulness of breaking the base period into different phases (4, pp. 12-13), and showed the sometimes striking improvements made as infrastructure, for example, was improved.

When the sweet potato and cassava series are broken down to a beginning (1976-1978) and an ending period (1985-1987) (see Table 4.1), it is clear that the cassava market has become substantially more integrated than the sweet potato market. A little more than one-tenth of the pairs of cassava markets were moderately integrated in 1976-1978; by 1985-1987 roughly one-fifth were in that category. The sweet potato market had only reached a moderately integrated ratio of a little over one-tenth by 1985-1987. The sweet potato sector has also been less successful in reducing the share of markets that are poorly integrated or completely unconnected. The percentage of pairs of sweet potato markets with adj-R^2's less than 0.25 has decreased by 16 percent while the percentage of pairs of cassava markets in the same category has decreased by 24 percent. The number of completely unconnected (adj-R^2's less than

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[6] An alternative definition of the categories of integration is this. If 89-90 percent or more of the variation in prices in one market is explained by variation in the other, then those two markets are well integrated. If 56-80 percent is explained, then the markets are moderately integrated. If, however, no more than 55 percent of the variation is explained, the markets are considered to be poorly integrated.

[7] The base period for sweet potato and manioc is 1976-1987; for the other crops it is 1970-1986. This reflects differing access by SESA and the author to Miniplan data.

TABLE 4.1: RWANDA: DEGREE OF MARKET INTEGRATION FOR KEY CROPS, 1970-1987
(PERCENT OF ALL PAIRS OF MARKETS IN EACH INTEGRATION CATEGORY)

Integration categories "r"	"R²"	Beans	Sorghum	Bananas	Potatoes	Manioc 1976-1987 base period	S.Potato 1976-1987 base period	Manioc 1976-1978 beginning	S.Potato 1976-1978 beginning	Manioc 1985-1987 end	S.Potato 1985-1987 end
		---1970-1986 average---									
						(percent)					
Well integrated											
95+	90+	4.4	2.2	0	0	0	0	0	0	0	0
90-94	81-89	13.3	13.3	33.3	0	5.6	0	0	0	0	0
Moderately integrated											
85-89	72-80	17.8	13.3	24.4	0	0	11.1	0	0	8.8	0
80-84	64-71	28.9	15.6	8.9	13.4	2.8	2.2	11.1	0	5.9	4.6
75-79	56-63	31.2	11.1	8.9	33.3	2.8	4.4	0	0	5.9	6.8
Poorly integrated											
70-74	49-55	2.2	8.9	11.1	22.3	8.3	4.4	0	0	2.9	0
65-69	42-48	0	8.9	2.2	17.8	2.8	6.7	0	4.4	5.9	4.5
60-64	36-41	0	2.2	2.2	2.2	0	4.4	5.6	0	5.9	4.5
55-59	30-35	0	2.2	0	2.2	2.8	4.4	0	0	0	4.5
50-54	25-29	0	8.9	0	0	8.3	4.4	5.6	8.9	5.9	2.3
0-49	0-24	0	8.9	4.4	4.4	44.4	53.3	11.1	42.2	32.4	34.1
<0		2.2	2.2	4.4	4.4	22.2	4.4	66.7	44.4	26.5	38.6
All categories		100	100	100	100	100	100	100	100	100	100
Number of markets[1]		10	10	10	10	9	10	7	10	9	10
Number of pairs		45	45	45	45	36	45	18	45	34	44

Source: MINIPLAN monthly price series for markets in the capitals of each prefecture in Rwanda, 1970-1987.

Notes: Market integration categories are based on the system of classification used in Bylenga, S. and Scott Loveridge. "Integration regionale des prix alimentaires au Rwanda, 1970-1986", Rwanda, Ministry of Agriculture, Working Paper. The values for beans, sorghum, bananas and potatoes are from correlations done in the same study. Sweet potato and manioc figures are from correlations run by this author on 1976-1987 prices. R^2's are adjusted for degrees of freedom constraints which differ according to the completeness of price series for pairs of markets. [1]For most crops all 10 prefecture capital market price series have been used in the correlation analysis. The exception is manioc; observations for Byumba have been discarded for the 12 year average (1976-1987) and the last three years (1985-1987). Both Byumba and Ruhengeri have been discarded for the first three years (1976-1978).

0) markets has been reduced by nearly two-thirds in the cassava sector, and by only one-eighth in the sweet potato sector.

Maps 4.1 and 4.2, which are drawn from the data presented in Table 4.1, show the relative degree of market integration. Map 4.1 shows the strength of market integration between pairs of markets for beans, cassava, and sweet potatoes. Thick lines represent well-integrated markets, thin lines represent moderately integrated markets, and dotted lines represent poorly integrated markets. Where adj-R^2's are less than 0.20, no lines are drawn. What is immediately apparent in comparing the markets during the full period is that the market for beans was relatively highly integrated, the cassava and sweet potato markets poorly integrated. Map 4.2 shows the evolution of market integration between 1976/78, which we have arbitrarily made the beginning period, and 1985/87, the ending period. Both markets show improvement over time, but the improvement seems to be much more marked in the cassava market than the sweet potato market.[8] Neither was even moderately integrated in 1976/78. The sweet potato market remained poorly integrated in 1985/87, although the markets that were connected were the closer ones where trade might be expected to begin. The cassava market, by contrast, had a greater number of moderately integrated markets and fewer completely isolated ones in 1985/87 than in 1976/78. It is clear from cursory examination of Map 4.2 that the cassava market has evolved to a substantially more integrated market than has been the case for the sweet potato market.

Analysis of Weekly and PAP Data

Similar correlations were run on the weekly prices we had collected, and on monthly prices collected by PAP, the results of which are shown in Tables 4.2 through 4.5. The data shown in Tables 4.2 and 4.3 are from weekly sweet potato and cassava price series collected in five Butare, Gitarama, and Kigali markets. In addition to weakly supporting the findings from Miniplan data, the regression and correlation results support the hypothesis that price integration improves as traders have more time to react. Measures of integration should generally be smaller when weekly rather than monthly data are observed, other things the same. Correlation coefficients (r's) using weekly data are uniformly lower than corresponding data from monthly data. For example, the correlation coefficient for sweet potatoes between the Butare and Gitarama markets was 0.18 using weekly price series (see Table 4.2) and 0.43 using monthly data. For Butare and Kigali (Nyabugogo) it was 0.24 versus 0.32, and for Gitarama and Kigali, 0.36 versus 0.61.

The data shown in Table 4.3 support the findings from Miniplan data that neither the sweet potato nor the cassava markets are particularly well integrated, but that the cassava market has fewer completely unconnected markets. One-half of the pairs of sweet potato markets surveyed were completely unconnected. The corresponding figure for cassava was one-third.

The results of correlation analyses of monthly prices (1981-84) in five regionally important markets in northern Butare and southern Gitarama prefectures are presented in Tables 4.4 and 4.5. Once again the finding that the cassava market was marginally better integrated than the sweet potato market is supported. What is suggested from cursory review of the correlation coefficients in Table 4.4 is confirmed in Table 4.5; more pairs of cassava markets than sweet potato markets were found to be well

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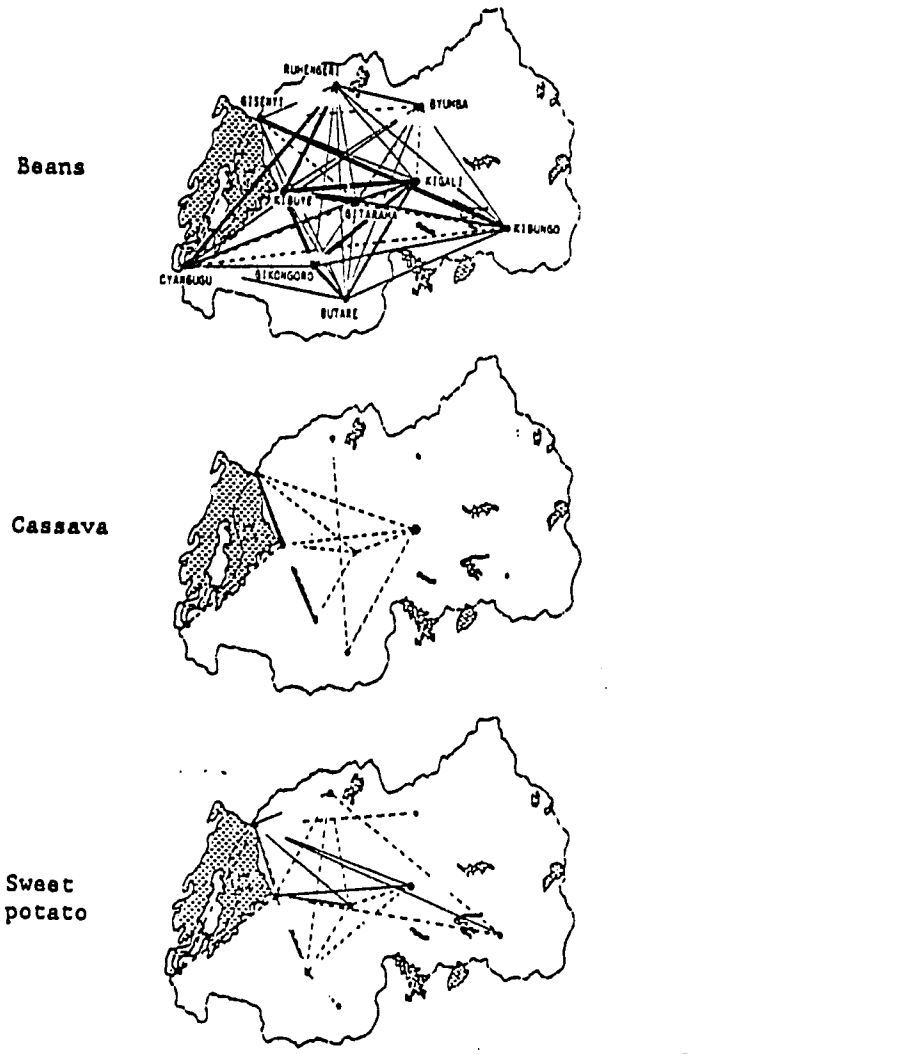
[8] There seems to be a relationship between poor integration and erratic, nonsensical connections between markets. Map 4.2 shows how much more erratic were the price relationships between markets during the early period than the later period.

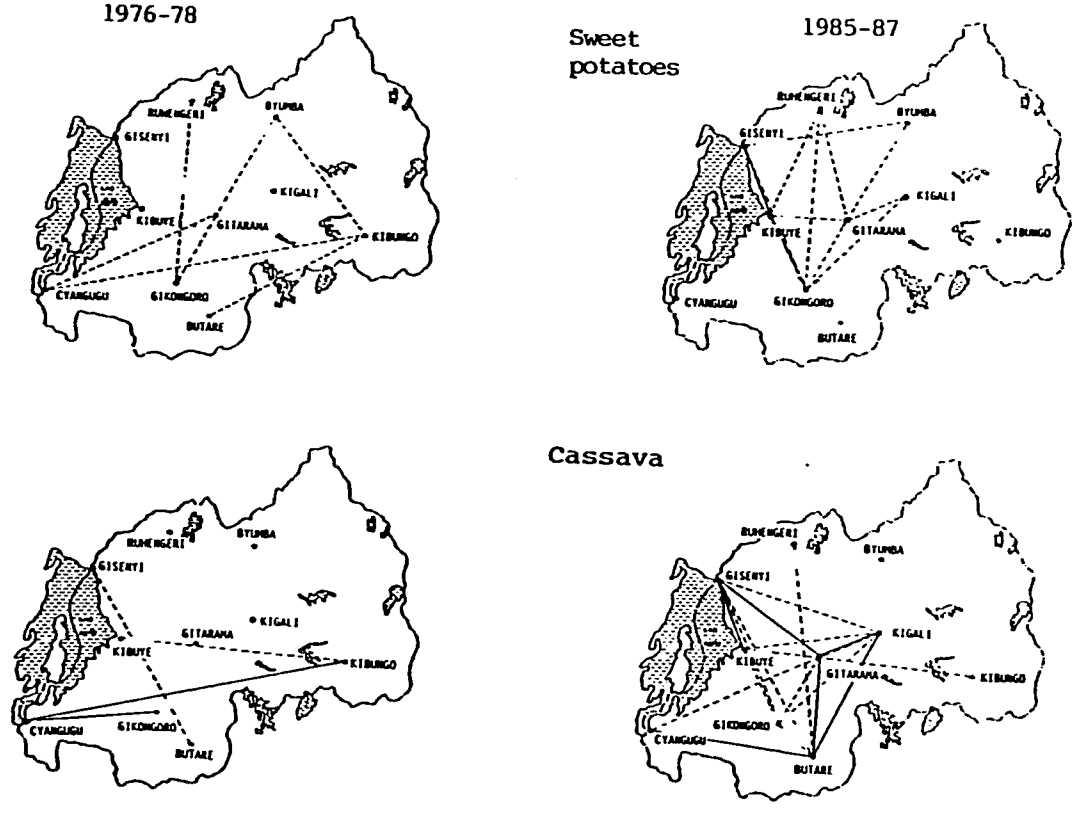
MAP 4.1: RWANDA: REGIONAL PRICE INTEGRATION FOR BEANS, CASSAVA AND SWEET POTATOES, 1970-1987



Source: Monthly price series generated by Rwanda, Ministry of Planning, 1970-1987.

Notes: R^2's are coefficients of determination, the square of adjusted correlations coefficients. No connections are made between markets for which R^2's are inferior to 0.20.

MAP 4.2: RWANDA: CHANGES IN PRICE INTEGRATION OF THE SWEET POTATO AND CASSSAVA MARKETS BETWEEN 1976-78 AND 1985-87



Source: Monthly prices generated by Rwanda, Ministry of Planning, 1970-87.

TABLE 4.2: SURVEY OF WEEKLY PRICES, 1987/88: CORRELATION COEFFICIENTS FOR FIVE MARKETS

	Sweet Potato			
	Butare	Gitarama	Nyabugogo	Nyamata
Butare (urban Butare)	1.00			
Gitarama	0.18	1.00		
Nyabugogo (urban Kigali)	0.24	0.36	1.00	
Nyamata (rural Kigali)	0.26	-0.35	0.02	1.00
Nyaruteja (rural Butare)	0.51	0.46	0.60	0.37

	Cassava			
	Butare	Gitarama	Nyabugogo	Nyamata
Butare (urban Butare)	1.00			
Gitarama	-0.37	1.00		
Nyabugogo (urban Kigali)	0.66	-0.74	1.00	
Nyamata (rural Kigali)	--	--	--	--
Nyaruteja (rural Butare)	0.94	-0.22	0.62	--

Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991.

Notes: Correlation coefficients were calculated for observations where all variables had non-zero elements; seven for sweet potatoes, and five for cassava. Insufficient cassava prices were collected in Nyamata to allow correlation analysis.

TABLE 4.3: SURVEY OF WEEKLY PRICES, 1987/88: DEGREE OF MARKET INTEGRATION FOR SWEET POTATOES AND CASSAVA
(Percent of all pairs of markets[1] in each integration category)

Integration categories	"r"	"R^2"	Sweet Potatoes	Cassava
			------ percent ------	
	Well integrated			
Well integrated	95+	90+	0	0
	90-94	81-89	0	0
	Moderately integrated			
Moderately integrated	85-89	72-80	0	0
	80-84	64-71	0	0
	75-79	56-63	0	0
	Poorly integrated			
Poorly integrated	70-74	49-55	0	0
	65-69	42-48	0	0
	60-64	36-41	0	16.7
	55-59	30-35	0	0
	50-54	25-29	10.0	16.7
	0-49	0-24	40.0	33.3
	less than 0		50.0	33.3
Percent, all categories			100	100
Number of markets			5	4
Number of pairs of markets			10	6

Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991.

Notes: 1. Markets surveyed included Butare, Gitarama, Nyamata (rural Kigali), Nyaruteja (rural Butare) and Nyabugogo (urban Kigali).

TABLE 4.4: PAP: CORRELATION COEFFICIENTS FOR FIVE SWEET POTATO AND CASSAVA MARKETS, 1981-1984

	Sweet Potato			
	Buhanda	Kinazi	Nyanza	Ntyazo
Buhanda (Gitarama)	1.00			
Kinazi (Butare)	0.68	1.00		
Nyanza (Butare)	0.80	0.76	1.00	
Ntyazo (Butare)	--	--	--	--
Ruhango (Gitarama)	0.96	0.78	0.91	--

	Cassava			
	Buhanda	Kinazi	Nyanza	Ntyazo
Buhanda (Gitarama)	1.00			
Kinazi (Butare)	0.88	1.00		
Nyanza (Butare)	0.90	0.96	1.00	
Ntyazo (Butare)	0.79	0.80	0.80	1.00
Ruhango (Gitarama)	0.92	0.94	0.95	0.74

Source: Preissler, R., "Commercialisation des produits agricoles: Structures des marchés et évolutions des prix dans la région du Projet," *Etudes et Experiences*, No. 6, Projet Agro Pastoral de Nyabisindu, Rwanda.

Notes: The data are monthly averages collected from 1981-1984. There are insufficient price data for sweet potatoes in Ntyazo market.

TABLE 4.5: PAP: DEGREE OF MARKET INTEGRATION FOR FIVE SWEET POTATO AND CASSAVA MARKETS, 1981-84
(Percent of all pairs of markets[1] in each integration category)

Integration categories	"r"	"R^2"	Sweet Potatoes	Cassava
			------ percent ------	
	Well integrated			
Well integrated	95+	90+	16.7	20.0
	90-94	81-89	16.7	30.0
	Moderately integrated			
Moderately integrated	85-89	72-80	0	10.0
	80-84	64-71	16.7	20.0
	75-79	56-63	33.3	10.0
	Poorly integrated			
Poorly integrated	70-74	49-55	0	10.0
	65-69	42-48	16.7	0
	60-64	36-41	0	0
	55-59	30-35	0	0
	50-54	25-29	0	0
	0-49	0-24	0	0
	less than 0		0	0
Percent, all categories			100	100
Number of markets			4	5
Number of pairs of markets			6	10

Source: Preissler, R., "Commercialisation des produits agricoles: Structures des marchés et évolutions des prix dans la région du Projet," Etudes et Experiences, No. 6, Projet Agro Pastoral de Nyabisindu, Rwanda.

Notes: 1/ PAP (Projet Agro-Pastoral de Nyabisindu) markets surveyed included Buhanda (Gitarama prefecture), Kinazi, Nyanza, Ntyazo (Butare prefecture) and Ruhango (Gitarama prefecture).

integrated. One-half of the pairs of cassava markets were well integrated, but only one-third of the sweet potato markets were well integrated. Furthermore, more than half the pairs of sweet potato markets were found to be in the poorly integrated category, albeit at the top end of that category. Only one-fifth of the cassava markets were considered poorly integrated.

Although these results are not as generally applicable at the national level as are the results from Miniplan data, they are suggestive of the edge the cassava market seems to have developed over the sweet potato market. Furthermore, they show that correlation coefficients do, indeed, provide useful initial information about market integration. Markets closer together would be expected to be more integrated than those farther apart. That national-level (Miniplan) price series indicate lower price integration than is indicated for regional markets is as would be expected.

Higher correlations for 1981-84 PAP prices than for 1985-87 Miniplan prices may appear initially to contradict our finding that integration has been improving over time. Actually, PAP prices and Miniplan prices are for very different sets of markets. The correlation between pairs of PAP price series should be expected to be greater since the markets in question are relatively close together. No market is more than 20 kilometers from any other market. Miniplan prices series are for prefecture capitals, which are generally much more distant from each other. Proximity and, possibly, accuracy and consistency in reporting contribute to the greater flow of information and the subsequent higher price correlation seen in PAP prices.

Results from Application of the Ravallion/Timmer Model

The results of the price correlation analyses we made suggest a poorly integrated market for sweet potatoes relative to markets for easily commercialized crops such as beans. They also indicate retardation in the development of the sweet potato market as compared to the development of the cassava market. Furthermore, analysis of PAP price series suggests that the cassava market, at least in Gitarama and Butare, which are key sweet potato producing prefectures, is substantially better integrated than the sweet potato market. The Ravallion/Timmer model was then applied to the same monthly price series used for the simpler correlation/regression analysis, and supported, albeit weakly because of poor data, the premise that the sweet potato market is relatively poorly integrated (2. pp. 141-146).

The Ravallion model (*5* and *6*), of which the Timmer model (*7*) appears to be a special case, adds a dynamic structure to the commonly used "static price correlation measure of spatial market integration in agriculture." (*6*, p. 102). With a dynamic structure, the model is better able to determine the effects of other markets as well as past events within the same market, to measure the degree of integration or segmentation. Furthermore, the achievement of short-run integration can be made distinct from forces pushing towards as yet unachieved market integration in the long run (*6*, pp. 102 and 103).

Application of the model provided little additional information about the condition of the sweet potato market in spite of the promise the model holds (see 2, pp. 141-146). With better, more precise data, it is likely that the Ravallion/Timmer model will perform better, thereby providing the analyst with more detailed insight into market performance, which will in turn enable the analyst to provide more concrete recommendations than are possible from correlation/regression analyses.

CITATIONS

1. Mukezangango, J. Chrysostome, "Enquêtes sur les prix: Description des séries des prix déjà existants," *Working Paper, 1986*, Rwanda, Ministry of Agriculture, Statistical Service (SESA).

2. Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions" (unpublished dissertation, Cornell University, 1991).

3. Preissler, R., "Commercialisation des produits agricoles: Structures des marchés et évolutions des prix dans la région du Projet," *Etudes et Experiences*, No. 6, (1986) Projet Agro Pastoral de Nyabisindu, Rwanda.

4. Bylenga, S., and Scott Loveridge, "Regional Integration of Food Prices in Rwanda, 1970-1986," in Rwanda, Ministry of Agriculture, Statistical Service (SESA), *Working Paper* 1987.

5. Ravallion, M., "The Performance of Rice Markets in Bangladesh During the 1974 Famine," *Economics Journal* 92 (1985b), pp. 15-29.

6. Ravallion, M. "Testing Market Integration," *American Journal of Agricultural Economics*, February (986), pp. 102-109.

7. Timmer, C. Peter, "Corn Marketing and the Balance Between Domestic Production and Consumption," *Working Paper No. 14*, BULOG-Stanford Corn Project, November 1984.

CHAPTER FIVE

MARKETING MARGINS AND MERCHANT EFFICIENCY

We have shown that the sweet potato market is performing its functions relatively poorly and is poorly integrated relative to markets for other locally produced foods. For prescriptive purposes, however, it is not enough to show that the market is inefficient. Particular components of the marketing margin need to be analyzed more closely, and the activities of producer-vendors and intermediaries studied, to identify specific group or individual behavior that contributes to inefficiency. Cost-reducing modifications to the system require in-depth understanding of the costs and risks faced by market participants, as well as of their responses to these costs and risks.

The results presented in this chapter are those of a one-month study of all business transactions of 29 merchants — local retailers and bulker-shippers. Levels of profitability were analyzed to further determine the efficiency of the market as a whole as well as the relative efficiency of different levels of intermediaries and types of merchants. The findings provide greater specificity about the type and level of interventions that might best be made.

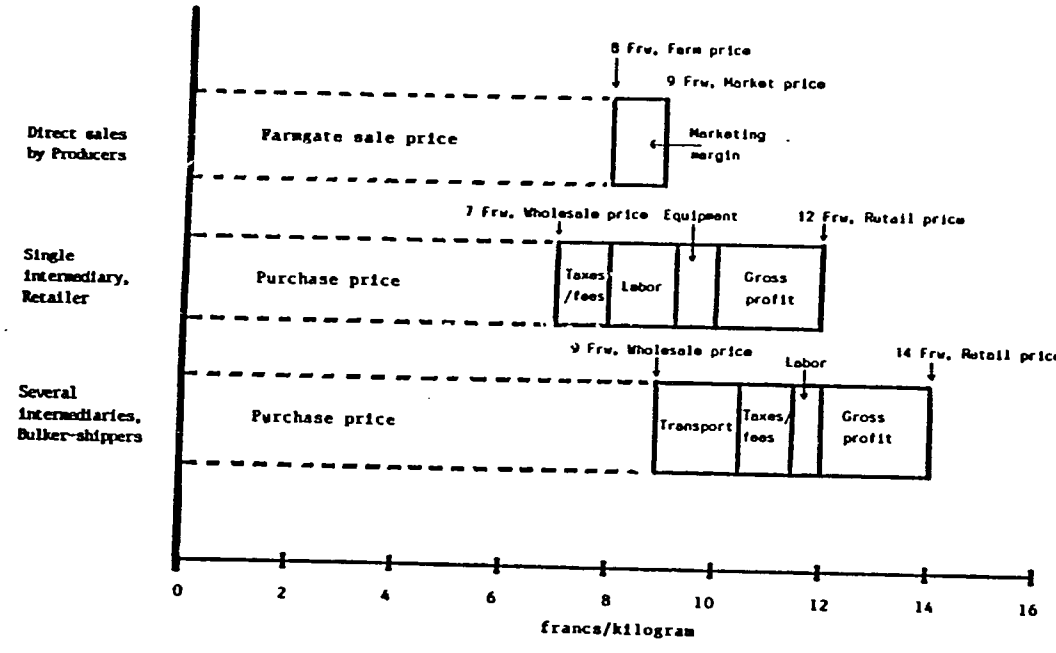
THE DIFFERENT MARKETING CHANNELS AND THEIR MARGINS

Figure 5.1 shows a breakdown of the margins of typical participants in the different marketing chains used most commonly in the sweet potato market. These are average costs; those of individual merchants differ depending on amount transported, market from which purchases are made, and ability to avoid taxes, among other differentiating factors, some of which are discussed below. It can be seen from the figure that prices received by producers who sold directly to consumers were not the same as those paid by intermediaries in the other two systems of marketing. There are two explanations for this. The first has to do with sampling; the price recorded in the direct sales chain was the average of a large sample of prices collected over an extended period of time. Local retailer and bulker-shipper prices were from smaller samples and shorter periods. That producers' market price and bulker-shippers' purchase price were the same may simply be coincidental. There should be no expectation that the prices would be the same; producers' market price was generally the price they received from direct sales. The purchase price in the other two systems was what the producer was paid when intermediaries were used to reach the consumer.

The most likely reason for the apparent difference in bulker-shipper and retailer purchase prices is that the former are less inclined to spend the time required to negotiate the price down. Retailers have far-less-pressing time constraints and can use that to their advantage in lowering the price they must pay. Bulker-shippers, on the other hand, must make their purchases relatively quickly to be assured an adequate shipment size and to procure transportation. Consequently, they can be expected to pay more than simple retailers.

FIGURE 5.1: FIELD SURVEYS: MARKETING COSTS AND APPARENT MARGINS REPORTED BY DIFFERENT TYPES OF SELLER

(per kilogram costs and prices)



Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991.

Direct Sales by the Producer

The marketing margin in direct sales by the producer has few elements. One that is most evident to the observer of the market is the cost of carrying sweet potatoes to market. The typical producer intending to sell her sweet potatoes will carry a 10-20 kilogram basketful to market for 30-60 minutes. Most rural households are within a one-hour's trip from the market they frequent, but a large minority live more than an hour and a half from market ([1]):

Time to market	% Households
0 - 30 minutes	34
31 - 60 minutes	36
61 - 90 minutes	10
> 90 minutes	20

Cost of Headload Transportation

To compensate for the lack of information on transport costs at this level, producers were asked what they would have charged for the same unit of sweet potatoes they were selling at the market had they been able to sell it at home (*1*, p. 151). The difference between the two was taken to be the perceived opportunity cost of carrying sweet potatoes to market. The results of the price survey are presented in Figure 5.2.

The average margin producers receive by selling their sweet potatoes in the market rather than at the farmgate was a little more than one franc per kilogram, 13 percent of the market price. Eighteen francs of the price of the average 16-kilogram basketful was considered the amount required to cover costs of headload transport to market. The remaining 126 francs (87 percent of sales price) would go towards cost of production and opportunity cost of time spent making sales in the market.[1] Our results were not very different from Ministry of Planning findings in 1981[2] (*2*, pp. 1 and 2), or World Bank estimates (*3*, p. 34):

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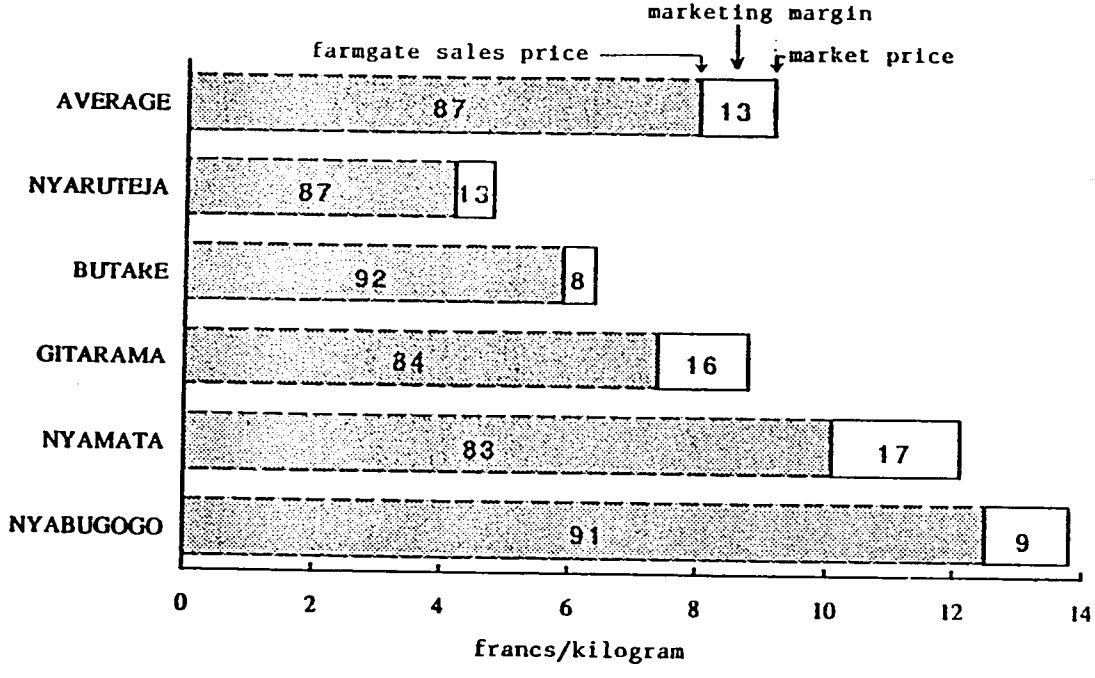
[1] The World Bank has estimated the cost of headload transportation at 340 francs per ton kilometer, which, for the average basket, converts to five francs for every kilometer. Based on the amount of time producers take to get to market, we can assume they travel between five and 10 kilometers. According to the World Bank estimate, then, their cost of headloading would be 25-50 francs per basket, which amounts to one-sixth to one-third of the sales price. Such high prices suggest that it might be more feasible for merchants to employ assemblers to assemble sweet potatoes for them in the hinterlands so the merchants can pass by and collect the sweet potatoes with a vehicle.

[2] The Ministry of Planning estimated the difference between "market" and "producer" prices at two francs per kilogram in 1981. Quotations are used because the study did not specify where or how these prices were collected.

FIGURE 5.2: SURVEY OF WEEKLY PRICES, 1987/88: MARKET PRICES AND EXPECTED FARMGATE PRICES FOR SWEET POTATOES SOLD BY PRODUCERS IN FIVE MARKETS IN RWANDA

(figures represent percent of market price)



Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991.

Source of estimate	Francs/kg/km	Francs/basket	% market price
Survey of weekly prices	-	18	13
Miniplan	-	30	21
World Bank[3]	0.34	27	19

Selling Costs

The other cost producers incur by selling in the marketplace is the opportunity cost of the time spent waiting for a sale. Opportunity costs vary according to season and the economic, social, or cultural value of the best alternative activity. Consequently, there is more marketing activity in some periods than others. Other things the same, the most active periods of sweet potato marketing will tend to be those during which opportunity costs are lowest. According to our producer survey, most farmers (58 percent) are most likely to sell their hillside crop of sweet potatoes during the long dry season (June/July to August/September) (*1*, p. 153). Other than a brief harvest period, this is a season during which there is little agricultural work. It follows that with little agricultural work the opportunity cost of transporting sweet potatoes to market and waiting in the market for sales is relatively low.

The longest most producers will wait for sales in most markets is probably between four and five hours, roughly from 7:00 a.m. to 12:00 noon. They spend only a few minutes making their sales in wholesale markets such as Gitarama, however, and subsequently incur a smaller opportunity cost, other things the same. The rural wage rate of 30 francs[4] is the best available estimate of the average daily opportunity cost, but probably overstates the real cost because it is unlikely that work paying 30 francs a day would be available to the entire rural labor force. A rough estimate of the alternative earnings forgone when the typical producer sells her sweet potatoes at market is 20-25 francs in most markets, and 20 francs in wholesale markets, which is between 15-18 percent of the price of the average 16-kilogram basketful of sweet potatoes. These estimates take into account the probability that the rural wage rate overstates the real opportunity cost, and are based on the assumption that on average slightly less than one-half day is spent in the market.

Producers carrying their produce to market also face price risk, which manifests itself in two ways: the risk of returning home with unsold sweet potatoes that will have to be disposed of (or consumed) quickly, or the risk of having to sell at unfavorable prices. For most households we surveyed (71 percent), the predominant risk was of selling at unfavorable prices; more than two-thirds of the farmers bringing sweet potatoes to market indicated they would be unwilling to return home with them (*1*, p. 154).

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[3] Estimates based on World Bank calculation of cost of headload transport per ton kilometer assume producers travel on average five kilometers to market.

[4] Official estimates of daily wages were in the range from 30 francs (rural wage rate) to 60 francs (government minimum for rural areas) (*2*, p. 171).

Sales Through One Intermediary

The typical local retailer sells an average of 560 kilograms of sweet potatoes each month. Sales are normally made in the marketplace. Local retailers face numerous costs in comparison to producer-vendors: cash or out-of-pocket, opportunity, as well as the costs inherent in the risk and uncertainty of their business. Out-of-pocket costs include purchases of sweet potatoes for resale; payment of marketplace fees (usually for vending stalls); community taxes; and purchase of wrapping material, baskets, scales, and bags. In some cases there also are handling fees, payment for overnight storage in or around the marketplace, and payment for headload or other forms of transportation.

The average margin, and its components, for local retailers we surveyed is shown in Table 5.1 Average gross profit on monthly sales of 6,496 francs is 1,120 francs, or 17 percent of sales value. The most important of the typical retailer's cash costs is the purchase value of sweet potatoes, which accounts for two-thirds of the sales value. The next most important expenditures are taxes and market fees, which together represent a little less than one-sixth of the marketing margin and 6 percent of sales value. Cash costs vary substantially, however, in importance. Retailers selling only from their homes, for example, pay no taxes, while those selling in the marketplace pay taxes and fees of a little over one quarter of their margin.

The "capital flow" or depreciation cost of bags, baskets, buckets, and the cost of "other"[5] inputs used in retailing together account for roughly one-tenth of the margin. The value of own labor (hired labor is rarely used) is estimated at one-third of the marketing margin. The residual, taken to be average profit or payment to time and capital used is two francs per kilogram, nearly one-fifth of the sales value, and just under half the marketing margin.[6]

The importance of each element of the marketing margin varies according to the system of merchandising, size of operations, experience, and other characteristics of individual retailers. These differences, the reasons for them, and their effect on pricing and technical efficiency are considered in more detail in section three of this chapter.

Long-Distance Sales through Several Intermediaries

Because of prevailing technical, financial, and commercial arrangements, many intermediaries are needed to move sweet potatoes relatively great distances from where they are grown. In addition to producers and retailers, there are bulker-shippers who control the product from wholesale to terminal market. Other intermediaries with varying levels of responsibility for the product include buyers working on commission with bulker-shippers, baggers and loaders, and truckers. Unlike the potato trade, in the sweet potato trade truckers rarely own what they transport. Consequently, all parts of the marketing margin, excluding producer and retailer costs, can be subsumed under costs incurred by bulker-shippers.

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[5] This category included expenses in which capital use and hired labor costs could not be separated.

[6] Results of our local retailer survey (part of the merchant survey discussed earlier) indicate that the modal profit of the 32 retailers to whom the preliminary questionnaire was administered was 1-2 francs per kilogram, which would mean that the typical local retailers had a monthly profit of 560-1,120 francs.

TABLE 5.1: RETAILER SURVEY, 1988: AVERAGE MARKETING MARGINS AND COMPOSITION OF MARGINS FOR SWEET POTATO RETAILERS (N=18)

	Average monthly value[1] (francs)	Francs per kg.	Percent retail price	Percent marketing margin
Sales	6496	11.6	100	--
Purchase	4032	7.2	62	--
Marketing margin	2464	4.4	38	100
Composition of margin:				
Own labor	728	1.3	12	31
Taxes/market fees	392	0.7	6	15
Equipment	112	0.2	2	4
Other	112	0.2	2	5
Gross profit	1120	2.0	17	45

Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991. Transaction and time use notebooks maintained for each of 18 merchants in five markets, throughout one month.

Notes: [1] Average amount handled by local retailers in one month was 560 kilograms.

Bulker-shipper costs can be divided into cash, opportunity and risk components. Cash costs are shown in Table 5.2. They include transport fees, taxes and market use fees, hired labor used for product handling (bagging, loading, and off-loading), and equipment (bags, scales, and rope) used in the business. The table shows actual values for merchants handling the average monthly quantity of 3,340 kilograms of sweet potatoes or 2,870 kilograms of cassava in the first column, and per kilogram purchase and sales prices, the marketing margin and its components, for sweet potato and cassava merchants, in the second column. The third and fourth columns show the percent each component represents of the sales price and of the marketing margin.

The average margin, less gross profit, for sweet potato marketing was two-thirds greater as a percentage of sales value than the average margin for cassava marketing. The key factor making it larger was transport, which was twice as large a percentage of sales price in the sweet potato market as in the cassava market, and represented two-thirds of the marketing margin for sweet potatoes versus one quarter for cassava. Scott estimates the marketing margin for potatoes shipped from Ruhengeri to Kigali through four intermediaries to be 57 percent of retail price, of which only 29 percent goes to the trucker/traders, the closest analog to sweet potato and cassava bulker-shippers ([4], pp. 90-92). From this it appears that, in spite of much greater shipping distances, potato trucker/traders also have lower marketing margins (29 percent) then their sweet potato counterparts (35 percent).

The most important explicit component of the margin is transportation, which averages somewhat more than one-third of the whole for sweet potato merchants. Its relative importance is lower for merchants dealing in larger lots (18 percent), and higher for those with small shipments (57 percent). The other key components of the marketing margin, in descending order of importance, are taxes and market-use fees, one-fifth of the margin in the sweet potato trade and one-seventh in the cassava trade; hired labor, one-eighth the margin in both; and the amortized cost of equipment, a small share of the margin in both markets. Some of these differences in capitalization, labor utilization, and shipping costs are tested in section three for their efficiency effects.

Gross profits, defined as the residual return to the labor and unaccounted capital supplied by the merchants themselves, were one third smaller as a percentage of the margin for sweet potatoes than for cassava. This is primarily because transportation and taxes are relatively more costly in the sweet potato than the cassava trade. Higher-value cassava shipments are charged the same per unit transportation fees and taxes as lower-value sweet potato shipments.

In addition to the cash costs and returns to own capital and labor, there are opportunity costs. Theoretically they will vary according to the skills and the alternative activities available to different merchants. A reasonable proxy, however, is the amount merchants consider their day of activity to be worth. Merchants were asked to estimate the value of their own time. Those who responded indicated that they expected to be "paid" between 200 and 500 francs per day. Risk is also an important, albeit a less-explicit, cost of doing business for bulker-shippers, and is considered at length later in this chapter.

COMPONENTS OF THE MARKETING MARGIN

The components of the marketing margin are treated in detail in this section to provide insight into how they are used at different levels of the market and in different chains, and the extent to which size and other aspects of marketing organization influence the importance of each. Accounting as well as economic costs are considered.

TABLE 5.2: BULKER-SHIPPER SURVEY, 1988: AVERAGE MARKETING MARGINS AND COMPOSITION OF MARGINS FOR SWEET POTATO AND CASSAVA BULKER-SHIPPERS DURING ONE MONTH OF OPERATION (N=12)

	Average monthly value[1]	Francs per kg.	Percent sales price	Percent marketing margin
	Sweet potatoes			
Sales	47,094	14.1	100	--
Purchases	30,394	9.1	65	--
Marketing margin	16,700	5.0	35	100
Composition of margin:				
Transport	6,012	1.8	13	36
Taxes/market fees	3,340	1.0	7	20
Hired labor	2,004	0.6	4	12
Equipment	334	0.1	1	2
Gross profit	5,010	1.5	11	30
	Cassava			
Sales	61,131	21.3	100	--
Purchases	44,772	15.6	73	--
Marketing margin	16,359	5.7	27	100
Composition of margin:				
Transport	4,018	1.4	7	25
Taxes/market fees	2,296	0.8	4	14
Hired labor	2,009	0.7	3	12
Equipment	287	0.1	1	2
Gross profit	7,462	2.6	12	46

Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991. Transaction and time use notebooks maintained for each of 12 merchants during one month.

Notes: [1] Average monthly shipment was 3,340 kilograms for sweet potato merchants and 2,870 kilograms for cassava merchants.

Transport

Transport is the most important cost of marketing after the cost of the sweet potatoes. It warrants in-depth analysis since improvements in transportation and reductions in costs associated with it stand to yield large dividends.

Modes of Transportation

Numerous methods are used to get sweet potatoes to market. They differ in their overall importance as well as their importance in different marketing chains. The most frequently observed are shown in Figure 5.3. Market types are reduced, in this figure, to two types: the primary market, which includes local markets as well as wholesale markets; and the terminal market. Clearly, for local-rural and local-urban markets, sweet potatoes travel no farther than the primary market.

The greatest amount of sweet potatoes move to market by headload, generally being carried by women directly to market or, in some cases, to retailers' homes or shops. Bicycles are used only in the relatively infrequent instances when a producer or local assembler wishes to sell more than the standard basketful.[7] Even less frequently producers will load one or two baskets, or a bag of sweet potatoes into a taxi headed for market.[8]

Taxis are used more often by small, basically local retailers traveling relatively short distances to make their purchases. Given the low volume of trade of most retailers, however, the cost of the trip can rarely be justified by sweet potato sales alone; usually other activities help defray expenses.

Light trucks, mostly of one-and-one-half ton capacity, are the principal mode of transport for the long-distance trade in sweet potatoes, from primary to terminal markets. Loads are generally small, rarely more than 15-20 bags per truck. Further, because of limited space, most merchants are unable to accompany their shipment. The usual scenario is that the trucks are used for shipping produce while merchants return, as they came to market, by taxi. This results in high travel costs for the merchants themselves. The trucks used are of moderate age (four years) and have generally been owned by truckers for two years. They are nearly without exception gasoline- rather than diesel-powered. Being gasoline powered and rarely maintained, these trucks must operate at very high cost (*1*, p. 162). The cassava trade generally suffers from the same high transport cost, but cassava traders can spread those costs over larger sales values. In the potato market there is a tendency to use more trucks of larger capacity.

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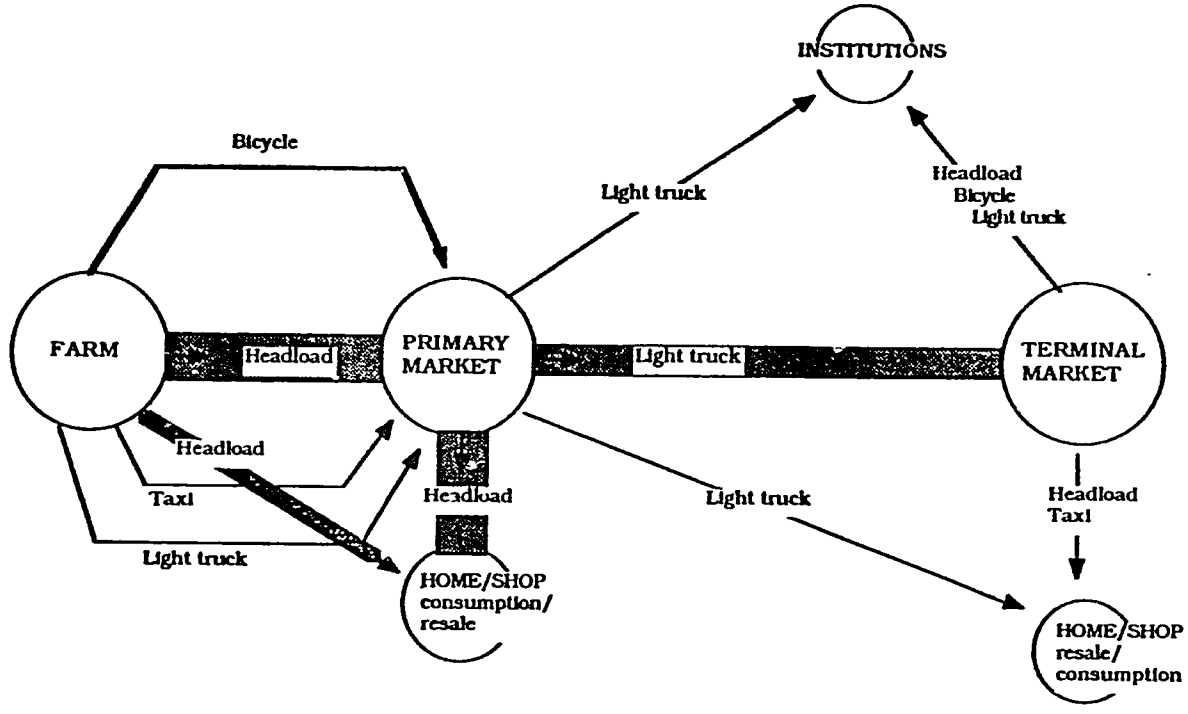
[7] Local assembly occurs infrequently and usually involves producers buying the produce of their neighbors and combining it with their own to bring a larger quantity to market.

[8] The use of taxis at this level has been reported only in the Ruyenzi market, an extension of urban Kigali demand, and consequently a relatively high-price market.

FIGURE 5.3: FIELD NOTES, 1988: METHODS BY WHICH SWEET POTATOES AND CASSAVA ARE SHIPPED FROM FARM TO MARKET



Source: Tardif-Douglin, D., Field Notes, 1988.

Notes: Relative thickness of lines connecting two nodes is indicative of importance of each method of transportation. Distance between nodes is only suggestive of relative real distances.

Range of Transportation Costs

The cost of headload transport has already been addressed at length. Here we look at the relationship between distance and type of vehicle, and the cost of transport when vehicles are used. Given that the trucks used to transport sweet potatoes are of the same general capacity (1.5-3 tons), the range in transportation costs in the wholesale-to-terminal market chain is a function primarily of distance and difficulty of access.[9] Figure 5.4 shows the relationship between fees quoted to us by truckers surveyed in seven wholesale markets, and the distance of each market from Kigali. Fees are in Rwanda francs per bag (the fee was generally the same regardless of the size or weight of the bag). They are what truckers charge bulker-shippers to ship their produce directly to the terminal market. The scatterplot and the accompanying regression equation show that there is a strong relationship between the distance to supply market and the fee charged per bag. The fee seems to be made up of two components, a fixed rate of 51 francs per bag and a variable cost of 1.90 francs per bag/kilometer.[10]

Transport costs represent a larger margin in the sweet potato trade than they do in the cassava and, perhaps, the potato trade. They are nearly twice as important as a percent of sales value for the typical sweet potato merchant as they are for cassava merchants. The bulkiness of sweet potatoes and the comparatively small shipment value is responsible for the relatively high transport margins. Precise comparison with the potato market is not possible because no potato merchants were studied during our field work, and because potato merchants generally operate out of different markets. Scott, however, gives some evidence of the upper limit of transport costs in the potato market, from which estimates of transport margins might be made. Trucker/traders received roughly one-third of the retail price for their marketing services, which include, among other things, shipping (*6*, pp. 91-92).

Transport costs represent one quarter of overall margins in both the cassava and the sweet potato markets (see Table 5.2). If these ratios hold for the potato market as well, transport cost can be estimated at roughly 8 percent of retail price, a little over two-thirds the cost in the sweet potato market.[11]

Comparison of the cost of transport in the sweet potato and cassava markets and the potato market should be made with care, however. In the sweet potato and cassava trades, cost of transport generally refers to fees bulker-shippers pay independent truckers. In the potato market it appears to be an estimate of actual costs of transport rather than transport fees. The real costs of transport for potatoes are likely to be overestimated relative to costs in the sweet potato and cassava markets because generally larger, more cost-effective trucks are used in the potato market then are used in the other two. Highly localized potato production allows merchants to easily assemble large shipments that warrant the use of larger vehicles. Average shipment size for potatoes is probably 2,000-3,000 kilograms, the capacity of the typical light truck used for shipment (*4*, p. 81). We have found the average shipment size for sweet potatoes to be 400 kilograms (*1*, p. 165).

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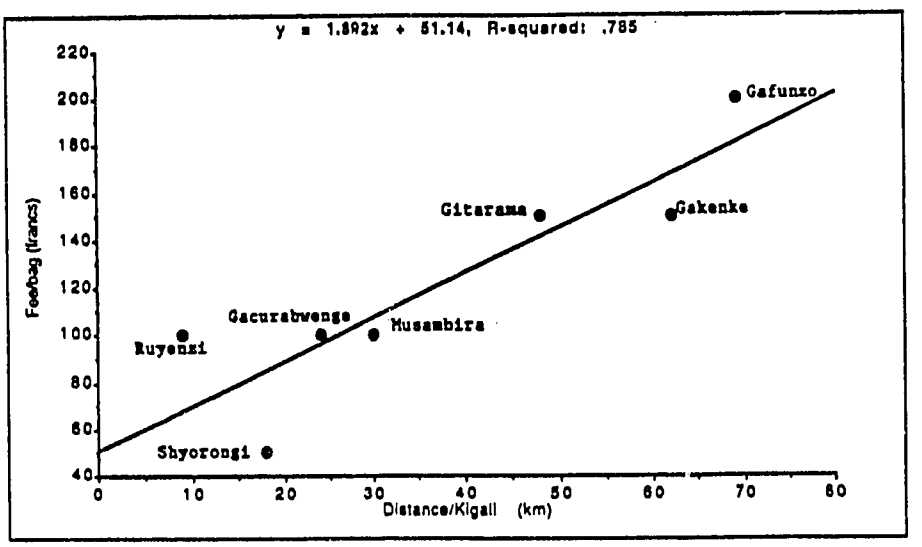
[9] A World Bank study estimated costs of transport to be 20 francs per ton kilometer on paved roads in good condition and 60 francs per ton kilometer on unpaved and poorly maintained roads (*3*).

[10] The equation's coefficient of determination, the R^2, is 0.78, which means that 78 percent of the variation in fees charged is explained by distance.

[11] Trucker/trader margins of 29-30 percent, as reported by Scott, divided by four, gives 7 or 8 percent attributable to transport.

FIGURE 5.4: TRUCKER SURVEY, 1988: RELATIONSHIP BETWEEN SHIPPING FEES AND DISTANCE SHIPPED FOR SWEET POTATO AND CASSAVA

(fees in francs per bag, distance in kilometers)



Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991.

Handling Costs

Other than the obvious out-of-pocket costs of wages paid baggers and handlers, handling costs are often not well appreciated by merchants. Shrinkage and own labor costs are probably the least well understood.

Handling costs vary in importance according to the level of the market. Their importance at the producer level is hard to ascertain. About two-thirds of all rural households wash and sort their sweet potatoes before taking them to market. The former appears to be a controversial practice. According to some it accelerates deterioration; others believe it improves storability. The implications of washing throughout the market depend substantially on which argument is true. Our suspicion is that given the amount of damage that normally occurs to tubers, washing them before taking them to market simply increases the chances of introducing bacteria that will hasten spoilage. If sweet potatoes have been harvested from a dry field, they probably should not be washed. Tubers would receive less damage if the soil adhering to them were lightly brushed off instead. If conditions are wet, sweet potatoes would be best left unharvested until the soil is dry. If tubers must be harvested in wet conditions, then washing them might make sense, since rubbing them to remove soil might tend to scratch the skin, thereby allowing the entry of bacteria.

An important cost of handling at the producer level is the spoilage and losses that occur further down the marketing system. The opportunity cost of handling sweet potatoes at the producer level is currently not very high. Improving quality and lengthening the shelf life of sweet potatoes would, however, entail substantially greater time and opportunity cost, especially in slower, more careful harvesting and postharvest handling. Unfortunately we have no reasonable estimates of current costs of harvesting or on how much more time would likely be spent. The opportunity cost of harvesting could be in the vicinity of 600 francs for a .10-ha sweet potato field.[12] It could well double or triple if greater care were taken to avoid damage at harvest. Whatever the cost and its importance at the producer level or as a part of the overall marketing margin, handling is far less involved for sweet potatoes than it is for cassava. Producers take a substantial amount of time to process fresh tubers into dried cassava, which is the form taken to market.

During Retail

Handling costs become more important considerations during retail and bulking-shipping. At the retail level sorting is the key cost. Mounds of tubers of similar quality and size are formed, classified as high or low quality, and priced accordingly. Because customers do not always buy in standard units, and because retailers invariably add a tuber or two to keep their customers happy, mounds are constantly

[12] This estimate is based on an estimated 300-400 person-days needed to plant, cultivate and harvest a one hectare field of sweet potatoes, and on a rural daily wage rate of 30 francs. Planting (and preparation for planting) and harvesting are the two important labor using activities in sweet potato cultivation. So, we have assumed that half of the labor is attributable to harvest, which makes for roughly 175 person-days for a one-ha field, or 18 person-days for a .10-ha field. This multiplied by 30 francs/day gives 540 francs.

being remade, and a great deal of time is spent doing that. Shrinkage[13] costs become apparent at this level when retailers realize the ratio of high- to low-quality mounds they were able to form from the baskets of sweet potatoes they purchased. A high ratio signifies low shrinkage. Simply keeping a sales inventory during the day entails shrinkage loss as tubers lose their freshness. This is compounded if the sweet potatoes must be stored overnight. The full contribution of handling costs to retailers' share of the marketing margin is unknown. It is likely, however that much of retailers' own labor is given to handling and preparing produce for customers. Explicit handling costs at the retailer level, then, probably account for a little less than one-third of the margin, on average 728 francs each month (see Table 5.1). The contribution of shrinkage and other losses from handling are not quantifiable from our surveys, but are probably not very high.

During Bulking and Shipping

During bulking and shipping, handling becomes especially important. It has two components: the cost of labor used and shrinkage that occurs from handling. Merchants use their own as well as hired labor to handle sweet potatoes. The first handling usually involves emptying the producer's basket of sweet potatoes to verify the condition of the contents. After ascertaining overall quality, some merchants will sort tubers roughly according to size and quality, maintaining separate bags for high and low quality. Baggers are then hired to fill the bags and load them onto trucks. At the terminal market, laborers must also be hired to off-load and carry these bags to each merchant's sales station.

We were unable to disaggregate bulker-shippers' own time into the various activities, so can only make a rough estimate of the importance of their own time in processing and handling. Paid labor, which consisted primarily of baggers and loaders, is completely attributable to handling costs. On average it contributed one-tenth of bulker-shippers' marketing margins, roughly 2,000 francs per month (see Table 5.2). Including merchants' own labor, the labor component of handling costs can be estimated at about one-sixth of the marketing margin, which would mean 2,780 francs for the average monthly shipment.

Tuber Damage and Other Losses

In addition to the relatively well-understood labor costs, losses such as damage, theft, and shrinkage are incurred by sweet potatoes during handling. These are much more difficult to quantify. In some cases they are simply not recognized as losses; in others they are accepted as inevitable costs of doing business. Damage to tubers is widespread, often beginning at harvest.

There are two important explanations for the extent of damage to tubers, and the contributing factors make improvements exceedingly difficult to make. The first is that few participants in the market recognize the adverse affect tuber damage, other than outright cuts, has on freshness.[14] This is the simpler of the obstacles to improvement, and might be removed by information disseminated through extension agents. The other, probably more intractable, problem arises because there is a significant

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[13] Defined most broadly to include loss in weight and volume (in aggregate as well as for individual tubers) that occurs as sweet potatoes move from producer to consumer.

[14] About 90 percent of bulker-shippers surveyed in wholesale markets in 1988 said they would not buy tubers having cuts in them.

externality component to the damage of tubers. The cost resulting from damage is rarely directly borne by the person or persons causing it. Baggers, for example, are rewarded for packing each bag as fully as possible because merchants pay transport on a per bag basis. In the process of packing, substantial damage is caused, for which merchants ultimately pay in the form of lower sales. Sweet potatoes are often further damaged in loading, transport, and off-loading; none of those responsible for providing these services directly bears the cost of damage.

Theft appears to be a relatively negligible cost of handling; whatever occurs can probably be subsumed under the general category of shrinkage. The merchants surveyed did not consider theft an important consideration. Spoilage appears to be the principal component of shrinkage in the sweet potato trade. Only one-third of the bulker-shippers interviewed, however, recognized losses from spoilage. For most, average losses from spoilage apparently did not exceed 5 percent of shipment value (835 francs for the average monthly shipment). This refers to outright losses rather than the less obvious losses in quality and value of tubers that often occur. Total shrinkage losses probably amount to about one-tenth of produce value for most sweet potato bulker-shippers (1,670 francs in one month) (*1*, p. 169).

Taxes and Market Use Fees

Other costs associated with processing and handling are those associated with the physical and legal infrastructure provided in marketplaces. For these services, which include stall sales, security, warehousing, roads, and in some cases protection from the elements, merchants pay market use fees and local taxes. On average, taxes and fees represent the second most important cost of marketing. Nearly all bulker-shippers (97 percent) considered taxes and fees to be among the first or second most important cost of doing business (1, p. 170).

	Rank as Cost of Doing Business			
Cost	1	2	3	4
		(percent)		
Taxes and fees	44	53	-	-
Transportation	56	41	-	-
Labor	-	3	93	6
Equipment	-	3	7	82

Roughly one-sixth of the average bulker-shipper's marketing margin is comprised of taxes and fees (2,783 francs for average monthly sales) (see Table 5.2). As a percent of retail price, taxes and fees are nearly twice as important in the sweet potato trade as they are in the cassava trade. From the point of view of sweet potato merchants, the flat per unit (bags of variable weight) rate of taxation that is currently applied to bulker-shippers is an unfair financial burden. The effect of per unit rather than ad valorem taxes is considered in more detail in the next chapter.

Risk and Other Costs of Marketing

Because the sweet potato is highly perishable, merchants have to judge demand and supply conditions accurately if they are to avoid substantial losses. This is especially so where markets are not held every day; it has been shown above that what remains unsold at the end of the day loses value

precipitously. Producers and retailers manage this risk by dealing in very small lots. This is, however, not a feasible option for bulker-shippers. Consequently the risk to them of incorrectly estimating overall demand as well as competition in supply can be great. One of the important unknowns to bulker-shippers is the supply of preferred substitutes, that periodically flood the market, driving down the demand for, and the price of, sweet potatoes.[15]

Bulker-shippers perceive the price risk to them in two ways: the risk of buying at a price higher than the sales price, and the risk of paying more than other merchants for similar quality produce. One quarter of the respondent of the merchant survey indicated they had experienced losses of that sort (*8*). But it was not considered a frequent occurrence, and as such is unlikely to figure into any implicit or explicit risk consideration. Furthermore, most had no regular way of dealing with this risk; one-sixth of those surveyed stated there was nothing that could be done to manage the risk of adverse price moves of this type.

The other type of price risk recognized by bulker-shippers has to do with timing and bargaining power. Three quarters of the bulker-shippers claimed to have at one time bought their produce only to find prices improving after they made their purchases. Most, however, considered this to be an infrequent occurrence. But nearly one quarter claimed to experience this type of loss in 10 out of 20 days of trading. Trying to second-guess competing bulker-shippers to get the best purchase price is apparently an important problem experienced by merchants.

MERCHANT EFFICIENCY

The principal objective of this section is to compare the relative efficiency of different merchants and classes of merchant — small versus large, local retailer versus bulker-shipper, and within-marketplace sales versus nonmarketplace sales — to determine what changes might ultimately lead to improvement in the efficiency of the entire market.

Sweet potato merchants cannot readily be classified according to the standard wholesaler-retailer categories by which merchants are often classified. Bulker-shippers behave like wholesalers in some ways — they bulk smaller amounts together, ship them relatively long distances, and sell them in markets different from where they were purchased. Their selling, however, is purely (with a few exceptions) at retail. They usually break the bulk of what they shipped into smaller units of 1-1.5 kg mounds, for resale. Although some retailers in terminal Kigali markets buy wholesale from bulker-shippers, most seem to prefer to make their own purchases at what we have called wholesale markets (the markets that supply terminal/urban Kigali markets).

Instead of classifying merchants according to the wholesale-retail division, which for sweet potato merchants is not clear-cut, we have chosen to classify them according to size/system and location of sales. Bulker-shippers tend to handle larger sales volumes than their local retailer counterparts. Hence, there is substantial multicollinearity between dummy variables for size (less than 1,000 kilograms per month versus 1,000 and more per month) and organization of trade (bulker-shipper versus local retailer). For that reason, we have combined organization of trade with size, and have chosen to emphasize size as the

[15] At one point there was an influx of cooking bananas in the urban Kigali market. Sweet potato sales plummeted as customers bought generally preferred bananas rather than sweet potatoes.

factor most likely to influence performance. This is especially likely to be true among bulker-shippers who must pay for their travel out of the receipts of their shipments. Smaller sales volume means a greater share of gross receipts must go towards paying for merchant travel. The division between large (monthly volume above 1,000 kilograms) and small (monthly sales up to 1,000 kilograms) merchants is practically the same as that between bulker-shippers and local retailers.

Most merchants, both large and small, tend to sell within the marketplace. But roughly one-third sell either from their homes or shops, both of which are outside the marketplace. Merchants selling in the marketplace would seem to have the advantage of more potential customers. Those selling from their homes or shops generally do not have the same tax burden as their counterparts selling in markets. Merchants selling from their homes do not generally pay sales taxes.

Economic efficiency is perhaps best measured and considered in a relative sense. It is made up of two components. The first is technical or productive efficiency, which concerns maximizing the productive capacity of every input or combination of inputs. A firm is technical-efficient if it is producing on the industry production possibility frontier, the maximum attainable output from given combinations of inputs. Firms closer to the frontier are considered relatively more efficient than those further away.

The other component is allocative, or pricing, efficiency, which is based on marginal conditions. When a firm is using all of its inputs to the point at which their marginal value product (marginal addition to the value of product) just equals their unit price or opportunity cost, that firm is considered price-, or allocatively, efficient. When both technical and allocative efficiency are attained a firm is considered to have attained economic efficiency.

Application of the Unit Output Price Profit Model to Merchant Data

To get at the economic, pricing, and technical efficiency of sweet potato merchants, we have used a model that is based on the concept of the profit function. Microeconomic theory states that profit maximization and price or allocative efficiency are the same; a firm that is maximizing profits is also price-efficient. One that is not price-efficient is not maximizing its profits.

The model we have used is called the unit output price (UOP) profit model, whose primary attraction is that it facilitates the assessment of the attainment of relative economic efficiency as well as of its components — technical and allocative efficiency — across firms facing different input and output prices.

The UOP profit model was developed by Lawrence Lau and Pan Yotopoulos in response to what they considered to be the empirical and conceptual problems inherent in the usual measures of efficiency. Partial productivity indices used for analyses of economic efficiency, for example, cannot provide information on overall relative efficiency among similar firms, and ignore the "presence of other factors which affect average (and marginal) productivity." (5, p. 94). Ratios of marginal products and opportunity costs used to test for pricing efficiency perform poorly when used to compare between groups of firms. "Direct comparison among firms that satisfy this equality to different degrees is almost impossible." (5, p. 94). Finally, the more traditional approach (Farrell) often used to measure technical efficiency does not incorporate relative prices and as a result cannot compare firms facing different sets of prices. It is also considered extremely sensitive to outliers. The UOP, as is shown below, addresses

each of these problems, and for those reasons, as well as its relatively small data requirements, is applied here. The model is described in greater detail in Tardif-Douglin (*1*, pp. 173-178).

The primary objective of this section is to use the UOP model to test hypotheses about relative efficiency of sweet potato merchants operating under different conditions. Equally important is the identification of factors affecting efficiency in the use of key inputs. It has been pointed out above that the purchase price of wholesale sweet potatoes, and shipping and labor are the most important variable costs incurred by merchants.[16] Consequently, the efficiency with which the associated resources are used will determine the relative efficiency of individual merchants and groupings of merchants. The model estimated to test some of the efficiency hypotheses presented above includes data on each of these three inputs as well as dummy variables corresponding to the size and system groupings of merchants:

$$\ln\Pi = \ln A + \beta_i D_i + \alpha_1 \ln c_1 + \alpha_2 \ln c_2 + \alpha_3 \ln c_3 + \ln v \qquad (5.1)$$

and derived demand equations for variable inputs:

$$-c_1 X_1 \left(\frac{1}{\pi_j}\right) = \alpha_4 + \beta_i' D_i + v', \qquad (5.2)$$

$$-c_2 X_2 \left(\frac{1}{\pi_j}\right) = \alpha_5 + \beta_i'' D_i + v'', \qquad (5.3)$$

and

$$-c_3 X_1 \left(\frac{1}{\pi_j}\right) = \alpha_6 + \beta_i''' D_i + v''', \qquad (5.4)$$

where, lnA is the intercept of the UOP profit equation, the D's are the dummy variables for size/organization and location of sales groupings, c_1 represents normalized per kilogram purchase price (price paid to producers) of sweet potatoes (price divided by per kilogram sales price), c_2 is normalized hourly wage rate, c_3 is normalized per kilogram shipment cost, X_1 is number of kilograms of sweet potatoes handled, X_2 is number of hours of hired labor, and v's represent error terms.

For this analysis we have classified sweet potato merchants into four groups according to their size (and how they procure their produce), and in what location they sell (within the marketplace or outside it). D_1 represents the dummy variable for size and system of procurement. $D_1 = 1$ for merchants whose monthly sales volume exceeds one ton, and 0 for those with smaller sales volume. $D_2 = 1$ for merchants who sell in marketplaces, and 0 for merchants selling outside the marketplace. The interaction

[16] Taxes and market fees are important but, because merchants have negligible control over their incidence, they are not explicitly considered in efficiency analyses.

term D_1D_2 is a control dummy, which equals 1 only for large volume merchants selling in marketplaces and 0 for all other combinations — small volume in market, small outside market, and large outside market.

Economic theory holds that a well-behaved profit function will be a dual transformation of the production function and, as a consequence the UOP profit function, will be "decreasing and convex in the normalized prices of variable inputs and increasing in quantities of fixed inputs." (*8*, p. 99). The expected signs of the coefficients of c_1, c_2, and c_3 are negative; as the prices and costs of these inputs increase, UOP profit level should be expected to decrease, other things the same.

Results

The parameter estimates of the profit and the derived variable input demand functions are presented in Table 5.3. The profit function (equation 5.1) has a reasonable fit ($R^2 = 0.48$) and where there was a priori expectation of signs, they generally hold. Of the variable inputs it is only the coefficient of shipping fees that seems incorrectly signed. One would expect a negative relationship between the costs of variable inputs and profit levels, other things constant. The price of sweet potato is inversely related to profit level as is the hourly wage rate.

Of the parameters measuring the effect of dummy variables, only β_2, the coefficient of the dummy representing differences in sizes of operation, is significantly different from zero. The R^2 indicates that nearly half of the variation, across merchants, in real profit levels is explained by the model.

Derived demand equations performed uniformly poorly. Outside of possible measurement error, it is not clear why the derived demand equations performed so poorly. Because of their poor fits, hypothesis tests of relative pricing efficiency are practically precluded. Consequently, the analysis focuses on tests that can be performed using the parameters in the profit equation alone.

Two related tests can be performed. The first is to determine whether economic efficiency differs by size and system grouping of sweet potato merchant. If there is a difference, the second test determines its sources. The null hypothesis in the first test is of equal economic efficiency; that in equation 5.1, $\beta_1 = \beta_2 = \beta_3 = 0$. This would mean the size and system dummy variables have no effect on profit levels. The second test compares intercept values of pairs of size and system groupings of merchants. 'T' values are computed to determine the statistical significance of intercept differences; the largest values being considered most efficient.

The unrestricted profit model (equation 5.1) is compared to the restricted model incorporating the null hypotheses above. The coefficients of the restricted model:

$$\ln\Pi = \ln A + \alpha_1 \ln c_1 + \alpha_2 \ln c_2 + \alpha_3 \ln c_3 + \ln v \qquad (5.5)$$

are shown in Table 5.3. The computed F (3,23) is 5.40, the critical F (3,23) is 4.76 at the 1 percent significance level. The null hypothesis of equal economic efficiency must be rejected; either size and system of marketing, location of sales, or both affect economic efficiency within the sweet potato trade.

TABLE 5.3: MERCHANT SURVEY, 1988: ESTIMATES OF UOP PROFIT FUNCTION AND INPUT DEMAND EQUATIONS

Variables	Symbols	Sample mean	Regression Results: Profit (5.7)	Profit (5.11)	Input demand: Sweet potato (5.8)	Labor (5.9)	Shipping (5.10)
Dependent:							
UOP profit	ln Π	4.93	--	--	--	--	--
Sweet potato demand	$-c_1X_1/\Pi$	-11.42	--	--	--	--	--
Labor demand	$-c_2X_2/\Pi$	-0.61	--	--	--	--	--
Shipping demand	$-c_3X_3/\Pi$	-92.50	--	--	--	--	--
Intercept			3.548	4.257	-1.337	-0.037	-16.174
			(3.151)	(4.463)	(0.142)	(0.057)	(0.007)
Price of sweet potato	$\ln c_1$	-0.47	-1.857	-2.014	--	--	--
			(1.346)	(1.518)			
Hourly wage rate	$\ln c_2$	0.36	-0.910	0.119	--	--	--
			(2.085)	(0.309)			
Shipping cost	$\ln c_3$	-4.51	0.033	0.071	--	--	--
			(0.307)	(0.541)			
Dummy variables:							
Size/organization	D_1	0.33	2.882	--	-1.25	-0.075	-693.180
			(2.684)		(0.067)	(0.057)	(0.141)
Location of sales	D_2	0.73	0.132	--	-16.201	-0.887	-2405.363
			(0.198)		(1.337)	(1.130)	(0.820)
Interaction	D_1D_2	0.27	-0.277	--	8.304	0.370	-2961.795
			(0.273)		(0.389)	(0.247)	(0.531)
R^2			0.480	0.120	0.090	0.050	0.130
F			3.586	1.180	0.817	0.496	1.321

Source: Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions," unpublished dissertation, Cornell University, 1991.

Notes: Numbers in parentheses are t-statistics.

The second test enables further precision on the sources of apparent differences in economic efficiency. Test statistics and intercept values are presented in Table 5.4. The systems considered are ranked in order of efficiency, with highest intercept values representing most efficient systems of sweet potato trading. Equal economic efficiency is rejected for three pairs. Small-volume merchants working outside the marketplace are less efficient than their large-volume counterparts, both of whom sell either in their homes or in shops removed from the central marketplace. They are also less efficient than large-volume merchants selling within the marketplace. Small-volume merchants trading within the marketplace are less efficient than their large-volume counterparts. At the 5 percent significance level, equal economic efficiency between small-volume merchants selling within the marketplace and large-volume merchants trading without cannot be rejected. Consequently, size of operation is a major determinant in economic efficiency of sweet potato merchants, but system and location of sales has some influence as well.

For large-volume merchants, location of sales does not affect economic efficiency. There is no difference, either, in the economic efficiency of small-volume merchants selling within or without the marketplace. Large-volume merchants are generally more efficient than small-volume merchants unless the latter are operating in the marketplace and the former outside the market.

The differences in economic efficiency could be the result of differences in pricing efficiency, the extent to which each variable input is used to the point at which the value of its marginal product just equals its price; or differences in technical efficiency, extracting maximum output for given variable and fixed inputs. This is where the analysis is unable to proceed because of the poor results of the derived demand functions. Had their fits been better, the next step would have been to estimate relative pricing efficiency for each of the variable inputs: sweet potato, hired labor, and shipping services.

TABLE 5.4: MERCHANT SURVEYS, 1988: TEST OF EQUAL ECONOMIC EFFICIENCY BETWEEN PAIRS OF SWEET POTATO MERCHANT GROUPINGS

System (ranked from least to most efficient)	Intercept value	Intercept hypothesis	Null hypothesis H_0:	Computed t-value[a]
Small, outside marketplace (SOM)	3.548	SOM - LOM	$\beta_2=0$	2.684[b]
Small, within marketplace (SIM)	3.680	SIM - LIM	$\beta_2=\beta_3=0$	2.803[b]
Large, within marketplace (LIM)	6.285	LIM - SOM	$\beta_1=\beta_2=\beta_3=0$	2.323[b]
Large, outside marketplace (LOM)	6.430	LOM - LIM	$\beta_1=\beta_3=0$	0.202
		SOM - SIM	$\beta_1=0$	0.198
		SIM - LOM	$\beta_1=\beta_2=0$	2.050

[a] The critical value for all tests is t(23) = 2.07 at the 5 percent significance level.
[b] Significant at the 5 percent level.

CITATIONS

1. Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions" (unpublished dissertation, Cornell University, 1991).

2. Rwanda, Ministry of Planning, *Comptes Economiques Nationaux du Rwanda*, 1981.

3. The World Bank, *Rwanda Agricultural Sector Memorandum: Working Paper, Food Crop Marketing* (Washington, D.C., 1990).

4. Scott, Gregory, J., *Potatoes in Central Africa: A Survey of Burundi, Rwanda, and Zaire*. Lima: International Potato Center, 1988. p. 159.

5. Lau, Lawrence J., and Pan A. Yotopoulos, "A Test for Relative Efficiency and Application To Indian Agriculture," *The American Economic Review*, 61, March 1971, 94-109.

CHAPTER SIX

SCOPE FOR IMPROVEMENT

Sweet potato cultivation has long been a mainstay for most Rwandan farm households, assuring adequate calories on ever-smaller farms. The sweet potato's future as a principal staple for the rural population is secure because of its great adaptability to the high, wet, and rugged natural conditions, as well as its inherently high yields. Whether the sweet potato will become an important food in urban areas as well will depend to a large extent on whether there is scope in its marketing system for dramatically reducing costs.

Numerous interrelated problems exist in the sweet potato market that seem to inhibit its ability to provide a needed, low-cost, nutritious source of calories to the urban poor at the same time as providing a reliable source of income for producers. Most problems grow out of the twin disadvantages of bulkiness and perishability. Our analysis of the marketing system enables us to make some suggestions that might allow the sweet potato to duplicate the success that cassava has had overcoming similar problems.

KEY PROBLEMS FACING THE SWEET POTATO MARKET

The reasons for the apparent inability of the sweet potato market to develop rapidly can be classified into the product-related problems of perishability and bulkiness, and market organization weaknesses including logistical problems, the lack of weights and standards, lack of contracts, and taxation based on volume rather than value.

Problems that are primarily product-related include:

- *Bulkiness and low unit value, which result in high marketing margins relative to product value. This is a particular problem for transport, the most important cost associated with the long-distance trade.*
  The transport margin as a percent of sales value is 13 percent for sweet potato and 7 percent for cassava.

- *Perishability, which results in strategies that are costly, and increases the cost of certain marketing activities:*

  - *Usually merchants handle only small quantities to ensure rapid turnover and to reduce the costs associated with spoilage. Consequently, fixed costs such as travel to market become greater as a percentage of shipment value.*
    It costs merchants 300 francs to travel to and from the market. That is 7 percent of the average shipment value.

  - *Dealing in small quantities also requires frequent trips to supply markets, which adds to transport costs.*

If tubers could last twice as long as they do now, which could happen if handling was improved, merchants could conceivably reduce the number of trips to market.

Additionally,

- *Because of its perishability, the sweet potato is especially susceptible to damage in handling, which, if done improperly or too frequently, results in low quality, accelerated spoilage, reduced demand, and lower prices.*
  Shipment value may be as much as 14 percent lower than might be the case because of reduced quality from damage to tubers.

Those problems whose origins appear to be primarily organizational or policy related include:

Market Organization

- *Uncertain availability of transport, which increases the risks involved in long-distance trade from potential supply markets.*

- *Lack of standards, weights, and uniformity leads to the dissemination of unclear and inaccurate market information, further complicating arbitrage.*

- *Discontinuous and limited flow of market information reduce the ability of merchants to effectively provide arbitrage between markets.*

- *Lack of contracts or contract-like arrangements in the long-distance segment of the market increases uncertainty and costs.*

- *Lack of record keeping keeps merchants from developing a clear picture of which procedures are profitable and which are not. This is especially important in such a low margin product.*

- *Lack of specialization at petty retail level may explain the relative inefficiency of small-scale merchants.*

- *The small number of bulker-shippers and transporters results from some degree of barriers to entry, and increases chances of oligopoly power.*

Government Regulations

- *Volume- versus value-based taxation is biased against trade in low-value products and creates a disincentive to trade in sweet potato.*

- *Gasoline tax applied equally across all uses does not appear to discriminate between commercial and leisure (productive and unproductive) uses of fuel.*

- *Overly restrictive regulations on when and where trade may take place curtail market activity and promote a discontinuous flow of market information.*

SPECIFIC RECOMMENDATIONS FOR IMPROVEMENT

One of the principal findings of this study is that although the sweet potato market is inefficient traders appear to be operating effectively given the product-related and institutional constraints facing them. There are some changes that can be made at the individual merchant (as well as producer and other intermediaries) level (discussed in *1*, pp. 189-197), but the most important changes would seem to require institutional innovation — changes in policy, but especially research into ways to reduce bulkiness and increase storability. These system-wide modifications are listed below in order of their expected contribution to the development of the market:

Regulations

- Modification of tax structure to make burden commensurate with value of product. Fairness and incentive issues.
- Relaxation of rigid adherence to restrictions on when and where transactions may take place. At the least, re-evaluation of the reasons for those restrictions and assessment of their costs and benefits.
- Enforcement of contracts.

Market Assistance

- Provision of access to credit to enable merchants to expand the size of their operations and potential merchants to enter the trade.
- Improvement of market information service, in conjunction with the development of market standards.
- Development of market standards in cooperation with market participants.

Regulations and Tariffs

Rwanda's sweet potato market, like other food markets, is relatively unregulated, it being official policy to let markets clear according to the forces of supply and demand. This remarkably hands-off policy runs counter to the practice in much of Africa, and has contributed greatly to the ability of Rwandan markets to function properly. There are, nonetheless, some regulations whose modification might enable the sweet potato market to operate more efficiently and thereby broaden its scope.

Change to Value-Based Taxes

A principal concern is the system of taxation, which is biased against traders in the low-value, low-margin foods such as sweet potato. Market exit taxes are levied by volume rather than value, which creates a powerful disincentive to trade in lower-value foods. Sweet potato traders must pay twice as

much in taxes as a percentage of sales value as cassava merchants simply because the latter ship a higher-value product. Taxation based on value would be more equitable and less regressive, but if it were deemed too complicated, a schedule of tax rates related to broad product value categories could be developed. If sweet potato shipments were taxed the same percentage as cassava shipments, 5 percent of purchase value, their tax bill would drop by one-half, to 50 francs per bag.

Similarly, indirect tax burdens such as gasoline taxes might be reduced for bonafide food transport. The price of gasoline is high in part because of high taxes, which account for approximately 12 percent of the price of gasoline (68.2 franc per liter) (2, p. 21). If this is part of government policy aimed at reducing fuel consumption, the policy might be reconsidered for the transport of necessities such as food. Unfortunately, while reducing gasoline taxes might be an ideal way of increasing the flow of bulky products such as sweet potato, it would prove exceedingly difficult to avoid cheating and ensure that low price gasoline was being used solely or primarily for food transport. Furthermore, it is not clear how, or if, reduced fuel costs would be passed through the marketing system.

Relaxation of Market Restrictions

There are restrictions on when, where, how often, and how long markets may meet. Some of them are related to traditional market regulations, others based on more recent policy considerations. Although for the most part these regulations seem to promote well-behaved markets, there are instances in which regulations are applied overly restrictively and curtail market activity. When, for example, producers attempting to sell their sweet potatoes in the Gitarama market are forcibly removed from the market at a certain time, it becomes clear that the primary objective of market administrators is no longer to facilitate sales. Also, limiting the number of days markets may meet reduces the flow — makes it sporadic — of market information, especially for sweet potato, which is rarely sold outside of the marketplace.

Market Assistance

Specific steps to assist merchants and would-be merchants include easing loan requirements, developing product standards in conjunction with market participants, strengthening of market information services, assisting in the development of contracts (primarily between bulker-shippers and transporters where risk is greatest), and assisting in the development and maintenance of record keeping.

We have already pointed out the importance of credit and record keeping, especially for bulker-shippers and high-volume retailers. If merchants are not using them because they do not know they are available or useful, extension services could provide the necessary information.

Improvement of Market Information Service

The government has recognized the importance to a market economy of providing the widest possible access to market information. This is to be done by widely disseminating prices through two government instruments, the official weekly newspaper and the national radio. In both cases, however, the tendency is to report official or suggested prices rather than actual market prices. Emphasis needs to be placed on the latter. Rapid and regular communication of real prices from around the country can contribute to better integration of the market by providing potential arbitragers with information about

regional price differences. To the extent that government involves itself in price dissemination to inform market participants, including consumers, of market conditions, the prices must accurately reflect those conditions actually prevailing.

Development of Market Standards

For the market information contained in those prices to be meaningful for commercial purposes, the exact specifications of product and period to which the price pertains — midmorning price, medium, red grade AA, sold in Gitarama, for example — must be clear. Shaffer, et al. (*3*) emphasize the importance of the development of product grades and standards to make market information accurate. Knowledge that the per kilogram price of sweet potatoes is seven francs in Gitarama and only five francs in a competing Ruhengeri market is not very useful to merchants if they do not also know that the higher-quality Gitarama sweet potatoes sell at a premium of more than two francs per kilogram over Ruhengeri sweet potatoes. The standardization of quality and size classification is indispensable to market information. Without it market information remains inaccurate and insufficiently precise to stimulate trade or reduce risk.

An additional requirement for the accurate conveyance of market information, either through a market reporting service or through the normal trade channels of the market, is that there be clarity about the units of sale to which the prices refer, and that those units be the same as those that are commonly used in trade. Prices are reported on a per kilogram basis, but most trade is in baskets, bags, or mounds that vary greatly in size across markets. Furthermore, merchants at all levels appear resistant to changing from volume- to weight-denominated sales. We are not suggesting that merchants be required to use scales to facilitate the job of a market information service. All information about the market that is based on unstandardized units will tend to be inaccurate and, as a result, risky. Weight-denominated sales would entail purchasing or renting scales and the costs of learning the new system, but could lead to an improved flow of market information and greater market integration. These should lead, in turn, to lower prices in deficit areas and higher prices in surplus areas that had previously been segmented.

Finally, training and assistance in drawing up contracts, especially between bulker-shippers and transporters, where the potential losses from breach of contract are high, could help reduce the risks of trade and lower gross margins that are otherwise kept high to cover these risks. Without the force of law to back them up, contracts, of course would be practically meaningless. Some branch of the government like the commune-level administration that administers marketplaces, or a market-wide association, could have primary responsibility for enforcement.

RECOMMENDED RESEARCH INTO STORAGE AND PROCESSING

Research into storage and processing techniques is probably the single most important contribution that can be made at the macro level because it can address the twin problems of bulkiness (low unit value) and perishability that underlie many of the other marketing problems. Research into storage could extend the advantages offered by storage to the marketing chain, and could provide farmers with alternatives to the in-ground storage they already practice. Processing has the greatest potential for developing the market, by virtue of its likely effects on bulkiness and perishability.

Storage

There is no long- or even intermediary-term postharvest storage of sweet potatoes in Rwanda. Some very-short-term storage, generally overnight warehousing, is done by retailers, and was the only kind we encountered during our field work. Otherwise, what storage there is occurs in the field as part of attempts by farmers to ensure continuous food supplies.

In-Ground Storage

The only kind of storage regularly practiced in Rwanda is in-ground storage, by which farmers keep unharvested, mature sweet potatoes in the field until they are needed for consumption or sale. By planting the first hillside crop between September and January, the second crop between March and May, and the bottomland crop between April and July, and engaging in in-ground storage, they can be sure of year-round availability (refer to Figure 2.1).

Sweet potatoes mature after four to six months, depending on the varieties and climatic conditions. After that they can be left in the ground unharvested for as long as 12 months if conditions are ideal — well-drained soil and lack of pests and disease vectors (*4*, p. 52). The normal duration of in-ground storage is three to four months after maturity (*5*, p. 75).

In-ground storage is appealing primarily for its ability to provide farm households a constant supply of food. It also provides a continuous supply of planting material. In-ground storage is, to some extent, a by-product of the strategy of continuous planting and piecemeal harvesting. Piecemeal harvesting supplies the necessary cuttings for continuous planting, which in turn provides the necessary outlet for cuttings. If harvesting were done all at once, a large field would be needed to accommodate the cuttings.

In spite of its benefits, in-ground storage has costs and limitations. After maturation a number of problems begin to appear in tubers that are left in the ground. The most important are (*6*, p. 74):

- Diseases, which are especially problematic in wet and poorly drained soils;
- Pest infestations (weevils, termites, nematodes and rodents), which can become very heavy and cause large losses;
- Germination, which destroys their commercial value; and
- Cracking and increasing amount of inedible fiber, which leads to spoilage and loss of eating quality.

Unfortunately it is not clear when these problems become serious under Rwandan conditions, nor when they render in-ground storage impracticable. No estimates have been made of their magnitude, so no cost estimates can be made. Elsewhere it has been reported that losses become important in as few as two months after maturation (*7*, p. 68).

The costs of in-ground storage are the costs of not being able to use the land for the next best alternative and the costs associated with the deterioration in quality, described above.[1] At the very least, one alternative would be fallow, or a short resting of the land for improved productivity later. This is an alternative that is always possible but not always most profitable; it represents the minimum opportunity cost of in-ground storage.

The opportunity cost depends on the alternative uses of the land, which depend on the type of field (bottomland or hillside), the season, and the available technology. Rwandan agriculture is primarily rainfed; hillside fields exclusively so. Bottomland fields have drainage and limited irrigation that enable them to be used in the dry seasons as well as during parts of the wet season.

Land freed up from storage in hillside fields is most likely to be used only for new crops of sweet potatoes because farmers relegate the least fertile of their farmland to sweet potatoes. Furthermore, because hillside agriculture is purely rainfed, planting and harvesting periods for more demanding alternative crops such as sorghum and beans are sharply defined. In the absence of irrigation it is difficult for farmers to successfully plant beans or sorghum on hillsides outside of a fairly limited period at the beginning of the rainy season. Consequently, the most likely alternative to in-ground storage of sweet potatoes is the establishment of a new crop of sweet potatoes.

Bottomland fields are more versatile in types of crop as well as timing of planting. Their greatest limitation is flooding, which is most problematic at the height of the long rains. Other than sweet potatoes, the crops most often planted on bottomland fields are beans and sorghum, which are generally considered preferred crops. Beans are planted in the bottomland at the onset of the dry season at about the same time sweet potatoes are planted. When sorghum is cultivated in the bottomlands it is planted in the same months (September through October) that the bottomland crop of sweet potatoes is being harvested and, in some cases, stored in the ground. Early harvesting of sweet potatoes could free up land for a larger sorghum crop and for earlier planting; it could also enable another crop of sweet potatoes to be planted.

Opportunity costs will differ, depending on which crop could be planted. Computations presented in Table 6.1 suggest the opportunity cost is greater when sweet potato cultivation is an alternative to in-ground storage. The opportunity cost of using 2.5 ares of land for in-ground storage for two months when sweet potato cultivation is an alternative is a little over twice as much as it would be when sorghum is the sole alternative. This is because two months represents a larger proportion of time to maturity for sweet potato, and consequently the expected value at maturity is multiplied by a larger fraction, and because sweet potato has higher yields.

The costs of losses from diseases and pests is harder to quantify, no enquiries having been made about the magnitude of such losses in Rwanda. What is known is that they become greater the longer tubers are kept in the ground. Not including losses, the opportunity cost of leaving a 2.5-are field of sweet potatoes unharvested for two months after maturity is probably 270-700 francs in the expected value of alternative crops.

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[1] There are also the costs of losses associated with insect infestation and the other problems listed above, which become progressively worse the longer tubers are left in the ground.

TABLE 6.1: COMPONENTS OF OPPORTUNITY COST OF USING 2.5 ARES FOR TWO MONTHS OF IN-GROUND STORAGE OF SWEET POTATOES UNDER TWO CROP ALTERNATIVES

Alternative Crops	Field	Yield[1] (kg)	Price (frw/kg)	Value at Harvest (francs)	Months to Mature	Percent Maturity[2]	Two month share of expected value[3] (francs)
Sweet potato	Hillside & Bottomland	200	9	1800	5	40	720
Sorghum	Bottomland	30	27	810	6	33	270

1/ Based on per hectare yields of 8000 kilograms and 1,200 kilograms for sweet potato and sorghum, respectively. 2/ Number of months required for crop maturation, divided by two months of in-ground storage. 3/ Expected harvest value, kilogram yield multiplied by per kilogram price, multiplied by percent maturity (two months in-ground storage divided by months to mature) gives the expected two month share of harvested value.

Alternative Methods of Storage

There are two broad categories of alternative methods of storage that might be considered and provided as options for farmers and other intermediaries. One is the storage of tubers that are essentially fresh and unprocessed aside from a procedure called curing. The other entails processing tubers into forms that are less perishable (dehydration, canning, and so forth). Systems of fresh tuber storage are considered in this section, processing in the subsequent section.

Curing in preparation for storage. Curing is an essential first step in any but the shortest-term fresh tuber storage systems, and a limited amount occurs naturally immediately at harvest. Under controlled temperature and humidity conditions, the naturally occurring latex in the sweet potato is secreted to form a protective covering over any wounds to the tuber, hardening the skin in the process and making it more resistant to damage (*8*, p. 376).

Although curing is done in developed countries as a matter of course, it usually involves relatively capital intensive procedures impracticable in Rwanda.[2] It can be done simply. An ISAR study suggests this approach: as soon as sweet potatoes have been harvested, cleaned, and sorted, they should be placed in crates or baskets, covered with plastic sheeting, and placed over containers of water. By doing so the temperature (27*o* to 30*o* C) and relative humidity (85-90 percent) necessary for curing can be achieved (*6*, p. 73). For optimal storage results, curing should be done for four to five days. The study also reviews alternative methods of storage. The two that seem most promising for Rwanda are underground silos and aerated mound silos (*6*, pp. 72-77).

Underground storage. Underground storage, not to be confused with the in-ground storage strategies currently employed by producers, has the potential of conserving tubers for up to four months if conditions are ideal (undamaged tubers and proper temperature and relative humidity). Under normal conditions, tubers can be preserved for one to two months (*6*, p. 75). To store 200 kilograms of sweet potatoes, or the yield of 2.5 ares, a pit one meter deep by 80 centimeters in diameter is dug and lined with a layer of straw. The pit is filled with tubers, alternating layers of tubers with layers of straw, and covered with a layer of dry leaves, 25 cm of earth, and more straw to ensure that the pit stays dry.

In Cameroon, selected undamaged (but, apparently uncured) tubers are first dried in the shade while a pit lined with a layer of ash is prepared into which the tubers are to be placed. After filling the pit with alternating layers of tubers and ash, it is sealed with a layer of straw and earth. Average losses from respiration, insect infestation, and rotting have been found to be 30 percent after four months (*9*, p. 106). They would be less if tubers were first cured. Elsewhere, cured tubers have been found to lose about one-third the weight lost by uncured tubers during storage (*10*). Similar systems are reported in Zimbabwe and Malawi (*10*, p. 106).

Mound storage (clamps). To create a mound silo for the storage of the same amount of sweet potatoes, a 60-centimeter-high mound of tubers is formed on a bed of straw 1.2 meters in diameter, and covered by a 20-centimeter layer of straw and a 15-centimeter layer of earth. A straw chimney is placed vertically in the middle of the mound to eliminate excessive buildup of heat. The chimney is covered

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[2] Sweet potatoes intended for the fresh tuber market are harvested, cleaned, and immediately placed in climate controlled (temperature and humidity) rooms for curing. After curing they are generally removed to storage rooms where they remain at cool temperatures until they are to be placed on the market.

with screening and an overturned earthen pot to keep rodents and rain out. For proper drainage a trench 30 centimeter deep is dug around the mound. Storage in mound silos substantially improves aeration over underground storage, and is considered well suited to the highlands of tropical Africa, where climate is cool. Mound silos can conserve tubers for 30-50 days (*6*, p. 75).

Both underground and mound storage technologies appear technically feasible for Rwandan producers. The placement of underground silos would be more restricted than that for mound silos. It would be imperative that soil conditions not be excessively wet, and that soils drain well, which would probably preclude placing silos near bottomland fields. As long as a good drainage ditch is provided, mound silos could be placed anywhere. For security, however, silos of either type would probably be placed most frequently on the hillsides or hilltops where farmers have their compounds.

It is also extremely important that tubers be handled carefully and as little as possible. Any bruises or cuts from harvesting or through insect infestation will accelerate the rate at which tubers deteriorate. Furthermore, the optimum temperatures (between 13° C and 16° C) at which sweet potatoes should be stored tend to be lower than normal temperatures found in much of Rwanda's sweet potato growing region.[3] It is not clear whether the necessary temperatures could easily and cheaply be achieved by either method.

Cost Comparison

The costs of in-ground storage and alternative methods are roughly equivalent. No previous attempts have been made to determine what the costs of fresh tuber storage would be. The author has estimated investment or start-up costs for storage systems capable of handling 200 kilograms of sweet potatoes to be 2,600 francs:

• 2 large wooden crates @ 800 francs	1600 f
• 2 plastic basins @ 300 francs	600 f
• Plastic sheeting	200 f
• Straw	50 f
• Screening	100 f
• 1 Earthen pot @ 50 francs	50 f
	2600

This is a large cash outlay for the average farm household whose net annual cash income is 22,000 francs (*11*, p. 43), and would be one of the first hurdles to be cleared, possibly through government assistance.

The equipment cost associated with each time 200 kilograms of sweet potatoes are stored is 400 francs. This is based on the assumption that crates, basins, and screening could be used 10 times before replacement, that plastic sheeting could be used twice, and that the other equipment would have to be purchased every time a silo was prepared Labor costs are harder to quantify. We have estimated the labor requirements for curing and storing 200 kilograms to be five man-days. Calculated at a daily rural wage rate of between 30 francs and 60 francs, labor costs would be in the range of 150 to 300 francs.

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[3] Temperatures in the Central Plateau average between 18° C at the higher elevations and 22° C at lower elevations.

Together, labor and equipment costs would be between 550 and 700 francs. The costs of in-ground and alternative methods of storage are roughly equivalent:

	In-Ground		Alternative methods	
	francs			
Value of forgone production (sweet potato)	700		Equipment	400
			Labor	150-300
				550-700

This also assumes, in the absence of data to the contrary, that storage losses are equivalent. It is most likely, however, that losses from alternative methods would be larger, especially during a learning period. Alternative methods also carry relatively large start-up costs.

Risk of losses is the most likely impediment to adoption of alternative methods of storage, or to the replacement of in-ground storage by them.[4] It is up to research and extension services to develop simple, low-loss methods and to establish the probability of losses. It appears, nonetheless, that sweet potato storage at the farm level is at a threshold. Rapid population growth is creating pressures for greater intensification. As farming intensifies, and with it changes occur in agricultural technology such as irrigation and adoption of early maturing varieties, the opportunity cost of in-ground storage is likely to increase and before long exceed the cost of alternative methods. In preparation for that time, research should be ready with well-tested alternatives well-suited to Rwandan conditions.

Processing Sweet Potatoes

Fresh tuber storage addresses only the perishability problem, and even that in only a limited way; it is unlikely that tubers could be stored longer than three or four months. Storage would have little effect on the cost of transportation. An answer to both bulkiness and perishability problems is processing — making new, higher-value products that are less bulky and easier to handle and transport. The kinds of processing we emphasize are those that also have a relatively simple storage component to them like chipping and milling as well as those that are likely to produce foods that will be accepted in the urban and possibly the rural diet.

Acceptability and Uses

The success cassava flour has had in the urban areas of Rwanda, particularly Kigali, suggests sweet potato flour or meal might have similar acceptability, because it can be used in similar ways. Using flour to make a *fufu* or *ugali* is accepted in the urban diet. Cassava flour is a relatively new product in Rwanda. Cassava was introduced, or at least promoted and widely expanded, as a famine crop by the Belgian administration, but has begun to gain importance as a food, especially recently in the cities. Production and consumption have grown faster than that for any other crop in large part because of the advantages cassava flour affords to the marketing chain and ultimately the urban consumer.

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[4] If, for example, 30 percent of a 200-kilogram silo is lost, it will cost the farmer more than 500 francs in lost value.

Nine out of 10 urban households eat cassava flour, nearly all of which is purchased (*12*, p. 1-6.). The average annual value of household consumption of cassava is 5,500 francs, of which flour represents two-thirds. Unfortunately the study does not yet have figures on actual household consumption, nor on prices used in the estimate. Rural households consume roughly 200 kilograms of cassava flour annually. Having smaller households, but higher propensities to consume cassava flour, urban households probably consume as much if not more than their rural counterparts.

Dried sweet potato chips could be reconstituted, boiled, and eaten that way, or they could be pounded or milled into a kind of *fufu*, to be eaten with beans and sauce, much as is done with cassava flour. There are other uses to which sweet potato flour could economically and acceptably be put. It could find use, mixed with other flours, as an ingredient in the simple market pastries — doughnuts, and muffins — that are becoming more and more important in urban and rural markets.[5]

Sweet potato flour might also have commercial potential as a low-cost extender in bread making, much as manioc flour has been used periodically elsewhere in Africa. When sweet potato is used, the optimal mix for bread making is 20 percent sweet potato flour to 80 percent wheat flour. For bakery products for which gluten is less important, an even greater amount of sweet potato flour could probably be used. Even with a 50-percent marketing margin, sweet potato flour could undersell wheat flour, which is priced at 100 francs per kilogram at retail.

Type and Organization of Processing

There is no tradition of sweet potato processing in Rwanda. Elsewhere where sweet potato has some importance in the diet, numerous methods of processing are reported. In Papua New Guinea, for example, a relatively capital intensive technique is employed to make a gari-like product, called *kaukau* rice, out of sweet potatoes, which is stored, cooked and eaten much like rice (*13*, p. 429 and 430). In India, sweet potato flour is reportedly often used in bakery products, and can be 25 percent of a wheat-sweet potato flour mix in bread making (*14*, p. 305). In Cameroon, sweet potato flour is made for the preparation of cakes and other bakery products. Tubers are washed, grated, and dried, then pounded into a flour for use in a variety of cake-like products (*9*, p. 107). The ancient Maori of New Zealand developed *kao*, a product from cooked roots, as a storable product, and in South China farmers make a similar product, as well as storable forms of flour, *sago*-like granules (a *gari*-like product), and dried flakes (*15*, p. 25). In Nyanza in Kenya and in Western Tanzania tubers are peeled, sliced, dried and then ground into a flour with sorghum or maize for making *ugali* or *uji* (*16*, p. 71). In Tanzania, tubers are boiled, sliced, dried, and stored as dried chips (*9*, p. 107).

Cassava's example. The evolution of cassava processing in West Africa is instructive. Fresh cassava is highly perishable, and begins to show distinct signs of spoilage within two days of harvest. Consequently, when producers have desired to market or store surplus production they have had to resort to some form of processing. There are two basic types of processing in Africa, the production of *gari* or *farinha de mandioca*, which is a cassava meal made from grated, extruded roots, and the production

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[5] In most markets there is a section where doughnuts and other simple bakery products are made and sold. Wheat flour is rarely the only, or even the primary, flour in these products. Flours from sources as different as peanut, pea, and sorghum are often used. A doughnut maker to whom we gave some sweet potato flour claimed not to have had any problem selling doughnuts made with some sweet potato flour.

of *kokonte*, flour made from dried roots. It is only in West Africa that both systems are used, and it is of interest to sweet potato processing that where both products are made, flour, which is cheaper to produce and lower in market value, was the first to gain acceptance (*17*, p. 113). In East and Central Africa the predominant form of processing remains the production of flour by soaking, peeling, drying, and then pounding the dried roots into a fine flour.

The two procedures are distinct in the final product and in the ways they are consumed, *gari* being eaten like rice, cassava flour being made into a variety of dough-like products like *fufu* or *ugali*, to be dipped in a sauce and eaten that way. The two procedures also have different implications for the organization of production and marketing.

Making cassava flour requires little equipment and relatively little time, but results, nonetheless, in a product that is highly storable and marketable. Farmers can easily peel, soak, and dry the roots with a minimum of equipment. There are probably no economies of size to make centralization of processing attractive. Marketability is enhanced when farmers restrict themselves to producing and selling dried roots, flour being made at the point closest to the consumer. By so doing, costs of transportation and handling are substantially reduced.

Gari, a rice-like product, requires much more labor and equipment. It is a high-cost product with relatively high market value (*18*, p. 10). Because it is more capitalized, there are likely to be economies of size that warrant centralized processing. Kreamer shows that *gari*-making is evolving towards a highly centralized system as modern, commercial *gari* processors contract with farmers to buy entire fields of cassava and ship the roots to their processing plants (*18*).

In Central Africa, including Rwanda, cassava processing remains at the first and simplest stage, simple sun drying of peeled, split, sometimes soaked roots, destined exclusively for flour with which a *fufu* or *ugali* is prepared. There is reason for this. Farmers remain predominantly subsistence oriented, and this is the least cost way to render the roots storable. There is the additional influence, in Rwanda, of a dispersed settlement pattern that favors decentralization. These factors are likely to exert similar influences on the development of sweet potato processing in Rwanda.

Technical Feasibility

The simplest, least cost approaches will be adopted first, with farmers peeling, slicing and sun-drying sweet potatoes, and flour being made by the retailer or the consumer. Like cassava processing, sweet potato processing would initially be decentralized. Farmers would prepare dried chipped or shredded sweet potatoes, which would be marketed in that form and made into flour just before use. Making dried chips is feasible at the household level, which is where it would need to be done if the full advantages of low weight and ease of transport were to be realized.

During our field work, we experimented with a rudimentary approach to chipping and sun drying — hand peeling tubers, slicing them, drying them on mats in the sun for two days, then storing them in plastic bags or metal containers for several weeks.[6] The largest quantity we dealt with at one time was the dried equivalent of 30 kilograms of fresh tubers. Drying the chips adequately and keeping them dry

[6] For faster and more complete drying, chips could be placed above ground, on racks.

was easy during dry weather, but proved more difficult in the wet season. When chips were insufficiently dried they rapidly developed mold spores and spoiled.[7]

Inadequate periods of sunshine during wet seasons might constitute a limitation to the most rudimentary drying techniques. It does so for cassava, which is scarcest and lowest in quality when the weather is wettest (October, November, March, and April. Farmers should avoid drying their sweet potatoes during these months; sweet potato products being unlikely, for the foreseeable future, to have a high enough value to warrant more sophisticated methods and equipment that could moderate the problem of lack of sunshine. Once dried, however, if the chips can be kept in a dry space, storage should pose no problems regardless of the season. In Tanzania, dried chips are reportedly stored for as long as two years with no apparent deterioration (*9*, p. 107).

Cost of Production

Chips or sweet potatoes dried in one of the other ways described above can be milled in mills designed to make flour from maize, sorghum, or cassava. For direct consumption in *fufu*, a rougher, less expensive flour could readily be made by pounding the chips in a mortar.

In our experiment it took 30 kilograms of fresh tubers to make 11 kilograms of flour, a conversion rate of 3 to 1.1, which is similar to findings communicated to us by Joseph Mulindagabo, the principal technician responsible for extension work in root crops at ISAR. Elsewhere a conversion ratio of five to one was found (*19*, p. 393). The amount of flour that could be made from fresh tubers would vary by variety as wel as technique employed. We have assumed that the manual chipping and sun-drying used in our experimentation is technically inefficient, and that at higher volumes unit costs would decline; nevertheless, the per kilograms cost of producing 11 kilograms of flour, including purchase of the raw product, was 50 francs:

Cost component	Per kilogram cost (francs)
Sweet potato	23[8]
Labor (2 man-hours)	25
Milling (2f fee)	2
Total per kilogram cost	50

This included purchasing tubers in the market; paying hired labor to clean, peel, and slice the tubers; and paying a milling fee. Farmers would probably only peel, slice, and dry the tubers, leaving milling to intermediaries or the consumer. Their costs would be roughly half of ours:

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[7] For best storage results, chips should be dried to below 15-percent moisture. Above that they readily take up and retain water and spoil easily.

[8] The market price of the quantity of fresh tubers required to make one kilogram of flour. This is very likely a high-cost scenario, since part of the market price of fresh tubers reflects producers' imputed cost of head load transportation to market. It would be more expensive to transport the fresh tuber equivalent of dried chips or flour than to transport the dried ships or flour themselves. Furthermore, it is expected that part of the processing, at least chipping and drying of chips, would be done on the farm.

Cost component	Per kilogram cost (francs)
Sweet potato	20
Labor (2 man-hours)	8
Total per kilogram cost	28

The cost of tubers would be one franc lower per kilogram, since farmers would not have to carry the sweet potatoes to market. Labor costs would be lower in part because own household labor would be used rather than hired labor, but also because farm wage rates are lower than urban rates (30-60 versus 100 francs), and finally, milling would be done elsewhere in the system unless producers sold directly to consumers.

Benefits and Conclusions

A principal advantage to the marketing chain of processing fresh sweet potato into dried chips or flour would be the reduced importance of transport costs as a percentage of the marketing margin. Bag-denominated transport fees would be smaller because more flour or dried chips than fresh tubers could be fit into one bag. The relative cost of transport would be less because the value of one bag would be greater. Similarly, the tax burden would decline.

For the following estimates we have assumed dried chips, the form most likely to be transported from the farm gate to the consumer or to the retail market, would cost 30 francs per kilogram at the supply market and 40 francs at the terminal market.[9]

	Fresh Tubers	Chipped Dried Tubers
	francs/kg.	
Sales price	14	40
Purchase price	9	30
Margin	5	10

The 10-franc marketing margin is the same percentage margin as that in the cassava market (see Table 5.2). The expected sales value of one 110-kilogram bag would be 4,400 francs of which the per bag transport fee and the shipping tax would represent 3 percent and 2 percent, respectively. Drying before shipping would reduce shipping's share of the marketing margin. This does not even take into account the additional potential savings that would come from filling each bag more fully with chips than is possible with fresh tubers.

Fresh tubers sell for approximately 14 francs per kilogram in Kigali and can be bought for 9 francs in Gitarama supply markets. The 5-franc-per-kilogram margin must cover transport fees, taxes,

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[9] The difference between the 50-franc cost of producing one kilogram of flour and the 30-franc wholesale market price of dried chips is a function of two factors. In the first case, fresh tubers were bought in the market, which meant that producers had to head load them in at relatively high cost. In the second case it is assumed that lighter, easier-to-transport chips are brought to market. Secondly, an additional 2-franc-per-kilogram milling fee was paid in the first case.

labor costs, and profits of merchants engaged in the long-distance trade. If one considers the transport margin as a residual, the amount available to pay for transport services after all other costs, and gross profit of 2 francs per kilogram are subtracted, one finds on average 1.3 francs per kilogram available for transport (see Table 5.2). According to data we collected from six markets, the transport fee is approximately 23 francs per ton/kilometer, which amounts to a per kilogram fee of 0.02 francs for each kilometer.[10] The relatively low margin in the fresh tuber trade suggests bulker-shippers can travel 50-100 kilometers to supply markets depending on the quality of the road. This contrasts with a potential market supply radius for cassava bulker-shippers (also assuming a 2 franc per kilogram gross profit margin) of more than 100 kilometers.

Were merchants to trade in dried sweet potato chips costing approximately 30 francs per kilogram in supply markets and perhaps 40 francs in urban Kigali, the residual margin available for transport fees would be larger, as much as 4 francs per kilogram. As a consequence, the market supply radius could increase to 200 kilometers, more than double that for fresh tubers. Assuming similar rural prices for wholesale sweet potatoes, the hypothetical market supply radius increases by 50 kilometers as the part of the margin available to pay shipping fees increases by 1 franc:[11]

Amount available for shipping (francs per kilogram)	Market supply radius (in kms.)
1	50
2	100
3	150
4	200
5	250
10	500

With processing and improved storage options at all levels of the market, the sweet potato could achieve a degree of marketability similar to that achieved remarkably quickly by cassava. The advantage would be that the production base for sweet potatoes is larger and more evenly spread around the country; the income effect of increased demand would be spread more widely. Also, there is capacity for greater production through intensification. Were the market to develop, producers could meet product needs, thereby improving their incomes. It is conceivable that 20 years hence storage and processing will be regular features of the sweet potato market.

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[10] The World Bank estimates transport costs at between 20 francs per ton kilometer on paved roads, to 60 francs per ton kilometer on poorly maintained, unpaved communal roads (The World Bank, p. 34).

[11] This holds for truck transportation only. For head load transportation, by contrast, the market radius increases by only 1.5 kilometers for every franc available in the margin to cover transport costs.

CITATIONS

1. Tardif-Douglin, D., "The Marketing of Sweet Potatoes in Rwanda: Commercializing a Perishable Crop Under Adverse Conditions" (unpublished dissertation, Cornell University, 1991).

2. World Bank, *Rwanda: Recent Economic Developments and Current Policy Issues* (Report No. 6191-RW, Washington, October 31, 1986).

3. Shaffer, James D., Michael T. Weber, Harold Riley, and John Staatz, "Designing Marketing Systems to Promote Development in the Third World Countries," in *Agricultural Markets in the Semi-Arid Tropics: Proceedings of the International Workshop*, (ICRISAT, India, 1985).

4. Ndamage, G., "Développement et amélioration de la production de la patate douce au Rwanda," in *Séminaire atelier sur la production, la conservation, la transformation et l'utilisation des racines et tubercules* (UNICEF-IWACU, February 8-12, 1988, Kigali).

5. Preissler, R., "Commercialisation des produits agricoles: Structures des marchés et évolution des prix dans la région du Projet," *Etudes et Experiences*, No. 6, (1986) Projet Agro Pastoral de Nyabisindu, Rwanda.

6. De Lannoy, Guy, "Pertes après-récolte et principes de conservation des racines et tubercules amylaces," in *Séminaire atelier sur la production, la conservation, la transformation et l'utilisation des racines et tubercules* (UNICEF-IWACU, February 8-12, 1988, Kigali).

7. Jamieson, as reported in Siki, in Villareal, R. L., and T. D. Girggs, eds., *Sweet Potato: Proceedings of the First International Symposium* (AVRDC, Tainan, 1982).

8. Winarno, F.G., "Sweet Potato Processing and By-Product Utilization in the Tropics," in Villareal, R. L. and T. D. Griggs, eds, *Sweet Potato: Proceedings of the First International Symposium* (AVRDC, Tainan, 1982).

9. Kwatia, J., "Conservation, transformation et utilisation du manioc et des autres racines comestibles," in *Séminaire atelier sur la production, la conservation, la transformation et l'utilisation des racines et tubercules* (UNICEF-IWACU, February 8-12, 1988, Kigali).

10. Booth, R.H., "Post-Harvest Deterioration of Tropical Root Crops," *Tropical Science*, 1974, 16(2):49-63.

11. Rwanda, Ministry of Planning, "Consommation et sources de revenus des ménages ruraux," *Enquête Nationale sur le Budget et la Consommation des Ménages*, Vol. 3, May 1988.

12. Rwanda, Ministry of Planning, "Consommation finale des ménages urbains," *Enquête Nationale sur le Budget et la Consommation des Ménages*, preliminary report, 1986?

13. Moy, J.H., and S.P.S. Chi, "Solar Dehydration of Sweet Potato," in Villareal, R. L. and T. D. Griggs, eds, *Sweet Potato: Proceedings of the First International Symposium* (AVRDC, Tainan, 1982).

14. Hrishi, N., and C. Balagopal, "Processing of Root Crops in India," in D.L. Plucknett, ed., *Small-Scale Processing and Storage of Tropical Root Crops* (Westview).

15. Yen, D. E., "Sweet Potato in Historical Perspective," in Villareal, R. L. and T. D. Griggs, eds, *Sweet Potato: Proceedings of the First International Symposium* (AVRDC, Tainan, 1982).

16. Jana, R. K., "Status of Sweet Potato Cultivation in East Africa and Its Future," in Villareal, R. L. and T. D. Griggs, eds, *Sweet Potato: Proceedings of the First International Symposium* (AVRDC, Tainan, 1982).

17. Jones, W. O., *Manioc in Africa* (Stanford, 1959).

18. Kreamer, R. G., "Gari Processing in Ghana: A Study of Entrepreneurship and Technical Change in Tropical Africa" (Cornell Int. Agr. Study, A.E. Research 86-30).

19. Taylor, James H., Commercial Production of Sweet Potatoes for Flour and Feeds," in Villareal, R. L. and T. D. Griggs, eds, *Sweet Potato: Proceedings of the First International Symposium* (AVRDC, Tainan, 1982).