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PROFITABILITY OF CASSAVA PRODUCTION SYSTEMS IN WEST AFRICA: A COMPARATIVE ANALYSIS (COTE D'IVOIRE, GHANA AND NIGERIA)

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PROFITABILITY OF CASSAVA PRODUCTION SYSTEMS IN WEST AFRICA: A COMPARATIVE ANALYSIS (COTE D'IVOIRE, GHANA AND NIGERIA)

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ABSTRACT

PROFITABILITY OF CASSAVA PRODUCTION SYSTEMS IN WEST AFRICA: A COMPARATIVE ANALYSIS (COTE D'IVOIRE, GHANA AND NIGERIA)

By

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Sub-Saharan Africa (SSA) cassava- producing countries such as Nigeria, Ghana, and Côte d'Ivoire have developed, in recent years, an interest in cassava as an alternative food crop. This has led to a major expansion in cassava- based production systems in Nigeria and Ghana, whereas there has been a slower growth in Côte d'Ivoire.

The study examines, using the Policy Analysis Matrix (PAM) framework, the magnitude of the impact of various factors such as agricultural policies (i.e., trade and price policies, domestic production taxes or subsidies), location and technologies (production and processing) on the private and social profitability of cassava production and post-production processing in Côte d'Ivoire, Ghana and Nigeria. The study relies primarily on data for Côte d'Ivoire, Ghana and Nigeria from the Collaborative Study of Cassava in Africa (COSCA) survey.

The study is organized in three essays. The baseline results in essay 1 (chapter 2) show that cassava/maize systems have a competitive advantage over their competitors in Cote d'Ivoire. That is, profitabilities (financial and social) of cassava/maize systems significantly exceed those of rainfed rice/maize systems. In addition, the baseline results indicate that, farmers operating at the market located near the port city benefit from a

small implicit price support whereas farmers operating in the market located far away from the port city were subject to a small implicit tax. The simulation findings indicated that: 1) an increase in yields per hectare of cassava and rainfed rice would not only further enhance the comparative advantage of cassava/maize systems but also cause rice/maize systems, which were unprofitable at the baseline, to become socially profitable; and 2) a depreciation of the equilibrium exchange rate (more fcfa per $US) also increased the profitability of both systems.

The second essay (chapter 3) deals with the evaluation of the social profitability of cassava/maize systems, under alternative production and processing technology combinations, in Nigeria. The baseline results show that the net social profitabilities (NSP) of systems under "*Impmech*" technology exceed those of systems under other alternative technologies, namely "*Locmech*", "*Locman*" and "*Impman*". The simulation results indicate that a depreciation of the real exchange rate (more nairas per US dollar) would increase significantly the profitabilities of cassava/maize systems under the technology combinations "*Impmech*" and "*Locmech*".

The final essay (chapter 4) compares the competitiveness of cassava/maize systems in Cote d'Ivoire, Ghana and Nigeria. The baseline results demonstrate the similarity in efficiencies of production in these West African countries. The simulation findings indicated that, in Cote d'Ivoire, farmers benefited from the depreciation of the equilibrium exchange rate while farmers in Ghana and Nigeria suffered losses. Simulation results also indicated that Ivorian and Ghanaian cassava/maize farmers could benefit from growing IITA's improved variety and adopting mechanized processing methods.

To Papa Mamadou Camara

To Maman Marie-Therese Delompuy

To the HUMAN RACE

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CHAPTER 1

INTRODUCTION

1.1. Issues and Background

Cassava is an important commodity in many farming systems in Sub-Saharan Africa (SSA). Its relative importance stems from its adaptability to a wide range of agro-ecologies, including marginal lands and erratic rainfall conditions. Thus, regardless of the production environment, compared to other crops, cassava has lower production risks, and provides the possibility of maintaining a continuous food supply throughout the year (Nweke et al, 1994).

In most SSA countries, governments have avoided investing resources in the improvement of cassava production partly because they view cassava, in the words of Jones (1959), as "...a starchy staple that provides at best only a small part of protein requirement and only trivial amounts of vitamins". This has led many African policy-makers to regard cassava solely as a means to fight famine. However, this research is based on the argument that the role of cassava in improving household food security in SSA should be appraised not only from a nutritional point of view, but also in terms of its potential as a cash crop.

1.2. Research Problem and Knowledge Gap

SSA cassava- producing countries such as Nigeria, Ghana, and Côte d'Ivoire have developed, in recent years, an interest in cassava as an alternative food crop. This has led to a major expansion in cassava- based production systems in Nigeria and Ghana, whereas

there has been a slower growth in Côte d'Ivoire (Nweke, 1998). Indeed, Theberger (1985) and Babo (1995) have argued that the government of Côte d'Ivoire has invested very little in improving cassava-based production systems. A major focus has been the expansion of rice production (Adesina, 1995). The Ivorian policies have resulted in rice being much cheaper relative to cassava products around major market centers than is the case in either Ghana or Nigeria.

This study is based on the argument that the difference in various factors such as agricultural policies (i.e., trade and price policies, domestic production taxes or subsidies), location and technologies (production and processing) between Côte d'Ivoire, Ghana and Nigeria explains the difference in the level of growth in cassava-based production systems.

Trade policies include protectionism (duties or quantitative controls) or subsidies on imports and taxes or subsidies on exports that cause the domestic price of a commodity to differ from its international price. Another type of policy involves taxing or subsidizing inputs in producing a commodity.

The alternative production and processing technology-combinations examined are *"Impmech"*, *"Locmech"*, *"Locman" and "Impman"*, defined as follows: a) *Impmech* represents IITA's improved cassava varieties processed using a mechanized grating method, *Locmech* represents local cassava varieties processed using a mechanized grating method, *Locman* represents local cassava varieties processed using a manual grating method and *Impman* represents IITA's improved cassava varieties processed using a manual grating method.

The study examines the magnitude of the impact of these factors on the private and social profitability of cassava production and post-production processing in Nigeria,

Ghana and Côte d'Ivoire. The topic has not been examined in previous studies.

1.3. Research Questions and Hypotheses

The problem and the knowledge gap discussed above raise the following research question: What is the relative profitability of cassava-based production systems in Côte d'Ivoire, Ghana and Nigeria, and how do various factors such as agricultural policies (i.e., trade and price policies, domestic production taxes or subsidies), location and technologies (production and processing) affect profitability in each country?

*Question 1.*What is the relative financial or social profitability of cassava in Côte d'Ivoire, Ghana and Nigeria?

Hypothesis: Cassava production is more profitable (financially and socially) in Ghana and Nigeria relative to Côte d'Ivoire, essentially because the relative price level of cassava to cereals (especially rice) to cassava is significantly lower in Côte d'Ivoire because of cereals import tariffs. The consequence is a lower demand for cassava and cassava products in rural market centers. This in turn makes any investment to increase outputs not a viable proposition for Ivorian farmers since the supply cannot be absorbed by market demand at remunerative prices. The result is that improved production and processing technologies are not as widely used in Côte d'Ivoire as they are in Ghana or Nigeria.

*Question 2.*What is the profitability (financial and social) of cassava relative to rice in Côte d'Ivoire?

At this stage, it is not clear which is more profitable because imported rice has negative effects on both cassava and rice prices (substitution effects).

Question 3. What is the impact of improved production and labor-saving processing

technologies (graters) on the profitability of cassava in Nigeria?

This question can be analyzed for four different scenarios:

a) Improved processing technology in combination with improved production technology (*Impmech*);

b) Improved processing technology in combination with traditional production technology (*Locmech*);

c) Traditional processing technology in combination with traditional production technology (*Locman*);

d) Traditional processing technology in combination with improved production technology (*Impman*);

Hypothesis: The descending order of profitability is likely: scenario a, scenario b, scenario c, and scenario d because the yields of improved cassava varieties are higher than those of local varieties.

1.4. Data

1.4.1. Source: This study will be based on data for Côte d'Ivoire, Ghana and Nigeria from the Collaborative Study of Cassava in Africa (COSCA) survey. The COSCA project was coordinated by the project leader (Dr. Felix Nweke); two regional coordinators; one national and one assistant national coordinator in each country, consisting of a social scientist and a biological scientist in agriculture; and six subject matter specialists in the areas of agricultural marketing, agro-geography, food processing technology, processing economics, human nutrition and health, and anthropology. The funding for this project was provided mainly by the Rockefeller Foundation. The countries covered are Côte

d'Ivoire, Ghana, Nigeria, Zaire, Uganda and Tanzania.

The aim of the COSCA study was to provide baseline information on cassava over a wide area. Such information is needed to improve the relevance and impact of agricultural research, extension and policies on the crop in Africa in order to realize the potential of cassava in increasing food production and the incomes of the people of Africa. The data were collected between 1989 and 1992.

Data available in the COSCA survey that will be used will include farm-level technical coefficients, processing costs, transformation rates of cassava root into processed products, sources of cassava roots and destination of cassava products, unit storage cost, unit transportation costs, product and input market prices, taxes and subsidy levels. The table below summarizes the data needs and availability for each type of analysis.

Table 1.1: Summary of Data Needs and Availability

Types of Analysis	Variables	Data Required	Where are these data available?
Production Financial Profitability	Revenues, Variable and Fixed Costs, Technical Coefficients Interest on working capital Depreciation	Farm-Level Financial Budgets Farm-Level Financial Budgets	COSCA Phase 2 (field survey) and Phase 3 (marketing survey) data files
Production Economic Profitability	Same variables as in Financial Analysis Social prices	Farm-Level Financial Budgets Import parity prices	COSCA Phase 2 (field survey) and Phase 3 (market informant survey) data files
Post-Production Profitability	Revenues, Variable costs (transpor-tation, purchased inputs, labor), and Fixed Costs (Equipment)	Budget for Processing Phase	COSCA Phase 1 (household survey) and Phase 3 (Processing survey) data files
Policy Analysis	See table 1.2	Findings from above analyses	Results of above analyses

1.4.2. Collection procedure: Leaders in cassava research in the national agricultural research systems in each country administered survey questionnaires to local farmers and took various measurements. These researchers were knowledgeable about cassava production systems of their respective countries and hence qualified to collect the information.

A rapid rural appraisal technique was employed to collect village-level information in the Phase I survey. Farmer groups consisting of men and women of various ages were constituted and interviewed in each village. Structured questionnaires were used to collect qualitative information. This survey was conducted in 1989-1991.

The Phase II survey was carried out at the individual field plot level. Field size was determined by measurement with a compass, a tape, and ranging poles. Yield estimation was made for fields where roots were 12 months or more old, except when the farmer harvested at less than that age. The estimation was based on a representative sample plot of 40 m^2, except when the field was too small, in which case a 20-m2 plot was used. There were one or two plots per field depending on the size and heterogeneity of the fields in terms of soil and toposequence. The field-level information was collected in 1991.

The Phase III survey was at the household level. Relevant male and female household members were interviewed using structured questionnaires. The household information was collected in 1992. Phase III involves detailed studies on post harvest issues such as: 1) Processing: i) characterization of techniques; and ii) product quality assessment (nutritional, toxicity and quality assessment); 2) marketing; and 3) consumption/demand.

1.5. Methodological Framework

Following Pearson et al. (1981), the framework chosen for this study is the Policy Analysis Matrix (PAM), which involves the following:

1. Microeconomic analyses are carried out to determine the economic efficiency of alternative systems/techniques and locations of cassava-based production systems in systems that encompass farming, processing, and distribution.

2. The effects of government trade, price, tax/subsidy, and investment policies on incentives are analyzed by measuring transfers of income to or from farmers, processors, and traders.

3. Comparative analyses are undertaken of the productive efficiency/profitability of the various systems/techniques and locations and of the effectiveness of government policies, first within individual countries and then among countries.

Table 1.2: An Outline of the Policy Analysis Matrix (PAM)

	Revenues	Tradable Inputs	Domestic factors	Profits
Private prices	A	B	C	D
Social prices	E	F	G	H
Divergences	I	J	K	L
D = A - (B+C) = private profits which indicate competitiveness under existing policies H = E - (F+G) = social profits which measure efficiency or comparative advantage I = A - E = output transfers J = B - F = input transfers K = C - G = factors transfers L = D - H = I - (J+K) = net transfers				

Source: Adapted from Monke and Pearson (1989)

The PAM approach is a system of double-entry bookkeeping that consists of two accounting identities. The first identity holds that profit equals revenues minus costs measured either in financial or economic terms. The second identity measures the effects of divergences (between financial and economic values) as differences between observed

parameters and parameters that would exist if the divergences were removed. The main empirical task is to construct accounting matrices of revenues, costs and profits for each selected enterprise based on representative synthetic farm-level and marketing budgets, using data on farming, farm-to-processor marketing, processing, and processor-to-wholesaler marketing.

The main advantages of the PAM approach are that it allows varying levels of disaggregation, makes the analysis of policy-induced transfers (divergences between the observed market price and prices that reflect opportunity costs) straightforward, and makes it possible to identify the net effects of those policies. One of the main weaknesses of the PAM approach is the underlying assumption of fixed technical input-output coefficients. That is, the PAM model assumes that supply and demand elasticity equals zero and there is no change in input prices.

As can be seen in the PAM matrix in table 1.2, inputs are partitioned into tradables and domestic factors. Tradable inputs are inputs that are traded internationally (traded tradables) or potentially could be traded (non-traded tradables). Domestic factors (sometimes refer to as primary factors in standard DRC analyses) are factors that are not normally traded internationally and include chiefly land, labor, water, and capital.

However, labor might be considered tradable in cases where seasonal migration results in remittances of foreign exchange. Nevertheless, because the international labor market is not well developed, labor is generally treated as a primary factor in DRC analysis. Intermediate inputs such as fertilizers, pesticides, purchased seeds, compound feeds, transportation, and fuel are disaggregated into components of costs until all costs items are traced back to tradable inputs, domestic factors, and transfers (taxes and

subsidies). This process is referred to in benefit/cost analysis by Little and Mirrless (1974) as complete border pricing. The complete border pricing approach has not been fully adopted, and researchers have used several less ambitious versions. Probably the most popular of all is the partial border pricing approach developed by Squire and Van der Tak (1975). With this version, tracing back all costs items to tradable inputs, domestic factors, and transfers is selective, depending on the willingness to increasingly break minor items into cost components.

From the point of view of the society, a direct inspection of social profitability may be enough in order to assess the relative efficiency or comparative advantage of alternative production systems under consideration. For an efficiency-minded society, the higher the social profitability, the better. Nevertheless, when the systems produce outputs with different capital intensity (e.g., when they produce different outputs), the domestic resource costs (DRC) ratio is used as a proxy measure for social profitability. The system of matrices in the PAM provides the information necessary to assess the impact of policy on competitiveness and farm-level profits, the effect of new investments on economic efficiency and comparative advantage (i.e., on the pattern of efficiency), and the influence of agricultural research policy on changing technologies.

On the issue of farm policy impact, farm budget data (sales revenues and input costs) are collected for the principal agricultural systems, and profits are determined to show which farmers are currently competitive and how their profits may change if price policies were changed. To deal with the issue of how additional public investment might change the current pattern of efficiency, revenues, costs and profits are reassessed in social values. New investments that reduce social costs also increase social profits and improve

efficiency.

The third issue concerns how to best allocate funds for agricultural research. The existing levels of private and social revenues, costs and profits are calculated. Then sensitivity analyses are undertaken by projecting changes in yields and inputs resulting from alternative research programs and examining how these changes alter private and social profits of current technologies.

These results can be used to identify what kind of farmers or production systems are competitive under current policies affecting crop and input prices, and how their profits would change as alternative policies were implemented, and thus to compare the incentive effects associated with different policies and technologies.

At this point, it worth emphasizing a point that should be kept in mind concerning the results analyses. Conventionally, the PAM approach can provide analysts with a helpful understanding of the measurements of the magnitudes of "policy transfers". Given these measurements, the analyst may suggest a policy change for the sake of Pareto efficiency, but which of the many such points shall we refer to? Schmid (1987, 244) states, " it is useful to speak of the efficiency with which a given institutional rule achieves a given performance objective. But for clarity, objectives need to be explicit." Change rights and you change what is efficient. For example, the analyst may view a commodity (e.g., rice in Cote d'Ivoire) import tariff as irrational and distorting in terms of some presumed income distribution, but the analyst has no expertise in choosing an income distribution. Various policy outcomes may be efficient given policy-makers' definition of different economic agents' property rights at that point of time.

Policy-makers often justify tariff and other policies with the argument that the help

the poorest of the farmers. But any policy raising prices help rich (large) and poor (small) farmers if both are net sellers of the product in question. But a lot of research in Africa has shown that many small farmers are net buyers of basic staples. In that case, higher prices for staples help the large farmers (who are net sellers) and hurt the small farmers who are net buyers. Therefore, this instrument used to transfer income from consumers misses the target beneficiaries. The same total transfer could help the poorest farmers more if paid directly to them.

Little and Mirrlees (1974), 224-225) regard indirect taxes/subsidies on final consumption goods, as correcting income distribution and thus the net of tax price is a better measure for the social value of the good than the market price. They believe that a lump sum tax would be the tool to redistribute income, but it is costly. Therefore taxes may be a corrective not a distortion. In their words "taxation and subsidization of consumers' purchases is a useful and socially desirable weapon of policy. Project planners and economic advisors have no general warrant to nullify the effects of that tax system."

Policies are instruments of action that governments employ to affect change in a given period (often one year) for a given situation. Thus, policy outcomes are situation-specific. It would not be wise, therefore, to put too much weight upon the events of one year, No year's evidence should be neglected, nor should be given full weight Little and Mirrlees (1974). The point being that an efficiency objective is relevant given the structure of property rights that underlie it. A change in property rights will result in a change in what is efficient.

1.6. Specific Types of Analysis Planned

The profitability and the productive efficiency in the use of domestic resources in

cassava- based production and post-production systems will be examined using a combination of financial and economic analyses. In the particular case of Nigeria, for which number of observations are large enough (see tables A1-1, A1-2 and A1-3 in Appendix 1), the analyses will be carried out under two scenarios: 1) the farmer produces cassava to consume at home, and 2) the farmer produces cassava to sell in the rural market center. Comparative financial and economic analyses will be carried out for the following:

1. (a) Cassava fresh root production in Côte d'Ivoire, Ghana and Nigeria

   (b) Cassava processed food product production in Côte d'Ivoire, Ghana and Nigeria

2. Cassava fresh root production and rice production in Côte d'Ivoire

3. (a) Cassava fresh root production in Nigeria for farmers who produce to sell in rural markets

   (b) Cassava processed food product production in Nigeria for farmers who produce to sell in rural markets

   (c) Cassava production and processing by alternative technologies

      (i) Traditional variety and traditional processing method

      (ii) Traditional variety and mechanized processing method

      (iii) Improved variety and mechanized processing method

      (iv) Improved variety and traditional processing method

In this study, comparisons will be made between cassava and rice systems in Côte d'Ivoire and among cassava systems in Côte d'Ivoire, Ghana and Nigeria. A cassava or rice crop system is a system of intercropping where cassava or rice is the main crop, as the

specified by the farmer. In each case, the costs and returns of producing the main crop as well as the costs and returns of producing the subsidiary crops are charged or credited to the cassava or rice system as a whole rather than developing separate budgets for each crop. Trying to develop separate budgets for each crop produced in an intercropping system requires arbitrary allocation of joint costs across the different crops produced in the system.

The units for comparison of cassava-based production systems among the three countries and for comparison between the cassava system and the rice system in Côte d'Ivoire will be: 1) the net returns (to land or labor) from the systems based on all the crops in the association in each country and 2) the domestic resource costs (DRC) of each system based on all the crops in the association in each country.

1.6.1: Financial Enterprise Budgets for Cassava Production and Post-production in Côte d'Ivoire, Ghana and Nigeria, as well as of Rice in Côte d'Ivoire

Financial budgets will use available technical coefficients from survey data to estimate standard indicators of profitability, such as gross margins and returns to family labor and land. These will be estimated based on average market sale price in each country. Profitability measures will be based on farm-level finances.

1.6.2: Comparative Analyses of the Economic Profitability of Cassava-based Production Systems in the Three Countries and of the Competitiveness of Cassava as Compared to Rice-based System in Côte d'Ivoire

This analysis is performed from the point of view of the country as a whole. Consequently, it focuses on the analysis of the competitiveness of cassava-based production systems in Côte d'Ivoire, Ghana and Nigeria, both in terms of the relative profitability and the efficiency in the use of domestic resources.

First, sample data will be aggregated for: 1) each representative cassava-based system at each country level; 2) in Nigeria, for each agroecological zone and for each technology combination module. A policy analysis matrix for each system in will be constructed for each point of comparison, namely: a) farm-level in the three countries, and b) farm level and rural market center Côte d'Ivoire, Ghana and Nigeria.

Second, budgets will be calculated using economic prices (e.g., import parity prices) to assess the economic profitability of cassava based-production systems in each country and for rice production in Côte d'Ivoire.

Third, the same information used for the economic profitability analysis will be used to calculate DRC ratios of representative cassava-based production systems in each country (and for rice in Côte d'Ivoire) as the ratio of domestic factor cost (G) to value added in social prices (E-F)[1]. The DRCs allow us to assess the relative efficiency or comparative advantage of cassava production systems in each country. A direct inspection of these financial and social profitabilities and the DRC ratios will be used to assess the relative efficiency or comparative advantage of the selected cassava and rice production systems. Minimizing the DRC ratio is equivalent to maximizing social profit. A DRC ratio between zero and one indicates that the value of domestic resources used in production is less than the value of foreign exchange earned (export) or saved (import substitute). Consequently, the country has a comparative advantage in production. If the DRC ratio is more than one, this reveals that the value of domestic resources used in production exceeds the value of foreign exchange earned (export) or saved (import

[1]See outline of PAM in table 1.2

substitute). As a result, the system has no comparative advantage. Finally, a DRC ratio less than zero indicates a negative value added domestically; consequently, foreign exchange is being wasted. In other words, more foreign exchange is being used in production than the commodity is worth.

1.6.3: Comparative Analysis of Policy Income Transfers in Côte d'Ivoire, Ghana and Nigeria

In this section, further analyses are undertaken to (1) examine the static overall effect of policy initiatives and/or market failures, and (2) compare the incentive effects associated with or the extent of policy transfers in each country. The static overall effect of policy initiatives and/or market failures will be examined by comparing private and social profitability. A positive value of the difference between private and social net profitability (NNP-NSP) indicates that the policy overall increases private profitability, while a negative value reveals the opposite effect. To compare the incentive effects associated with the rice and cassava-based production systems' output, four specific ratios will be constructed: the nominal protection coefficient (NPC), the effective protection coefficient (EPC), the profitability coefficient (PC), and the subsidy ratio to producers (SRP).

The NPC is the ratio of private price of the output (NPCO), or a tradable input (NPCI), or a domestic factor (NPCF) to its social price. This ratio will indicate the degree of the impact of the factors causing a divergence between the two prices. The EPC is the ratio of value added in private prices (A-B) to value added in world prices (E-F). It will measure the degree of policy transfer from product market (output and tradable-input) policies. Because, like the NPC, the EPC ignores the transfer effects of factor market

policies, it is not a complete indicator of incentive. An extension of the EPC is the profitability coefficient (PC), which is the ratio of private to social profits and serves as a proxy for net policy transfers (i.e., incentive effects of all policies). In terms of table 1.2, the SRP is the net policy transfer (D-H) as a proportion of total social value (E). It shows the proportion of revenues in world prices that would be required if a single subsidy or tax were substituted for the entire set of commodity and macroeconomic policies; the measure thereby allows one to see the extent to which all policies subsidize a given production system. The SRP can be computed for output (SRPO), input (SRPI), and factors (SRPF).

1.6.4: Sensitivity Analysis

Sensitivity analysis will be carried out to test whether the DRC ratios and the transfers calculated under the baseline scenario are likely to be affected by changes in the values of key technical and economic parameters (e.g processing costs, labor costs, transportation costs, output prices) whose future behavior is difficult to predict with certainty.

1.7. Conclusion

The objectives of this study are: 1) To measure and compare the relative private and social profitability of cassava-based production systems in Côte d'Ivoire, Ghana and Nigeria; and 2) to discuss the implications for private and public-sector policies, extension and research interventions. The study is organized as follows. The first essay (in chapter 2) emphasizes the application of the PAM to evaluating the effects of government policies, in terms of an overvalued exchange rate, on the relative profitability and comparative advantage of cassava/maize and rainfed rice/maize systems in the humid lowland zones of

Cote d'Ivoire.

The second essay, in chapter 3, is based on the argument that cassava products such as tapioca are tradable and currently traded, to an extent, in Sub-Saharan Africa. Even more widely traded (as an export) are cassava chips for livestock feed. This means that cassava-based systems have a certain potential for generating export earnings. Furthermore, the expansion of peasant exports tends to promote economic development, both directly, through the "vent-for-surplus" mechanism, and indirectly, by improving the domestic economic organization of an underdeveloped country (Myint, 1979). Therefore, a policy analysis that helps determine combinations of production and processing technologies, under which cassava-based production systems are socially profitable (e.g., internationally competitive), can be very beneficial to policy-makers.

Following Adesina and Coulibaly (1998), this essay uses the Policy Analysis Matrix (PAM) to examine the relative profitability (financial and social) and comparative advantage of cassava/maize production systems under four alternative production and processing technology-combinations in Nigeria: "*Impmech*", "*Locmech*", "*Locman*", and "*Impman*" defined as follows: a) *Impmech* equals to IITA's improved cassava variety processed using a mechanized grating method, b) *Locmech* equals to local cassava variety processed using a mechanized grating method, c) *Locman* equals to local cassava variety processed using a manual grating method), d) *Impman* equals to IITA's improved cassava variety processed using a manual grating method .

The third essay, in Chapter 4, compares the profitability of cassava-based production systems in three West African countries: Cote d'Ivoire, Ghana and Nigeria. This analysis is based on the argument that the difference in various factors such as

agricultural policies (i.e., trade and price policies, domestic production taxes or subsidies), location and technologies (production and processing) between Côte d'Ivoire, Ghana and Nigeria explains the difference in the level of growth in cassava-based production systems in between Nigeria, Ghana and Côte d'Ivoire explains the difference in the level of growth in cassava-based production systems. The intent of this comparative essay is to use policy analysis matrix (PAM) approach to push policy analysis further than can be done within the context of a single country. The main advantage of carrying out similar policy studies in a number of countries is the scope presented for obtaining comparative insights. This essay uses the policy analysis matrix (PAM) model to examine the magnitude of the impact of agricultural policy on the private and social profitability of cassava/maize production systems in Nigeria, Ghana and Côte d'Ivoire.

Chapter 5 summarizes the conclusions for each essay and discusses avenues for further research.

REFERENCES

Adesina, A.A. and Djato, K.K., AFarm Size, Relative Efficiency and Agrarian Policy in Côte d'Ivoire: Profit Function Analysis of Rice Farms, *Agricultural Economics,* 14:93-102,1995

Adesina, A.A. and Coulibaly O. N., Policy and Competitiveness of agroforestry-based technologies for maize production in Cameroon: An application of policy analysis matrix, *Agricultural Economics,* 19:1-113,1998

Babo, Alfred, Circuits de Commercialisation et de Transformation du Manioc dans la Region de Bouake. *Memoire de Maitrise*. Option: Socio-Economie du Developpement Rural. Universite de Bouake, 1996.

Jones, W.O., *Manioc in Africa*, Stanford University Press, Stanford, 1959.

Little, I. M. D., and J. A. Mirrlees, 1974. *Project Appraisal and Planning for Developing Countries*. New York: BasicBooks

Monke, E.A. and S. Pearson. 1989. *The Policy Analysis Matrix for Agricultural Development*. Baltimore: John Hopkins University Press.

Myint, H., (1979), Exports and Economic Development of Less Developed Countries in *Economic Growth and Resources*, vol. 4, edited by Irma Adelman

Nelson, G C and Panggabean, M (1991), The costs of Indonesian sugar policy: a policy analysis matrix approach, *American Journal of Agricultural Economics*, 73(3) pp703-712

Nweke, F., Dixon, R.A., Asiedu, R., Folayan, S.A., A Cassava Varietal Needs of Farmers and the Potential for Production Growth in Africa, The Collaborative Study of Cassava in Africa, *Working Paper No. 10*, 1994

Nweke, Felix I., K. N'Goran, A.G.O. Dixon, B.O. Ugwu, O. Ajobo, and T. Kouadio. 1998. Cassava production and processing in Cote d'Ivoire. The Collaborative Study of Cassava in Africa, *Working Paper No. 23,* IITA, Ibadan, Nigeria.

Pearson, S.R., J.D. Stryker and C.P. Humphreys, (eds). *Rice in West Africa: Policy and Economics*. Stanford University Press, 1981

Schmid, A. Allan, *Property, Power, and Public Choice: An inquiry into Law and Economics*, Praeger Publishers, New York, 1987.

Squire, Lyn, and Herman G. van der Tak, 1975. *Economic Analysis of Projects*.

Theberger, R. Les principaux ravageurs et maladies du manioc, de l'igname , de la patate douce et aracées en Afrique, IITA, 1985.

APPENDIX 1

Table A1-1: Sample size (number of fields) by crop and by country

Crops\Countries	Côte d'Ivoire	Ghana	Nigeria	Total
Cassava/maize	46	49	154	249
Rice/maize	35	3	25	63
Maize	17	43	69	129

TableA1-2: Distribution of households by type of cassava processing technology by country

Processing\Countries Technologies	Côte d'Ivoire	Ghana	Nigeria	Total
Graters	1	12	111	124
Pressers	45	37	43	125
Total	46	49	43	249

Note: Graters are labor-saving technologies

Table A1-3: Distribution of cassava based fields by production technology in Nigeria

Production\ Country Technology	Côte d'Ivoire	Ghana	Nigeria
Improved	1	13	53
Traditional	45	36	101
Total	46	49	154

TableA1-4: Distribution of cassava-based fields by agroecological zones in Nigeria

Zones	
Humid	40
Subhumid	96
Nonhumid	18
Total	154

Table A1-5: Distribution of fields by production/processing technologies in Côte d'Ivoire, Ghana and Nigeria.

Processing \ Production	Côte d'Ivoire		Ghana		Nigeria	
	Improved	Manual	Improved	Manual	Improved	Manual
Graters	0	1	3	10	32	54
Manual	1	44	0	26	20	48

Note: Graters are labor-saving technologies

Figure A1-1: Cote d'Ivoire: Study Sites, Output Markets (Bonoua and N'douci) And Port City (ABIDJAN), 1989/1991.

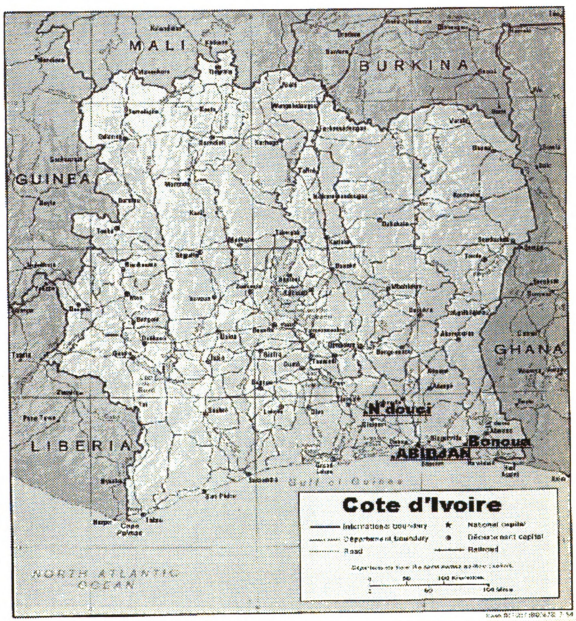


Figure A1-2: Ghana: Study Sites, Output Markets (Koforidua and Kumasi) and Port City (ACCRA), 1989/1991.

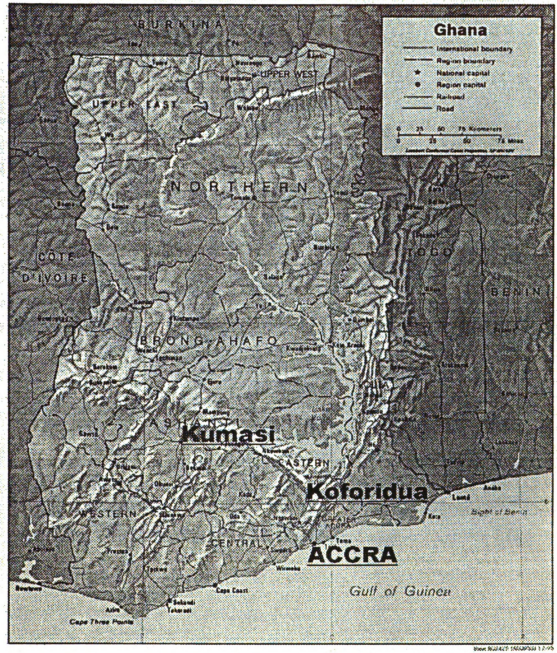


Figure A1-3: Nigeria: Study Sites, Output markets (Abeokuta and Onitsha) And Port City (LAGOS), 1989/1991.

CHAPTER 2

EVALUATING THE EFFECTS OF POLICIES ON THE COMPETITIVENESS OF CASSAVA-BASED PRODUCTION SYSTEMS IN COTE D'IVOIRE

2.1. Introduction

In Côte d'Ivoire, cassava has always been an important staple food in households' food basket and in their farming systems. A 1979 consumption survey (Enquetes-Budget-Consommation) indicated that, on the average, each Ivorian household member consumed about 50 kg of cassava annually, which ranked cassava as the second most consumed staple food after rice (60kg/head/year). In 1992, another national survey (Enquetes Prioritaires sur les Dimensions Sociales de l'Ajustement Structurel) also showed that Ivorian households spend 13.9 percent of their income on rice, 6.0 percent on cassava and cassava by-products and 3.4 percent on yams (Babo, 1995). Furthermore, the same study revealed that 90.1 percent of these households consumed rice, 85.0 percent wheat bread, 60.3 percent fresh cassava, and 73.1 percent *attieke*, a cassava meal. More recently, the national Statistics Bureau reported that the total cassava production in Côte d'Ivoire was 1,608,000 tons in 1995, compared to 890,000 in 1993 and 1,100,000 in 1994 (MEF, 1996).

In spite of the relative importance of cassava and cassava products in Ivorian households' food expenditures and cassava's favorable agronomic characteristics for the country, the government of Côte d'Ivoire has invested very little in improving the cassava sub-sector (Theberger, 1985; Babo, 1995). A major focus has been the expansion of rice production and major reliance on cereals (especially milled rice) imports to fill the gap

created by unsatisfactory growth in the domestic supply of food. The Ivorian policies have resulted in rice being much cheaper relative to cassava products around major market centers than is the case in either Ghana or Nigeria: a kilogram of processed cassava cost 78 percent as much as milled rice in Cote d'Ivoire, compared with 61 percent in Ghana and 41 percent in Nigeria. For example, although *attieke* is a convenient food product, which can potentially compete with food grains in the grain market, it was not able to express that potential because of the availability of low-cost rice, especially around market centers (Nweke *et al.*, 1999).

Questions have been raised about the sustainability of policies such as subsidizing rice imports that bear heavy social costs, considering the limited financial liquidity of the country and rapidly increasing urban populations. On the other hand, the question arises as to whether a policy for cassava production should be implemented to substitute for local rice in production and/or consumption. For example, in Ghana, improvements in cassava processing have increased food availabilities (Kreamer, 1986). However, outcomes of government policies that tend to raise private production incentives for particular crops against others may not be desirable for society in terms of efficiency of resource allocation.

This essay uses the Policy Analysis Matrix (PAM) method developed by Monke and Pearson (1989) to evaluate the effects of government price and macro (i.e., exchange rate) policies on the profitability and competitive advantage of cassava/maize production systems relative to rainfed rice/maize production systems in Cote d'Ivoire. Agricultural price policies, whether direct or indirect (via an exchange rate policy) have an important influence on the prices farmers receive and prices consumers pay. Product and inputs

prices levels affect profitability and, therefore, the amounts invested by producers among competing farm enterprises.

A review of the literature on the economics of cassava production in Africa identifies two types of analyses: the first type focuses on the importance of cassava in Africans' diet. Manioc in Africa by W.O. Jones (1959) is one of the classic works on that topic. Written in an easily understood style, it describes the introduction, spread, and use of cassava throughout the African continent.

The next major study on cassava in Africa is COSCA (Collaborative Study of Cassava in Africa), which has focused on providing baseline information on cassava in six countries in Africa: Côte d'Ivoire, Ghana, Nigeria, Zaire, Uganda, and Tanzania. The broad objective of COSCA was to improve the relevance and impact of agricultural research on cassava by international agricultural research centers (IARC) and national agricultural research systems (NARS) in Africa in order to realize the potential of cassava in raising food production and incomes in Africa. Therefore, the major question addressed in most of COSCA reports has been the benefits, in terms of food security and income generation, of investing in alternative cassava production and processing technologies in Africa. A striking feature of earlier studies on cassava in Africa (Nwajiuba, 1995; Nweke, 1996; Ipki and Hahn, 1989) is that none have looked at the profitability and competitive advantage of cassava /maize production systems relative to competing crop systems. The results of this study will not only add to the stock of knowledge relative to food commodities in Africa but also inform Ivorian policy-makers of the potential contribution of cassava and cassava by-products for national food policy objectives.

2.2. Methodological Framework

2.2.1. A Short Description of the Policy Analysis Matrix (PAM) Model

As mentioned earlier, the Policy Analysis Matrix (PAM) is the analytical framework used in this essay. This methodology is developed in detail in the first chapter; therefore in this section, the focus is on how it is used in estimating comparative costs and incentives for farm activities or enterprises.

The PAM is a product of two accounting identities. The first identity holds that profit equals revenues minus costs measured either in financial or economic terms. The second identity measures the effects of divergences between financial and economic values as differences between observed parameters and parameters that would exist if the divergences were removed. The main empirical task is to construct accounting matrices of revenues, costs and profits for each selected enterprise based on representative synthetic farm-level and marketing budgets, using data on farming, farm-to-processor marketing, processing, and processor-to-wholesaler marketing (Monke and Pearson, 1989).

The concept of economic profit is fundamental in PAM analysis. Profit, whether calculated at observed market prices or at imputed social (efficiency) prices, is defined as the difference between revenues (the value of outputs) and costs of all inputs. Measurement of costs and returns at private market prices reveals the presence of any excess profits (defined as the difference between total returns and the costs of all inputs, including capital) and the actual competitiveness of the enterprise. This may result in the expansion of production; however, if market prices for inputs or outputs differ from their values in alternative production or consumption uses, actual competitiveness and profitability may be misleading indicators of the potential for growth. The most common

source of such divergences is policies (Pearson *et al.*, 1995).

Policy analysis can help answer the question of allocation (and hence the level) of food production by considering food as seen from the standpoint of different socioeconomic and political agents. The commercial farmer sees food mainly as a source of income; the subsistence farmer sees food as a means of subsistence and survival; and the policy-maker sees food as a source of government income and as a strategic commodity, which can be used, as a means of control or as an instrument of social welfare. Food prices are policy instruments to the government, returns to farmers and costs to the consumer. Agricultural input prices are policy instruments to the government, costs to the farmers, and returns to the owners of factors of production (*e.g.*, wages for agricultural labor).

This paper emphasizes the application of PAM in evaluating the effects of government policies (i.e., *outputs and inputs pricing and exchange rates policies*) on the relative profitability and comparative advantage of cassava/maize and rainfed rice/maize systems in the humid lowland zones of Cote d'Ivoire.

2.2.2. Data

This study is based on data for Côte d'Ivoire from the Collaborative Study of Cassava in Africa (COSCA) survey. COSCA report number 2 provides a detailed discussion of the data collection procedures and the associated sampling method. The survey covered the period 1989/1991.

Data available in the COSCA survey that are used include farm-level technical coefficients, processing costs, transformation rates of cassava root into processed products, sources of cassava roots and destination of cassava products, unit storage costs,

unit transportation costs, product and input market prices and taxes and subsidy levels. In the case of rainfed rice and green maize, data used were obtained not only from the COSCA survey but also from primary sources of earlier studies and from secondary sources such as the Office of Agricultural Statistics of the Ivorian Ministry of Agriculture.

In addition, macroeconomic data needed in the estimation of economic prices (i.e., import parity prices and shadow exchange prices) were obtained mostly from secondary sources such as Statistiques des Transports Maritimes et Balance de Paiements en Cote d'Ivoire and from the IMF.

Unfortunately, the COSCA study did not record maize yields on its sample fields. Therefore, in computing the enterprise budgets developed in this study, it was assumed that those fields got the average maize yield for the country which was then converted to the number of fresh corn ears using the "Ear-Weight Method" discussed in the appendix. The numbers of corn ears were subsequently valued at the fresh corn price.

2.3. Empirical Analyses

Cassava/maize and rainfed rice/maize production systems are examined in this section using a combination of financial analysis, economic analysis and policy analysis. The tasks involved are the following:

1. To develop enterprise budgets (financial and economic) for each commodity system under a "baseline scenario".
2. To construct a Policy Analysis Matrix (PAM) for each commodity system, using the information from the enterprise budget and estimate indicator ratios such as DRC, NPC, etc.

3. To undertake sensitivity analyses in order to contrast the comparative advantage of the two commodity systems.

2.3.1. Financial Profitability Analysis

The purpose of this subsection is to estimate crop enterprise budgets and processed product (*attieke*) enterprise-budgets by system of production, and thereby provide the database for establishing the relative profitability of cassava-based systems versus rainfed rice-based systems in Cote d'Ivoire. Separate farm–level financial budgets were developed for cassava/maize systems and rainfed rice/maize systems. In addition, a post-farm level budget is constructed for the cassava/maize system only. The aim of input-output budget analysis is to derive farm recommendations, which are consistent with farmers' desires to increase expected income and to make the best possible use of the resources available to them. Furthermore, enterprise budgets are important in farm income analysis because they help to explain the internal structure of the farm as a whole and to show the relative contribution of each enterprise to the whole organization. Therefore, these enterprise studies are very instrumental in an attempt to: (i) assess the profitability of each enterprise relative to the resources used; (ii) compare relative efficiency of various enterprises on the farm; and (iii) provide a basis for making rational decisions about the kind and size of enterprise to be expanded.

In the financial analysis, the main objective is to answer the question whether a particular enterprise under a given system of production will pay its way in strict monetary terms (Are returns greater than monetary costs?). Towards this end, inputs are valued at the average market prices that farmers paid for each type of input, while output is valued at the average unit price received at harvest period by farmers. For each enterprise budget,

financial returns to family labor are computed. Other performance measures computed from the budget data include gross margin per hectare, net returns to family labor, net returns per day of family labor, total production cost and average production per kilocalories for farm level analysis and average cost of processing per kilogram of output in the post-farm analysis.

2.3.1.1. Farm level Analysis

Each crop system enterprise-budget in this study was calculated from households in which that enterprise was considered important. In other words, these are:1) households where cassava contributed 30 percent or more of cash income from all food crops; and 2) households where cassava enterprises were an important source of subsistence (i.e., cassava represents 45 percent or more of the weight of the basic staple food supplies).

These budgets appear in tables A2-1 and A2-2 of the appendix. Following Crawford (1982), data for each field were first checked for consistency by comparing the mixtures implied by the planting and harvest data with mixtures reported by farmers. However, it should be noted that very simple cluster analyses were performed to aid the process of narrowing down the number of mixtures. Two mixtures (cassava/maize and rainfed rice/maize) were eventually selected based on their importance (in terms of total number of fields and total cultivated area) in the local farming system.

Table 2-1 below summarizes the results of the baseline runs of the farm-level financial profitability analysis. The summary focuses mainly on performance measures that can be used to identify the enterprise with the highest financial return and lowest cost of production.

Table 2-1: Farm-Level Summary Estimates of Financial Budget Indicators for Cassava/Maize And Rainfed Rice/Maize Production Systems in Cote d'Ivoire, 1989/91

Production Systems	Returns to Family Labor Per ha (fcfa)	Returns to Family Labor Per Person-day (fcfa)	Total System Production Costs Per ha (fcfa)	Net Enterprise Profits Per ha (fcfa)	Average Cost Of Production Per kcal [1] (fcfa)
Cassava/maize	214014	1597	200961	129594	5
Rainfed Rice/Maize	60801	640	174049	3801	13

Source: tables A2-1 and A2-2 in the appendix

Clearly, the cassava/maize system is the more profitable crop system, since it generates higher returns, higher net profits and lower average cost of production per kilocalorie than rainfed rice/maize. Although the cassava/maize system has higher returns, under both systems farmers were able to cover all their operating costs. Therefore, both systems are valid candidates to stay in the farming business; however, cassava/maize systems have higher total system production costs, suggesting that cassava/maize systems are bidding away resources (mainly family labor) from rice/maize systems.

When converted to a per person-day basis, the returns to family labor (RFL) are 1597 fcfa for the cassava/maize system and 640 fcfa for the rainfed rice/maize system. Under both systems, the RFL per person-day is higher than the average wage rate paid to the hired labor, which is 630 fcfa per person-day for cassava/maize systems and 600 fcfa for rice/maize systems. Thus, there is no financial advantage of family members seeking

[1] It is assumed that the energy content is: 146 kcal for 100 grams of fresh cassava, 359 kcal for 100 grams of rice and 247 kcal for 100 grams of fresh maize (Manuel de Nutrition Africaine, Appendix 2).

wage employment in other farms, when they are needed on their farms in the village, although the return to the rice/maize system is close to the opportunity cost of labor.

To compute the net enterprise profits (NEP), opportunity costs were assigned to family labor and land. That is, family labor was valued at hired labor wage rate and land was attributed a value equal to net returns to land if farmers were producing green maize only. Both the cassava/maize enterprise and the rainfed rice/maize enterprise realized positive NEPs of 129,594 fcfa per hectare and 3801 fcfa per hectare, respectively.

Results from table 2-1 also show that the costs of providing a kilocalorie is lower (5 francs cfa per kcal) under cassava/maize systems than with rice/maize systems (13 francs cfa per kcal).

2.3.1.2. Post-harvest Level Financial Analysis for Cassava

It is assumed that green maize is harvested and consumed or sold at the farm level. Therefore, only cassava roots harvested are taken to the next level (the village) to be processed. The technology used in most villages is called traditional in the sense that most, if not all, of the processes are carried out manually at home. This analysis also assumes, as indicated in the COSCA (phase 2) survey data, that only 45% of the cassava goes into *attieke* production. The remaining 55% is consumed either fresh or in other forms such as *foufou or kokonte.*

The major form into which cassava roots are processed in Cote d'Ivoire is *attieke,* which is made of steamed cassava granules. The estimated average financial budget per hectare for *attieke* production in Cote d'Ivoire is presented in table 2-2 above.

Transformation coefficients were computed and used to calculate actual *attieke* yields. With a conversion ratio of 56 percent, *attieke* yield was 2706 kilograms per

Table 2-2: Estimated Average Financial Budget per hectare for *Attieke* Production2 in Cote d'Ivoire, 1989-1991, *assuming that 45% of roots production goes into attieke production*

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)[3]	57	0
Raw Material (kgs of roots)[4]	4832	
2.OUTPUTS		
Transformation Rate	0.56	
Kilograms of Processed Output per ha	2706	
Village Market Price of Processed Output (fcfa/kg)[5]	47	
Gross Revenues (fcfa/ha)	127169	
3. COSTS		
Fixed Costs (fcfa/ha)[6]	0	
Operating costs (fcfa/ha)		
Hired Labor (persondays)	0	
Raw Material (roots)[7]	72475	
Bagging Materials	16234	
Firewood	2205	
Transportation[8]	7670	
Interest on Working Capital (8%)	7887	
Total Operating Costs (fcfa/ha)	106471	
Family Labor (valued @ hired labor wage rate) (fcfa/ha)	35910	
4. PERFORMANCE MEASURES		
Gross Margin (fcfa/ha)	20698	
Net Returns to family Labor (fcfa/ha)	20698	
Net Returns per day of Family Labor (fcfa/day)	363	
Total production Costs (fcfa/ha)	142381	
Net Enterprise Profits (fcfa/ha)	-15212	
Production Costs per Kg of attieke (fcfa/kg)	53	

Source: COSCA data

2 There were forty-three (43) farmers using traditional techniques versus three (3) using modern techniques. Therefore, this budget includes only farmers using traditional (manual) processing techniques.

3 This item includes labor for Peeling, Washing, Grating, Pressing, Sieving and Steaming.

4 This represents 45% of the average root yield per hectare (see page 23 in COSCA Working Paper No 6)

5 Weighted average village market price estimated from COSCA data

6 No mechanical equipment was used in any processing activity. Grating was performed manually (COSCA Working Paper No.14, page 15).

7 Valued at its opportunity cost which is the weighted average farmgate price computed from the COSCA data

8 This item includes home-to-market transportation costs only.

hectare. This yield is valued by the average consumer price based in COSCA village survey data. It should be noted that prices vary a lot from season to season, mainly because of changing seasonal conditions (e.g., abundance vs. hungry seasons). To account for this diversity, the weighted average price was estimated. Since farmers do not own processing machines, no fixed costs was assigned processing enterprises.

The budget analysis shows a positive return per day of family labor (RDFL) of 363 fcfa per day, which, however, is below the daily wage rate of 630 fcfa. The average cost of production (53 fcfa per kilogram) is greater than the market price (47 fcfa per kilogram) and the result is a net enterprise profit (NEP) of -15212 fcfa. However, it should be noted that the negative NEP observed does not mean that farmers are losing incoming cash money on this crop; but rather, it means that net margin is not enough to yield a positive return to the management factors when family labor costs are taken into account. The NEP assuming zero opportunity cost of labor is positive.

A question that arises at this point is why farmers are staying in the *attieke* business if returns are so low. The COSCA survey data indicate that women control *attieke* production in Cote d'Ivoire and receive all the benefits from that activity. In addition, when asked why they were involved in this activity only, their answer was that there is no better alternative. Therefore, the opportunity cost of *attieke* production, from their point of view, is zero.

This situation reflects the segmentation of the rural labor market for cassava farming systems in Cote d'Ivoire. Women manage a very important part of cassava production systems: 1) they predominate in cassava processing and *attieke* preparation

and, 2) they devote a large amounts of time in obtaining the fuel and water required to make cassava processed products ready for sale or home consumption. Yet this analysis suggests that returns to women from these activities are below the rural wage rate, which is available mainly to men.

2.3.2. Economic Profitability Analysis

The farm level economic returns were calculated using import parity prices of cassava roots and financial prices of green maize at selected regional markets, Bonoua and N'douci (see tables A2-3, A2-4, A2-5 and A2-6 in appendix 2). These two markets were selected because they are located in regions where farmers ranked cassava as the most important crop in the farming system (Nweke *et al.*, 1998*)*. The economic budgets are presented in tables A2-7 through A2-10 in the appendix.

The estimation of the economic budgets required the following assumptions: 1) it is assumed that green maize is nontraded internationally and that its price is the observed market price. Therefore, its financial price (the observed market price) reflects its shadow price; 2) *Attieke*, the main cassava product in Cote d'Ivoire, is not traded internationally, but tapioca, another cassava product and the closest substitute of *attieke* is traded internationally. Consequently, the price of imported tapioca was used to estimate the import parity of cassava root; and 3) the official exchange rate (266 fcfa for $1US in 1991) was adjusted to reflect its equilibrium value, by using a premium of 48 percent (Stryker, 1990)

Tables 2-3 and 2-4 summarize the results of the economic analysis for: 1) cassava and rice farmers who are net sellers of roots or paddy in regional markets; and 2) cassava and rice farmers who are net buyers in these markets.

Table 2-3: Summary Estimates of Farm-Level Economic Budget Indicators for *Commercial* Cassava/Maize and Rainfed Rice/Maize Production Systems,by Regional Output Markets, Cote d'Ivoire: 1989/91

Production Systems And Production Zones		Returns to Family Labor Per Ha	Returns to Family Labor Per Person-day	Total System Production Costs Per ha	Net Social Profits Per ha
Bonoua					
	Cassava/maize	120778	857	210891	31948
	Rice/ maize	53206	578	179361	-1994
N'douci					
	Cassava/ maize	162823	1139	210420	72733
	Rice/ maize	60845	669	177869	6245

Source: tables A2-7 and A2-8 in the appendix

Table 2-4: Summary Estimates of Farm-Level Economic Budget Indicators for *Subsistence* Cassava/Maize and Rainfed Rice/Maize Production Systems, by Production Zones, Cote d'Ivoire: 1989/91

Production Systems And Production Zones	Returns to Family Labor Per Ha	Returns to Family Labor Per Person-day	Total System Production Costs Per ha	Net Social Profits Per ha
Bonoua Zone				
Cassava/mai	238129	1689	211766	149299
Rice/maize	69557	756	179361	14357
N'douci Zone				
Cassava/mai	286454	2003	210420	196364
Rice/maize	71357	784	177869	16757

Sources: tables A2-9 and A2-10 in the appendix

An initial notable result is that the net social profit (NSP) for rainfed rice/maize systems is negative in the Bonoua market for commercial farmers. This suggests that the Bonoua area is not able to substitute profitably local production of rice[9], from rainfed

[9] The outputs from the rainfed rice /maize system are paddy and green maize. However, green maize is not internationally tradable nor is it traded, whereas milled rice is internationally tradable and traded.

rice/maize systems, for imported rice sold in that market. This lack of profitability results in the net returns per day of family labor (RDFL) being less than the average daily wage rate of 600 fcfa for cassava farmers.

Overall, the result of the economic analysis indicates that cassava/maize production systems are the more profitable than rainfed rice/maize systems. Cassava/maize systems generate significantly higher net social profits (NSP) at both regional output markets (31,948 fcfa /ha in Bonoua and 72,733 fcfa/ha in N'douci) and in both production zones (149,299 fcfa/ha in Bonoua Zone and 196,364 fcfa/ha in N'douci Zone) for subsistence farmers. The net social profit refers to the difference, valued in border and shadow prices, between the gross value of output and the total costs of all inputs (traded and nontraded intermediary and primary inputs). The implication is that, from society's point of view, it pays to expand cassava/maize production systems. That is, cassava/maize systems are a more efficient use of national resources than rainfed rice/maize systems. A more efficient use of resources means that one can produce more from what one has and attain a higher level of welfare.

It should be noted that both systems are more profitable financially than they are socially. That is, there are net transfers to farmers (see tables A2-11 through A2-14 in appendix 2). The subsequent PAM analysis will help illustrate the sources of these transfers.

2.3.3.Policy Matrix Analysis

By completing a PAM for a production system one can simultaneously determine the economic efficiency of the system and the degree of transfers in the input /output markets (Yao, 1997). First, the PAM was constructed using the information on costs and

returns obtained from the financial and economic analyses. Second, the extent of policy-induced transfers was computed. Third, six PAM policy-indicators were derived for policy analysis. They are the Domestic Resource Cost (DRC), the Nominal Protection Coefficient on tradable output (NPCO), the Nominal Protection Coefficient on tradable Input (NPCI), the Effective Protection Coefficient (EPC), the Profitability Coefficient (PC), and the Subsidy to Producers (SP). These indicators are calculated as follows:

(i) DRC *equals* domestic factors in social prices *divided* by revenues in social prices *less* tradable inputs in social prices.

(ii) NPCO *equals* revenues in private prices *divided* by revenues in social prices.

(iii) NPCI *equals* tradable inputs in private prices *divided* by tradable inputs in social prices.

(iv) EPC *equals* revenues in private prices *less* tradable inputs in private prices *divided* by revenues in social prices *less* tradable inputs in social prices.

(v) PC *equals* private profits *divided* by social profits.

(vi) SP *equals* private profits *less* social profits *divided* by revenues in social prices.

2.3.3.1.Baseline Results

The PAMs of each production system (for commercial and subsistence farmers) are presented in tables 2-5 and 2-6 below. Results from table 2-5 show that, for both production systems, the output transfers are positive for when the output is sold at the Bonoua market but negative when the output is sold in the N'douci market. This implies

Table 2-5: Policy Analysis Matrix (PAM) for *Commercial* Cassava/Maize and Rainfed Rice/Maize Systems in Cote d'Ivoire: Net Financial Profitability (fcfa /ha), Net Social Profitability (fcfa/ha), and Net Effects of Policy-Induced Transfers, 1989/1991.

Production Systems	*Regional Output Markets*							
	Bonoua				**N'douci**			
	Revenues	Costs		Profits	Revenues	Costs		Profits
		Tradable Inputs	Domestic Factors			Tradable Inputs	Domestic Factors	
Cassava/Maize								
Financial Prices	277011	4365	204264	68382	268958	4166	204094	60698
Social Prices	242839	6460	204431	31948	283153	6166	204254	72733
Divergences	34171	-2095	-168	36434	-14195	-2000	-160	-12036
Rainfed Rice/Maize								
Financial Prices	179050	3720	173713	1617	177850	3936	171893	2021
Social Prices	177367	5506	173856	-1994	184114	5825	172044	6245
Divergences	1683	-1786	-143	3611	-6264	-1889	-151	-4224

Source: 1) PAM Model constructed by the author but not shown due to space limitation
2) Tables A2-7, A2-8, A2-11 and A2-12 appendix 2.

Note: Divergences calculated as financial prices *minus* economic price

Table 2-6: Policy Analysis Matrix (PAM) for *Subsistence* Cassava/Maize and Rainfed Rice/Maize Systems in Cote d'Ivoire: Net Financial Profitability (fcfa /ha), Net Social Profitability (fcfa/ha), and Net Effects of Policy Distortions, 1989-1991.

Production Systems	*Production Zones*							
	Bonoua Zone				**N'douci Zone**			
	Revenues	Costs		Profits	Revenues	Costs		Profits
		Tradable Inputs	Domestic Factors			Tradable Inputs	Domestic Factors	
Cassava/Maize								
Financial Prices	277011	4365	204264	68382	268958	4166	204094	60698
Social Prices	361065	6460	205306	149299	406784	6166	204254	196364
Divergences	-84054	-2095	-1043	-80917	-137826	-2000	-160	-135666
Rainfed Rice/Maize								
Financial Prices	179050	3720	173713	1617	177850	3936	171893	2021
Social Prices	193719	5506	173855	14357	194626	5825	172044	16757
Divergences	-14669	-1786	-143	-12740	-16776	-1889	-151	-14736

Source: 1) PAM Model constructed by the author but not shown due to space limitation.
2) Tables 9, 10, 13 and 14 in the appendix.
Note: Divergences calculated as financial price *minus* economic price

that, as a result of government pricing policies, farmers at the Bonoua market were receiving production subsidies, whereas farmers at the N'douci market were being taxed. Furthermore, the levels of taxation and subsidy were higher for the cassava/maize systems than the rice/maize systems.

This is the result of farm-gate financial prices for cassava root departing from the estimated import parity prices (tables A2-3 in Appendix 2) of roots by +3 fcfa per kilogram when Bonoua is used as a point of sale and –1 fcfa per kilogram when N'douci is used as a point of sale. On the other hand, the farm-gate market financial price of paddy is 60 fcfa, which departs from its estimated import parity price (tables A2-4 in Appendix 2) by +1 fcfa per kilogram when Bonoua is used as a point of sale and –5 fcfa per kilogram when N'douci is used as a point of sale.

It should be emphasized that these differentials are relatively small. With this in mind, here are some plausible explanations of why market (financial) prices and economic prices (import parity prices) did not equal in both markets. The divergences between these two prices could be due to a combination of the effect of the rice import tariff and the effect of the overvaluation of the franc CFA. The indirect effect of the rice import tariff will be an increase in the financial price of cassava root relative to the economic price in the two markets (Bonoua and N'douci). On the other hand, the currency overvaluation will have the effect of lowering the financial price of tradables such as roots and transport in both markets.

However, the magnitude of the reduction in prices will be large in N'douci and small in Bonoua because the share of transport costs in the import parity price is relatively large for N'douci (distant from the port city) and relatively small for Bonoua (close to the

port city). Transportation costs thus provide a natural protection to domestic producers who supply markets located far from the import point.

Thus, the net effect is as follows: 1) in N'douci: an increase in the financial price of roots due to the import tariff and a relatively large decrease in the financial price of roots due to the currency overvaluation (via its impact on tradable goods such as cassava and transport costs); and 2) in Bonoua: an increase in the price of roots due to the import tariff and a relatively small decrease in the financial price of roots due to the currency overvaluation.

The results from table 2-5 are calculated using the weighted average of peak-season and off-peak season wage rate across cassava production zones. The off-peak season rate is two third of the peak-season rate.

As for the results presented in table 2-6, they show negative output transfers everywhere for both systems. This suggests that, subsistence farmers in both production areas (Bonoua zone and N'douci zone) were being taxed. Again, highest tax on cassava systems results from tables 2-5 and 2-6, which show negative input and domestic factors transfers for both systems everywhere. Tables 2-5 and 2-6 also show that net policy transfers are positive for both systems in the Bonoua market while they were negative everywhere else. These results indicates that, overall, when outputs and inputs were valued at their social (efficiency) prices, the effect of government policy was: a) some type of support system to both cassava/maize and rainfed rice/maize systems in the Bonoua market while they were taxed everywhere else; b) the provision of a subsidy, through an overvalued exchange rate, on sale of all inputs (imported and produced domestically).

However, the absolute measures of net policy transfers are not appropriate for

comparisons among systems comparing unlike outputs. The ratios computed for this purpose are shown in tables 2-7 and 2-8.

Table 2-7: Ratio Indicators for *Commercial* Cassava/Maize and Rainfed Rice/Maize Systems in Cote d'Ivoire: 1989/1991.

Output Markets/ Production Systems	DRC	NPCO	NPCI	EPC	PC	SP
Bonoua						
Cassava/Maize	0.86	1.14	1.00	1.15	2.14	0.15
Rice/Maize	1.01	1.01	1.00	1.02	-0.81	0.02
N'douci						
Cassava/Maize	0.74	0.95	1.00	0.96	0.83	-0.04
Rice/Maize	0.96	0.97	1.00	0.98	0.32	-0.02

Source: PAM Model constructed by the author

Note: **DRC**= Domestic Resource Cost, **NPCO**= Nominal Protection Coefficient on Tradable Output, **NPCI**= Nominal Protection Coefficient on Tradable Input, **EPC**= Effective Protection Coefficient, **PC**= Profitability Coefficient and **SP**= Subsidy to Producers

Table 2-8: Ratio Indicators for *Subsistence* Cassava/Maize and Rainfed Rice/Maize Systems in Cote d'Ivoire: 1989/1991.

Production Zones	DRC	NPCO	NPCI	EPC	PC	SP
Bonoua Zone						
Cassava/Maize	0.58	0.77	0.99	0.77	0.46	-0.22
Rice/Maize	0.92	0.92	1.00	0.93	0.11	-0.07
N'douci Zone						
Cassava/Maize	0.51	0.66	1.00	0.66	0.31	-0.33
Rice/Maize	0.91	0.91	1.00	0.92	0.12	-0.08

Source: PAM Model constructed by the author

Note: **DRC**= Domestic Resource Cost, **NPCO**= Nominal Protection Coefficient on Tradable Output, **NPCI**= Nominal Protection Coefficient on Tradable Input, **EPC**= Effective Protection Coefficient, **PC**= Profitability Coefficient and **SP**= Subsidy to Producers.

The domestic resource cost ratio (DRC) assesses social returns to domestic factors, and is the social cost of domestic resources required to produce a unit of value added to tradable goods and services. The DRC ratio indicates the efficiency of domestic

production of an export or of an import substitute. The computed values for the DRC ratios are consistent with the results of the economic analysis. Whether farmers are involved in subsistence farming or commercial farming, cassava/maize production systems have a clear comparative advantage over rainfed rice/maize production systems.

A word of caution: the result discussed above is based on output prices in specific markets. However, shadow prices vary (figures A2-1 and A2-2 in appendix 2), depending on the point of sale. As figures 2-1 and 2-2 below demonstrate, the corresponding DRC ratios vary also over space. These figures indicate the following: 1) the outputs from commercial cassava/maize systems harvested beyond 100 kilometers from the regional markets, are not competitive at either regional market; 2) the further away the point of harvest from the output market, the less competitive cassava/maize systems become; and 3) distance has less impact on the competitivity of rainfed rice/maize systems

These results suggest that only local expansion of cassava systems may be socially profitable. However, it is worth noting that the graphs above refer only to DRCs in the Bonoua and N'douci markets. Cassava systems may be profitable in other markets. The nominal protection coefficient in the output/inputs markets (NPCO/NPCI) is a summary measure of incentives provided by government pricing policy on outputs or inputs respectively. The computed NPCOs indicate that only commercial cassava/maize farmers and commercial rainfed rice/maize farmers operating in the Bonoua market have enjoyed a private price 1 to 14 percent higher than they would have received without government policy. This suggests that the actual policy was a trade-restrictive policy, which had an effect equivalent to that of an import tariff of 1 to 14 percent. On the other hand, computed NPCIs are equal unity everywhere, suggesting that the input market was

totally unprotected.

As mentioned earlier, the observed prices for both commodities are higher than their shadow prices when Bonoua is the regional market. This difference in prices serves as an implicit tariff to reallocate resources in the economy. That is, consumers reduce their consumption of the commodity, production expands in response to the higher domestic price, consumers transfer part of their surplus to producers.

Figure 2-1: DRC Ratios Over Space for Commercial Cassava/Maize and Rainfed Rice/Maize Production Systems- Bonoua is the Regional Output Market, Cote d'Ivoire:1989/1991

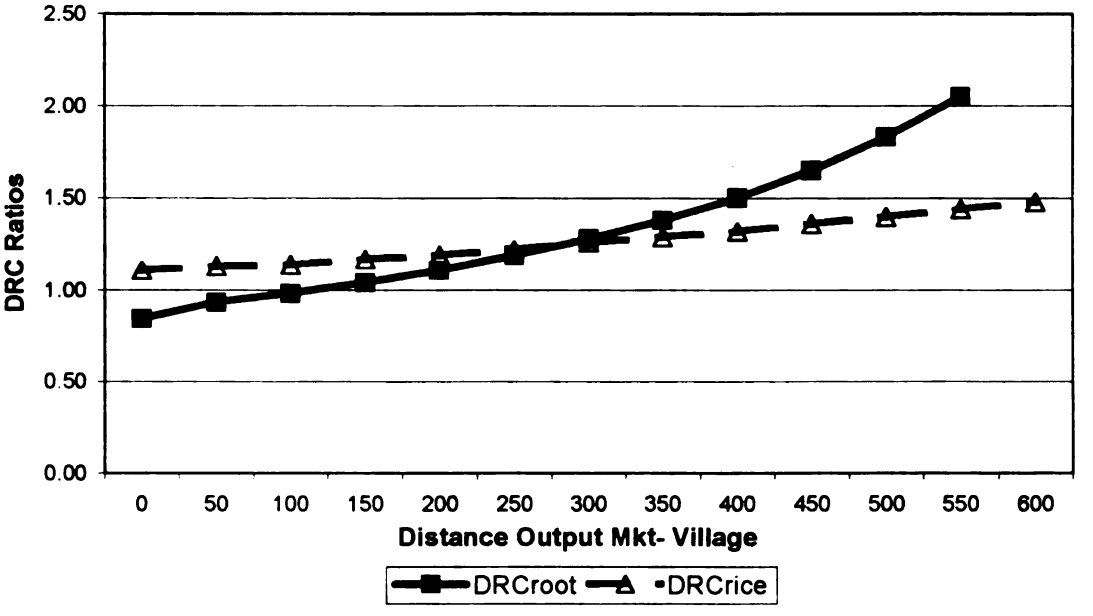
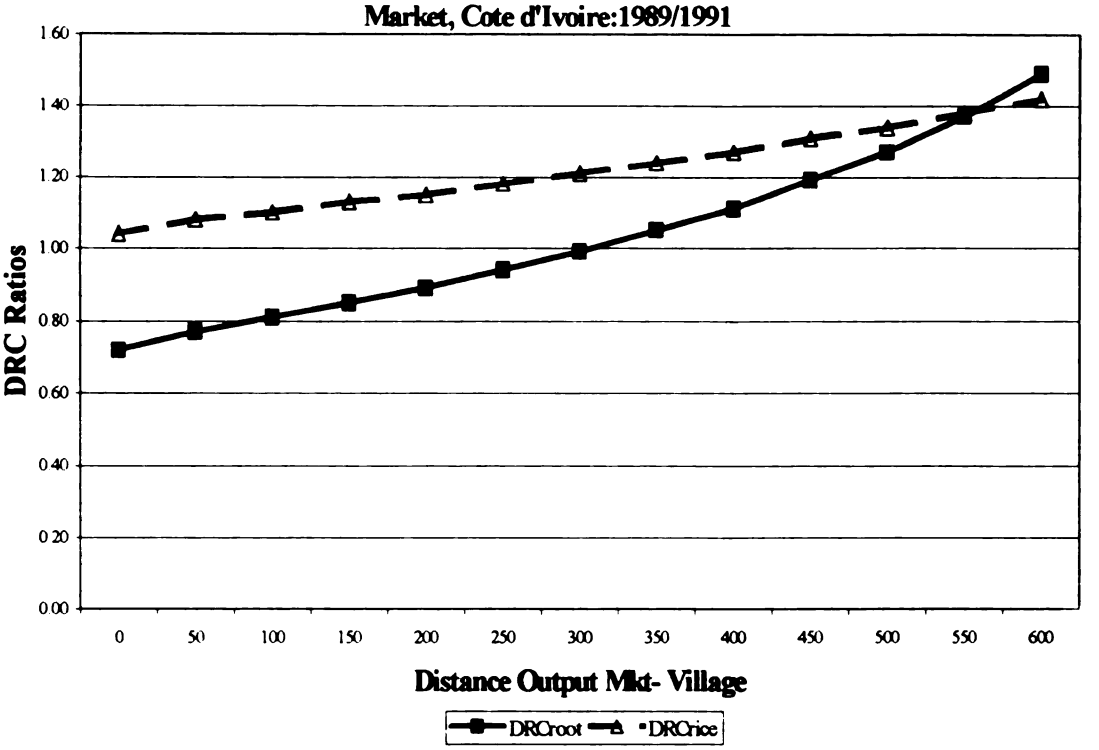


Figure 2-2: DRC Ratios Over Space for Commercial Cassava/Maize and Rainfed Rice/Maize Production Systems- N'douci is the Regional Output Market, Cote d'Ivoire:1989/1991



The effective protection coefficient (EPC) best measures the combined effects discussed earlier. The computed EPCs are between 1.02 and 1.15 for commercial production systems at the Bonoua market, suggesting that those production systems are enjoying a slight positive protection in that market. On the other hand, results show that the net effects of policy have been negative (EPCs are less unity) for all farmers under both systems everywhere else, with cassava systems being taxed more than rice systems.

The other ratios shown in tables 2-7 and 2-8 are the profitability coefficient (PC) ratio and the subsidy to producers (SP) ratio. The PC ratio shows the extent to which net transfers have caused private profits to exceed social profits, while the SP ratio shows the level of transfers from divergences as a proportion of the production system's social revenues (Monke and Pearson, 1989). The computed values of these two ratios lie

between –0.81 and 2.14 for the PC ratios and between -.02 and 0.15 for the SP ratio. It should be noted that no clear interpretation of the PC ratio is possible when its value is negative. Therefore, the focus will be on positive value of computed PC ratios, which indicate that: a) at the Bonoua market, policy transfers have permitted private profits nearly 2.14 times higher than social profits; b) everywhere else, private profits represent only 11 to 83 percent of social profits. The computed SP ratios indicate that distorting policies such as the pricing policies discussed earlier, have caused social revenues from both systems (commercial and subsistence) to be lower by 2 to 33 percent everywhere.

2.3.3.2. Sensitivity Analysis

Sensitivity analysis carried out in this sub-section aims to test the robustness of the results under the baseline scenario. Two scenarios are considered: the first scenario simulates increases in cassava and rice yields per hectare; and the second considers the effects of change in the shadow exchange rate. All the sensitivity analyses are done for commercial production systems.

Yields per hectare. The results of sensitivity analysis of the selected baseline-policy parameter to changes in yields per hectare are shown in table 2-9 below. The effect of possible future changes in production technology was modeled by increasing yields of the main crops (cassava roots and rice paddy) of the production systems. Yields were increased 5 percent, 10 percent and 15 percent to examine the extent to which the increases would alter the comparative advantage of both systems. The increases in yields may appear large but they are attainable using modern technology (Barry, 1994 and Nweke, 1996). As table 2-9 demonstrates, the simulation findings indicate that a 5 to 15 percent increase in yields per hectare of cassava would not only further enhance the

comparative advantage of cassava/maize systems but also cause rice/maize systems, which were unprofitable at the baseline, to become socially profitable (DRC less than unity) in the Bonoua region.

Table 2-9: The Effects of Changes in Yields per Hectare on Selected Policy Indicators for Commercial Production

Mkts/Systems	Policy Parameters						
		DRC Ratio			EPC Ratio		
Bonoua	Yield Increase	Baseline	% Change	Simulation	Baseline	% Change	Simulation
	+5%	.86	-6	0.81	1.15	-3	1.12
Cassava/maize	+10%	.86	-10	0.77	1.15	-5	1.09
	+15%	.86	-15	0.73	1.15	-7	1.07
	+5%	1.01	-2	0.99	1.02	-4	0.98
Rice/maize	+10%	1.01	-4	0.97	1.02	-6	0.96
	+15%	1.01	-6	0.95	1.02	-10	0.92
N'douci							
	+5%	0.74	-5	0.70	0.96	-2	0.94
Cassava/maize	+10%	0.74	-9	0.67	0.96	-4	0.92
	+15%	0.74	-14	0.64	0.96	-5	0.91
	+5%	0.96	-2	0.94	0.98	-1	0.97
Rice/maize	+10%	0.96	-4	0.92	0.98	-4	0.94
	+15%	0.96	-6	0.90	0.98	-7	0.91

Shadow Exchange Rates. In 1989/91 the shadow exchange rate was 394 francs cfa. By 1994, it has declined by 35 percent (from 394 fcfa to 532 fcfa), and the consequence was the devaluation of the franc cfa in January 1994. The second scenario of the sensitivity analysis is designed to examine the effects of this 35 percent decline in the shadow exchange rate between 1989/91 and 1994, on the net social profitability (NSP) and selected policy parameters (DRC, EPC and PC) ratios. The import parity prices were recalculated using the post-devaluation exchange rate of 532 fcfa to one US dollar. Post-devaluation studies (Camara, 1996; Babo, 1996) have shown that market prices have changed with devaluation: from 60 fcfa to 77 fcfa a kilogram for rice and from 15 fcfa to

18 fcfa for kilogram of cassava. Furthermore, these studies also show that devaluation had an impact on the prices of non-tradable inputs such as labor. Rural wage rates increased by 15 to 20 percent. These post-devaluation market prices were used in carrying this analysis. Tables 2-10 and 2-11 present the results.

Table 2-10: The Effects of a Change in the Shadow Exchange Rate on the Net Social Profit (NSP)/ha for Commercial Production Systems

Markets/Systems of Production		Baseline	Simulation	Profit Elasticity[10]
Bonoua	Cassava/maize	31948	141960	9.83
	Rice/maize	-1994	8200	N.A.
N'douci	Cassava/maize	72733	175529	4.03
	Rice/maize	6245	18716	5.69

Note: This analysis is based on a 35 % decline in the Shadow Exchange Rate

Table 2-11: The Effects of a Change in the Shadow Exchange Rate on Selected Policy Indicators for Commercial Production Systems, by Production Systems for Each Regional Output Markets.

Markets/Systems	Policy Indicators					
	DRC Ratio			**EPC Ratio**		
Bonoua	Baseline	% Change	Simulation	Baseline	% Change	Simulation
Cassava/maize	0.86	-25	0.64	1.15	-32	0.78
Rice/maize	1.01	-5	0.96	1.02	-3	0.98
N'douci						
Cassava/maize	0.74	-20	0.59	.96	-27	0.70
Rice/maize	0.96	-5	0.91	.98	-4	0.94

Note: This analysis is based on a 35 % decline in the Shadow Exchange Rate

As the profit elasticities (in absolute terms) in table 2-10 indicate, social profitability levels are very sensitive to a decline in the shadow exchange rate. Following the 74 percent decrease in the shadow exchange rate, each production system offered large social profits.

10 The profit elasticity is computed as follows: percentage changes in NSP/percentage change in exchange rate.

The results of table 2-11 show the effect of the exchange rate depreciation on the DRC and the EPC ratios. Two notable results: first, the EPC estimates are less than unity, suggesting that farmers are being implicitly taxed. That is, they could have received a higher return if they faced border prices instead of domestic prices on both outputs and inputs. However, it should be noted that values of EPC ratios for rice/maize production systems are all close to unity. This implies low government interference in the Ivorian rainfed rice/maize economy.

Second, the simulated values of the domestic resource cost (DRC) ratios are less than unity in Bonoua and N'douci. This result has one significant policy implication. One objective of the Ivorian government is the substitution of domestic production for imports, with the goal of saving foreign exchange. The DRC ratio is an indicator of the efficiency of a commodity production system in converting domestic resources into foreign exchange. Thus, the results of this sensitivity analysis indicate that, if the farmgate price of green maize did not change, the decline in the shadow exchange rate would cause resources used both systems to have a positive impact on Cote d'Ivoire balance of payments.

2.4. Conclusions

This essay is an application of the policy analysis matrix (PAM) for two competing production systems (cassava/maize and rainfed rice/maize) in Cote d'Ivoire. The purpose was to analyze the competitiveness of cassava/maize systems relative to rainfed rice/maize systems. The baseline results indicate that cassava/maize systems have a competitive advantage over their competitors. That is, profitabilities (financial and social) of

cassava/maize systems significantly exceed those of rainfed rice/maize systems. This result indicates that cassava/maize production systems are efficient given current technologies.

PAM is a static model, which cannot capture changes in prices and productivity (Yao, 1998); therefore, a sensitivity analysis was carried out. The simulation findings indicate that a 5 to 15 percent increase in yields per hectare and a decline in the equilibrium exchange rate would: a) enhance the comparative advantage of cassava/maize systems; and b) cause rice/maize systems to become socially profitable also.

REFERENCES

Babo, Alfred, Circuits de Commercialisation et de Transformation du Manioc dans la Region de Bouake. *Memoire de Maitrise*. Option: Socio-Economie du Developpement Rural. Universite de Bouake, 1996.

Barry, A.W., 1994, Comparative Advantage,Trade Flows and Prospects for Regional Agricultural Market Integration in West Africa: The Case of Cote d'Ivoire and Mali, Ph.D. Dissertation. Department of Agricultural Economics, Michigan State University.

Camara, A, La Filiere Riz en Cote d'Ivoire, Etude PRISAS/CIRES, Centre Ivoirien de Recherches Economiques et Sociales, 1996.

Crawford, E., A simulation Study of Constraints on Traditional Farming Systems in Northern Nigeria. Department of Agricultural Economics, Michigan State University, *MSU International Development Paper No.2*, 1982.

Ikpi Anthony E., 1989, "Economic Considerations of Cassava Development" in Ikpi Anthony E. and Hahn Natalie D. (eds.). *Cassava, Lifeline for the Rural Household*, Book Builders Limited, Ibadan, Nigeria.

IMF, 1989-1992, Various issues

Jones, W.O., *Manioc in Africa*, Stanford University Press, Stanford, 1959.

Ministere de l'Economie et des Finances, Direction de la Statistique. *Etudes des Evolutions recentes des Revenus Agricoles*, Abidjan, 1996.

Monke, E.A. and S. Pearson. 1989. *The Policy Analysis Matrix for Agricultural Development*. Baltimore: John Hopkins University Press.

Nweke, F.I., Cassava: A Cash Crop in Africa, *Working Paper No. 14*, The Collaborative Study of Cassava in Africa, 1996.

Nweke, Felix I., K. N'Goran, A.G.O. Dixon, B.O. Ugwu, O. Ajobo, and T. Kouadio. 1998, Cassava production and processing in Cote d'Ivoire. *COSCA Working Paper No. 23*, The Collaborative Study of Cassava in Africa, IITA, Ibadan, Nigeria.

Nwajiuba, C.U., Socioeconomic Impact of Cassava Postharvest Technologies on Smallholders in Southeastern Nigeria, *Farming Systems and Resource Economics in the Tropics*, Vol 20, 1995.

Pearson, Scott, Monke, Eric. 1995. " A Framework for Analyzing Policy Options" in

Buttel Frederick H., DeWalt Billie R. and Pinstrup-Anderson Per (eds.). Agricutural Policy in Kenya. Cornell University Press. pp.11- 28.

Theberger, R. Les principaux ravageurs et maladies du manioc, de l'igname , de la patate douce et aracées en Afrique, IITA, 1985.

Kreamer, R. G. , Gari Processing in Ghana: A Study of Entrepreneurship and Technical Change in Tropical Africa, *Cornell/International Agricultural Economics Study*, 86-30, December 1986.

Ministère de l'Economie et des Finances, Direction de la Statistique: *Etude des évolutions récentes des revenus agricoles*, Abidjan, 1996.

Monke, E.A. and S. Pearson. 1989. *The Policy Analysis Matrix for Agricultural Development.* Baltimore: John Hopkins University Press.

Stryker J. Dirck, " Trade, Exchange Rate, and Agricultural Pricing Policies in Ghana," *World Bank Comparative Studies*, 1990.

Yao, Shujie, 1997. "Rice Production in Thailand Seen Through a Policy Analysis Matrix". *Food Policy*, 22(6):547-560.

APPENDIX 2

Table A2-1: Estimated Average Financial Budget for Cassava/Maize Production Systems, Cote d'Ivoire: 1989/1991

Budget Items		
1. INPUT USE	Family	Hired
Family/Hired Labor Use (person-days)		
Land Clearing	18	14
Seedbed Preparation	22	20
Weeding	12	14
Planting		
Cassava	17	15
Maize	15	0
Harvesting		
Cassava	27	11
Maize	23	0
Total	**134**	**74**
2. OUTPUTS		
Average Root Yield (kg/ha)	10737	
Average Maize Yield (ears/ha)[1]	6780	
Market Price of Root (fcfa/kg)[2]	15	
Market Price of Green Maize (fcfa/ears)[3]	25	
Revenues from Green Maize (fcfa/ha)	169500	
Revenues from Cassava Roots (fcfa/ha)	161055	
Gross Revenues (fcfa/ha)	330555	
3. COSTS		
Fixed Costs (fcfa/ha)[4]	0	
Operating costs (fcfa/ha)		
Hired Labor	46620	
Transportation field-to-home (fcfa/ton)	4960	
Interest on Working Capital (8%)	4126	
Total Operating Costs (fcfa/ha)	55706	
Family Labor (valued @ hired labor wage rate)	84420	
Opportunity Cost of land	60835	
4. PERFORMANCE MEASURES		
Gross Margin (fcfa/ha)	274849	
Net Returns to family Labor (fcfa/ha)	214014	
Net Returns per day of Family Labor (fcfa/day)	1597	
Total System Production Costs (fcfa/ha)	200961	
Net Enterprise Profits (fcfa/ha)	129594	

Source: COSCA survey data

[1] Estimated using the "Ear Weight Method" discussed in Appendix 2. In West Africa, maize, which has a short cycle, is harvested before cassava establishes. Hence competition between maize and cassava is minimized, while sole plant density is maintained for both crops (COSCA Working Paper No.10, page 84).

[2] Weighted average farmgate price based on COSCA data

[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).

[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3 percent of the harvest is retained for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

Table A2-2: Estimated Average Financial Budget for Rainfed Rice/Maize Production Systems,Cote d'Ivoire: 1989/1991

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)		
Land Clearing	10	15
Seedbed Preparation	11	14
Weeding	23	18
Planting		
Paddy	19	15
Maize	7	0
Harvesting		
Paddy	15	17
Maize	10	0
Total	**95**	**79**
2. OUTPUTS		
Average Paddy Yield (kg/ha)	1300	
Average Maize Yield (ears/ha)[1]	3994	
Market Price of Paddy (fcfa/kg)[2]	60	
Market Price of Green Maize (fcfa/ears)[3]	25	
Revenues from Green Maize (fcfa/ha)	99850	
Revenues from Paddy (fcfa/ha)	78000	
Gross Revenues (fcfa/ha)	177850	
3. COSTS		
Fixed Costs (fcfa/ha)[4]	0	
Operating costs (fcfa/ha)		
Hired Labor	47400	
Transportation field-to-home (fcfa/ton)	4650	
Interest on Working Capital (8%)	4164	
Total Operating Costs (fcfa/ha)	56214	
Family Labor (valued @ hired labor wage rate)	57000	
Opportunity Cost of land (fcfa)	60835	
3. PERFORMANCE MEASURES		
Gross Margin (fcfa/ha)	121636	
Net Returns to family Labor (fcfa/ha)	60801	
Net Returns per day of Family Labor (fcfa/day)	640	
Total System Production Costs (fcfa/ha)	174049	
Net Enterprise Profits (fcfa/ha)	3801	

Source: COSCA survey data

[1] Estimated using the "Ear Weight Method" discussed in Appendix 2. In West Africa, maize, which has a short cycle, is harvested before cassava establishes. Hence competition between maize and cassava is minimized, while sole plant density is maintained for both crops. (COSCA Working Paper No.10, page 84)

[2] Weighted average farmgate price based on COSCA data

[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).

[4] Farmers did not purchase planting materials of food crops; they produced their own: for rice, only 2 to 3 percent of the previous harvest is retained for replanting and for maize, only 2 to 3 percent of the previous harvest is retained for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted

Table A2-3: Economic Import Parity Price of Cassava Root *For Sale in Regional Output Markets*, Cote d'Ivoire: 1989/1991

Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. World Price (FOB-$US/mt tapioca)	221	221
2. Freight and insurance ($US/mt tapioca)	48	48
3. CIF, port in Abidjan ($US/mt tapioca) (1+2)	269	269
4. Shadow Exchange rate (fcfa / $US)	394	394
5. CIF price at the port in Abidjan (fcfa/mt tapioca) (3*4)	105998	105998
6. Domestic costs (fcfa/mt tapioca)		
a. Port charges (fcfa/mt tapioca)	700	700
b. Transit and Transport (fcfa/mt tapioca)	2000	2000
c. Storage and Handling (fcfa/mt tapioca)	2000	2000
7. Abidjan gate price (5+ 6a...c) (fcfa/mt tapioca)	110698	110698
8. Importer marketing margin (%)	5%	5%
9. Wholesale price in Abidjan (7* (1+ 8))	116233	116233
10. Abidjan to Regional Market Center		
a Distance (km)	75	130
b. Transport cost (fcfa/mt tapioca)	2625	4550
c. Handling (fcfa/mt tapioca)	2000	2000
11. Regional Market Center (Reference Price) Farmgate price (fcfa/mt tapioca) (9 + 10a..c)	120858	122783
12. Wholesale marketing margin (%)	5%	5%
13. Wholesale price in Regional Market (fcfa/mt tapioca) (11* (1+12))	126901	128922
14. Regional Market Center to Village		
a. Distance (kms)	37	56
b. Transport and Handling cost (fcfa/mt tapioca)	3665	4520
15. Village gate price (fcfa/mt tapioca) (13-14b)	123236	124402
16. Semi-wholesale marketing margin (%)	5%	5%
17. Village Level Semi-wholesale price ((1-16)*15)/1000	117	118
18.Transformation rate (kg of tapioca / kg of root)	.5	.5
19. Processing cost (fcfa/kg of root)	46	43
20. Import Parity Price in the Village (fcfa /kg of root) (17*18) -19	12	16

Source: COSCA data, Institut de Documentaion de Recherches et d'Etudes Maritimes of the Ivorian Marine Ministry; UN Economic and Social Commission For Asia and the Pacific, Reports of 1989 through 1991.

Table A2-4: Economic Import Parity Price of Paddy *For Sale in Regional Outputs Markets*, Cote d'Ivoire: 1989/1991.

Items	*Regional Outputs Markets*	
	Bonoua	**N'douci**
1. World Price (FOB-$US/mt milled rice)	201	201
2. Freight and insurance ($US/mt milled rice)	48	48
3.CIF, port in Abidjan ($US/mt milled rice) (1+2)	249	249
4. Shadow Exchange rate (fcfa / $US)	394	394
5. CIF price at the port in Abidjan (fcfa/mt milled rice) (3*4)	98026	98026
6. Domestic costs (fcfa/mt milled rice)		
a. Port charges (fcfa/mt milled rice)	700	700
b. Transit and Transport (fcfa/mt milled rice)	2000	2000
c. Storage and Handling (fcfa/mt milled rice)	2000	2000
7. Abidjan gate price (5+ 6a...c) (fcfa/mt milled rice)	102726	102726
8. Importer marketing margin (%)	5%	5%
9. Wholesale price in Abidjan (7* (1+ 8))	107863	107863
10. Abidjan to Regional Market Center		
a Distance (km)	75	130
b. Transport cost(fcfa/mt milled rice)	2625	4550
c. Handling (fcfa/mt milled rice)	2000	2000
11. Regional Market Center (Reference Price) Farmgate price (fcfa/mt milled rice) (9 +10a..c)	112488	122783
12. Wholesale marketing margin (%)	5%	5%
13. Wholesale price in Regional Market (fcfa/mt milled rice) (11* (1+12))	118112	128922
14. Regional Market Center to Village		
a. Distance (kms)	37	56
b. Transport and Handling cost (fcfa/mt milled rice)	3665	4520
15. Village gate price (fcfa/mt milled rice) (13-14b)	114447	124402
16. Semi-wholesale marketing margin (%)	5%	5%
17. Village Level Semi-wholesale price ((1-16)*15)/1000	109	118
18.Milling Rate (kg of milled rice / kg of paddy)	0.65	0.65
19. Processing cost (fcfa/kg of paddy)	12	12
20. Import Parity Price in the Village (cfaf /kg of paddy) (17*18) -19	59	65

Source: COSCA data, Institut de Documentaion de Recherches et d'Etudes Maritimes of the Ivorian Marine Ministry; UN Economic and Social Commission For Asia and the Pacific, Reports of 1989 through 1991.

Table A2-5: Economic Import Parity Price of Cassava Root *For Home Consumption*, Cote d'Ivoire: 1989/1991.

Items	*Production Zones*	
	Bonoua Zone	**N'douci Zone**
1. World Price (FOB-$US/mt tapioca)	221	221
2. Freight and insurance ($US/mt tapioca)	48	48
3. CIF, port in Abidjan ($US/mt tapioca) (1+2)	269	269
4. Shadow Exchange rate (fcfa / $US)	394	394
5. CIF price at the port in Abidjan (fcfa/mt tapioca) (3*4)	105998	105998
6. Domestic costs (fcfa/mt tapioca)		
a. Port charges (fcfa/mt tapioca)	700	700
b. Transit and Transport (fcfa/mt tapioca)	2000	2000
c. Storage and Handling (fcfa/mt tapioca)	2000	2000
7. Abidjan gate price (5+ 6a...c) (fcfa/mt tapioca) 8.	110698	110698
Importer marketing margin (%)	5%	5%
9. Wholesale price in Abidjan (7* (1+ 8))	116233	116233
10. Abidjan to Regional Market Center		
a Distance (km)	75	130
b. Transport cost (fcfa/mt tapioca)	2625	4550
c. Handling (fcfa/mt tapioca)	2000	2000
11. Regional Market Center (Reference Price)		
Farmgate price (fcfa/mt tapioca) (9 + 10a..c)	120858	122783
12. Wholesale marketing margin (%)	5%	5%
13. Wholesale price		
in Regional Market (fcfa/mt tapioca) (11* (1+12))	126901	128922
14. Regional Market Center to Village		
a. Distance (kms)	37	56
b. Transport and Handling cost (fcfa/mt tapioca)	3665	4520
15. Village gate price (fcfa/mt tapioca) (13+14b)	130566	133442
16. Semi-wholesale marketing margin (%)	5%	5%
17. Village Level Semi-wholesale price ((1+16		
)*15)/1000	137	140
18.Transformation rate (kg of tapioca / kg of root)	0.5	0.5
19. Processing cost (fcfa/kg of root)	46	43
20. Import Parity Price in the Village (cfaf /kg of root)		
(17*18) -19	22	27

Source: COSCA data. Institut de Documentaion de Recherches et d'Etudes Maritimes of the Ivorian Marine Ministry; UN Economic and Social Commission For Asia and the Pacific, Reports of 1989 through 1991.

Table A2-6: Economic Import Parity Price of Paddy- *For Home Consumption*, Cote d'Ivoire: 1989/1991.

Items	*Production Zones*	
	Bonoua Zone	**N'douci Zone**
1. World Price (FOB-$US/mt milled rice)	201	201
2. Freight and insurance ($US/mt milled rice)	48	48
3. CIF, port in Abidjan ($US/mt milled rice) (1+2)	249	249
4. Shadow Exchange rate (fcfa / $US)	394	394
5. CIF price at the port in Abidjan (fcfa/mt milled rice) (3*4)	98026	98026
6. Domestic costs (fcfa/mt milled rice)		
a. Port charges (fcfa/mt milled rice)	700	700
b. Transit and Transport (fcfa/mt milled rice)	2000	2000
c. Storage and Handling (fcfa/mt milled rice)	2000	2000
7. Abidjan gate price (5+ 6a...c) (fcfa/mt milled rice)	102726	102726
8. Importer marketing margin (%)	5%	5%
9. Wholesale price in Abidjan (7* (1+ 8))	107863	107863
10. Abidjan to Regional Market Center		
a Distance (km)	75	130
b. Transport cost (fcfa/mt milled rice)	2625	4550
c. Handling (fcfa/mt milled rice)	2000	2000
11. Regional Market Center (Reference Price) Farmgate price (fcfa/mt milled rice) (9 + 10a..c)	112488	122783
12. Wholesale marketing margin (%)	5%	5%
13. Wholesale price in Regional Market (fcfa/mt milled rice) (11* (1+12))	118112	128922
14. Regional Market Center to Village		
a. Distance (kms)	37	56
b. Transport and Handling cost (fcfa/mt milled rice)	3665	4520
15. Village gate price (fcfa/mt tapioca) (13+14b)	121777	124402
16. Semi-wholesale marketing margin (%)	5%	5%
17. Village Level Semi-wholesale price ((1+16)*15)/1000	128	131
18.Milling Rate (kg of milled rice / kg of paddy)	0.65	0.65
19. Processing cost (fcfa/kg of paddy)	12	12
20. Import Parity Price in the Village (cfaf /kg of paddy) (17*18) -19	71	73

Source: COSCA data. Institut de Documentaion de Recherches et d'Etudes Maritimes of the Ivorian Marine Ministry; UN Economic and Social Commission For Asia and the Pacific, Reports of 1989 through 1991.

Table A2-7: Estimated Economic Farm Level Budget for *Commercial* Cassava/Maize Production Systems, by Regional Output Markets, Cote d'Ivoire, 1989-1991

Budget Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. OUTPUTS		
Average Root Yield (kg/ha)	11811	11274
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of root (fcfa/kg)[2]	12	16
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Root (fcfa /ha)	142989	183303
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	242839	283153
2. COSTS		
Fixed Costs (/ha)[4]		
Operating costs (/ha)	0	0
Hired Labor[5]		
Transportation field-to-home (fcfa)	49140	47880
Tradable		
Nontradable	6460	6166
Interest on Working Capital (8%)	1091	1042
Total Operating Costs (fcfa /ha)	4535	4247
Family Labor (valued @ hired labor wage rate)	61226	57335
(fcfa /ha)	88830	90090
Opportunity Cost of Land[6] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	181613	223658
Net Returns to family Labor (fcfa /ha)	120778	162823
Net Returns per day of Family Labor (fcfa /day)	857	1139
Total production Costs (fcfa /ha)	210891	210420
Net Social Profits (fcfa /ha)	31948	72733

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2.
[2] Estimated farm level import parity price of root
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops: they produced their own: for cassava, only one fifth of the stems from previous harvest is retained for replanting and for maize, only 2 to 3 percent of the harvest is retained for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted
[5] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[6] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A2-8: Estimated Economic Farm Level Budget for *Commercial* Rainfed Rice/Maize Production Systems, by Regional Output Markets, Cote d'Ivoire, 1989/1991

Budget Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. OUTPUTS		
Average paddy Yield (kg/ha)	1320	1300
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of paddy (fcfa/kg)[2]	59	65
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Paddy (fcfa /ha)	77446	84326
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	177367	184114
2. COSTS		
Fixed Costs (/ha)[4]	0	0
Operating costs (/ha)		
Hired Labor[5]	52200	51000
Transportation field-to-home (fcfa/ton)		
Tradable	5506	5825
Nontradable	930	984
Interest on Working Capital (8%)	4691	4625
Total Operating Costs (fcfa /ha)	63326	62434
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	55200	54600
Opportunity Cost of Land[6] (fcfa/ha)	60835	60835
4. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	114041	121680
Net Returns to family Labor (fcfa /ha)	53206	60845
Net Returns per day of Family Labor (fcfa /day)	578	669
Total production Costs (fcfa /ha)	179361	177869
Net Social Profits (fcfa /ha)	-1994	6245

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2.
[2] Estimated Farm level import parity price of paddy
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for rice, only 2 to 3 percent of the previous harvest is retained for replanting and for maize, only 2 to 3 percent of the previous harvest is for seed.Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted
[5] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[6] Land is very rarely sold or rented. In this budget the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A2-9: Estimated Economic Farm Level Budget for *Subsistence* Cassava/Maize Production Systems, by Production Zones, Cote d'Ivoire, 1989-1991

Budget Items	*Production Zones*	
	Bonoua Zone	**N'douci Zone**
1. OUTPUTS		
Average Root Yield (kg/ha)	11811	11274
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of root (fcfa/kg)[2]	22	27
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Root (fcfa /ha)	261215	306934
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	361065	406784
2. COSTS		
Fixed Costs (/ha)[4]	0	0
Operating costs (/ha)		
Hired Labor[5]	49140	47880
Transportation (fcfa)		
Tradable	6460	6166
Nontradable	1091	1042
Interest on Working Capital (8%)	4600	4407
Total Operating Costs (fcfa /ha)	62101	59495
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	88830	90090
Opportunity Cost of Land[6] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	298964	347289
Net Returns to family Labor (fcfa /ha)	238129	286454
Net Returns per day of Family Labor (fcfa /day)	1689	2003
Total production Costs (fcfa /ha)	211766	210420
Net Social Profits (fcfa /ha)	149299	196364

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2.
[2] Estimated farm level import parity price of root
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems is retained for replanting and for maize, only 2 to 3 percent of the harvest is retained for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[5] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[6] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A2-10: Estimated Economic Farm Level Budget for *Subsistence* Rainfed Rice/Maize Production Systems, by Production Zones, Cote d'Ivoire, 1989/1991

Budget Items	*Production Zones*	
	Bonoua Zone	**N'douci Zone**
1. OUTPUTS		
Average paddy Yield (kg/ha)	1320	1300
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of paddy (fcfa/kg)[2]	71	73
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Paddy (fcfa /ha)	93869	94776
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	193719	194626
2. COSTS		
Fixed Costs (fcfa/ha)[4]	0	0
Operating costs (fcfa/ha)		
Hired Labor[5]	52200	51000
Transportation (fcfa)		
Tradable	5506	5825
Nontradable	930	984
Interest on Working Capital (8%)	4691	4625
Total Operating Costs (fcfa /ha)	63326	62434
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	55200	54600
Opportunity Cost of Land[6] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	130392	132192
Net Returns to family Labor (fcfa /ha)	69557	71357
Net Returns per day of Family Labor (fcfa /day)	756	784
Total production Costs (fcfa /ha)	179361	177869
Net Social Profits (fcfa /ha)	14357	16757

Source: COSCA survey data

[1] Estimated farmgate price using the "Ear Weight Method" discussed in Appendix 2.
[2] Estimated farm level import parity price of paddy
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for rice, only 2 to 3 percent of the previous harvest is retained for seed and for maize, only 2 to 3 percent of the previous harvest is retained for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[5] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[6] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A2-11: Estimated Financial Farm Level Budget for *Commercial* Rainfed Rice/Maize Production Systems, by Regional Output Markets, Cote d'Ivoire, 1989/1991

Budget Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. OUTPUTS		
Average paddy Yield (kg/ha)	1320	1300
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of paddy (fcfa/kg)[2]	60	60
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Paddy (fcfa /ha)	79200	78000
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	179050	177850
2. COSTS		
Fixed Costs (/ha)	0	0
Operating costs (/ha)		
Hired Labor[4]	52200	51000
Transportation (fcfa)		
Tradable	3720	3936
Nontradable	930	984
Interest on Working Capital (8%)	4548	4474
Total Operating Costs (fcfa /ha)	61398	60394
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	55200	54600
Opportunity Cost of Land[5] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	117652	117456
Net Returns to family Labor (fcfa /ha)	56817	56621
Net Returns per day of Family Labor (fcfa /day)	618	622
Total production Costs (fcfa /ha)	177433	175829
Net Enterprise Profits (fcfa /ha)	1617	2021

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in the appendix.
[2] Weighted average farmgate price based on COSCA data
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[5] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A2-12: Estimated Financial Farm Level Budget for *Commercial* Cassava/Maize Production Systems, by Regional Output Markets, Cote d'Ivoire, 1989-1991

Budget Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. OUTPUTS		
Average Root Yield (kg/ha)	11811	11274
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of root (fcfa/kg)[2]	15	15
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Root (fcfa /ha)	177161	169108
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	277011	268958
2. COSTS		
Fixed Costs (/ha)[4]	0	0
Operating costs (/ha)		
Hired Labor	49140	47880
Transportation (fcfa)		
Tradable	4365	4166
Nontradable	1091	1042
Interest on Working Capital (8%)	4368	4247
Total Operating Costs (fcfa /ha)	58964	57335
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	88830	90090
Opportunity Cost of Land[5] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	218047	211623
Net Returns to family Labor (fcfa /ha)	157212	150788
Net Returns per day of Family Labor (fcfa /day)	1115	1054
Total production Costs (fcfa /ha)	208629	208260
Net Enterprise Profits (fcfa /ha)	68382	60698

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2.
[2] Weighted average farmgate price based on COSCA data.
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest is retained for replanting and for maize, only 2 to 3 percent of harvest. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[5] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A2-13: Estimated Financial Farm Level Budget for *Subsistence* Cassava/Maize Production Systems, by Regional Output Markets, Cote d'Ivoire, 1989-1991

Budget Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. OUTPUTS		
Average Root Yield (kg/ha)	11811	11274
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of root (fcfa/kg)[2]	15	15
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Root (fcfa /ha)	177161	169108
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	277011	268958
2. COSTS		
Fixed Costs (/ha)[4]	0	0
Operating costs (/ha)		
Hired Labor	49140	47880
Transportation (fcfa)		
Tradable	4365	4166
Nontradable	1091	1042
Interest on Working Capital (8%)	4368	4247
Total Operating Costs (fcfa /ha)	58964	57335
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	88830	90090
Opportunity Cost of Land[5] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	218047	211623
Net Returns to family Labor (fcfa /ha)	157212	150788
Net Returns per day of Family Labor (fcfa /day)	1115	1054
Total production Costs (fcfa /ha)	208629	208260
Net Enterprise Profits (fcfa /ha)	68382	60698

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2.
[2] Weighted average farmgate price based on COSCA data.
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest is retained for replanting and for maize, only 2 to 3 percent of harvest. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[5] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A2-14: Estimated Financial Farm Level Budget for *Subsistence* Rainfed Rice/Maize Production Systems, by Regional Output Markets, Cote d'Ivoire, 1989/1991

Budget Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. OUTPUTS		
Average paddy Yield (kg/ha)	1320	1300
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of paddy (fcfa/kg)[2]	60	60
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Paddy (fcfa /ha)	79200	78000
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	179050	177850
2. COSTS		
Fixed Costs (/ha)	0	0
Operating costs (/ha)		
Hired Labor[4]	52200	51000
Transportation (fcfa)		
Tradable	3720	3936
Nontradable	930	984
Interest on Working Capital (8%)	4548	4474
Total Operating Costs (fcfa /ha)	61398	60394
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	55200	54600
Opportunity Cost of Land[5] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	117652	117456
Net Returns to family Labor (fcfa /ha)	56817	56621
Net Returns per day of Family Labor (fcfa /day)	618	622
Total production Costs (fcfa /ha)	177433	175829
Net Enterprise Profits (fcfa /ha)	1617	2021

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2.
[2] Weighted average farmgate price based on COSCA data
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[5] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Figure A2-1: Farm-Level Economic Prices Over Space of Cassava Root a nd Rainfed Rice Paddy- *For Sale in the Regional Market of Bonoua*, Cote d'Ivoire: 1989/1991

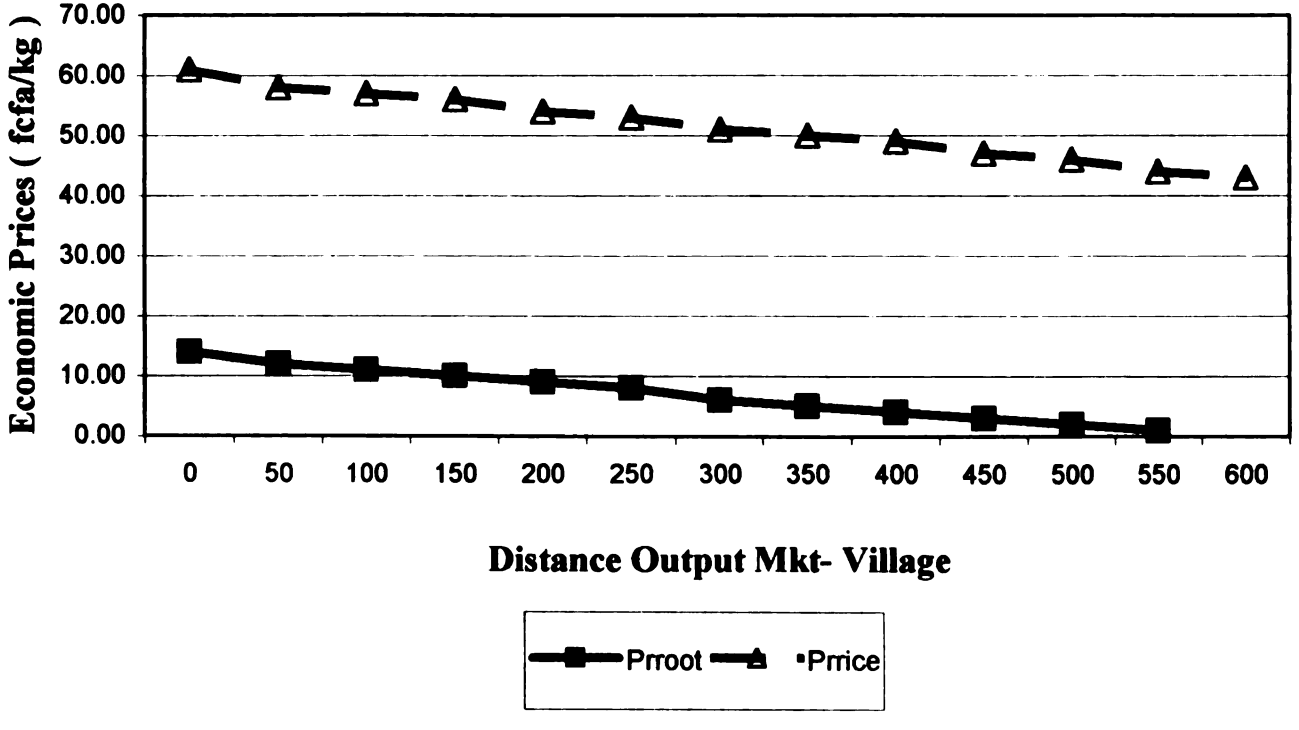
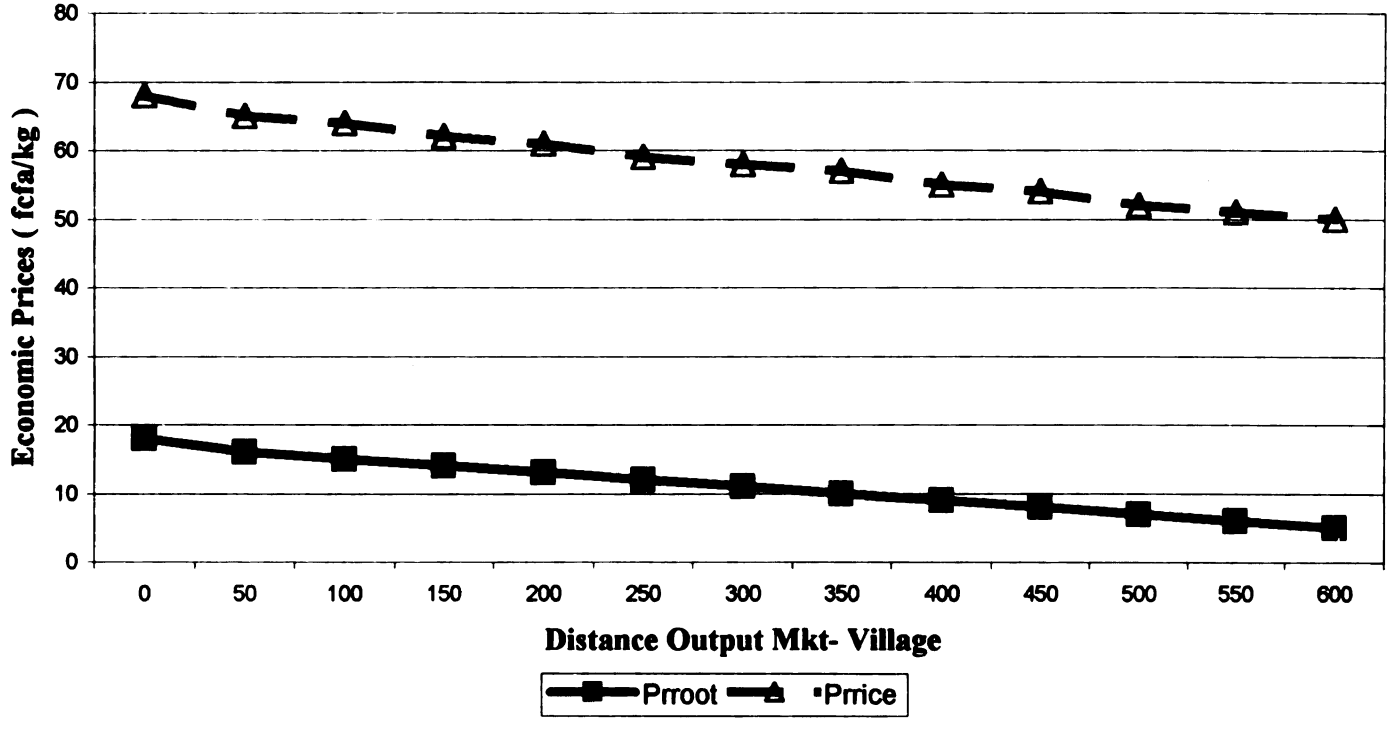


Figure 2-2: Farm-Level Economic Prices Over Space of Cassava Root and Rainfed Rice Paddy- *For Sale in the Regional Market of N'douci*, Cote d'Ivoire: 1989/1991



CHAPTER 3

EVALUATING THE SOCIAL PROFITABILITY OF CASSAVA-BASED PRODUCTION SYSTEMS UNDER ALTERNATIVE PRODUCTION-PROCESSING TECHNOLOGY COMBINATIONS IN NIGERIA

3.1. Introduction

The Collaborative Study of Cassava in Africa (COSCA) found that processing by a mechanized cassava processing method reduces the cost of the processed product by saving labor, thereby extending the market for the product. The COSCA study also found that under manual processing methods, high yields attained through planting of improved varieties might not have substantial cost-saving advantage because the cost constraint will be shifted to the processing stage (Nweke *et al.*, 1994). The study concludes that improvement in the processing technology would have as much effect on cassava production expansion as improvement in yield.

This essay builds on this conclusion to hypothesize that cassava-based production systems, under a combination of improved production technologies with modern processing technologies, are the most profitable (financially and socially) of all cassava-based systems in Nigeria.

A few studies have examined the impact of technologies on cassava production in Nigeria. Nweke (1994) estimated costs and returns for cassava root production and *gari* making in southeast Nigeria. They found that overall cost-saving advantage of yield increasing technology might not fully translate into expanded production if there is no cost-saving technology at processing stage.

Nwajiuba (1995) has analyzed the socioeconomic impact of the introduction cassava postharvest technologies in southeastern Nigeria. He concluded that the financial profitability of *gari* production has increased with the improvement of processing technologies.

However, no study has addressed the issue of the social profitability of cassava-based production systems under alternative combinations of production and processing technologies in Nigeria. Such an issue is important because the experience in bringing technical change to small-farm agriculture in Sub-Saharan Africa suggests that when human and financial resources are limited there are distinct advantages to focusing on a few, well chosen regions, staple crops and simple technologies. (Byerlee and Heisey, 1993).

This study is based on the fact that cassava products such as tapioca are tradable and currently traded, to an extent, in Sub-Saharan Africa. This means that cassava-based systems have a certain potential for generating export earnings. Therefore, a policy analysis that helps determine combinations of production and processing technologies, under which cassava-based production systems are socially profitable (e.g., internationally competitive), can be very useful to policy-makers.

Following Adesina and Coulibaly (1998), this essay uses the Policy Analysis Matrix (PAM) to examine the relative profitability (financial and social) and comparative advantage of cassava/maize production systems under four alternative production and processing technology-combinations in Nigeria: "*Impmech*", "*Locmech*", "*Locman*", and "*Impman*" defined as follows: a) *Impmech* refers to IITA's improved cassava variety processed using a mechanized grating method, b) *Locmech* refers to local cassava variety

processed using a mechanized grating method, c) *Locman* refers to local cassava variety processed using a manual grating method), d) *Impman* refers to IITA's improved cassava variety processed using a manual grating method.

3.2. Methodological Framework

The Policy Analysis Matrix (PAM) is the analytical framework used in this essay. This methodology is developed in detail in the first chapter; therefore in this section, the focus is on how it is used in estimating comparative social returns and costs to production and processing technology combinations.

This study is based on data for Nigeria, from the Collaborative Study of Cassava in Africa (COSCA) survey. COSCA report number 2 provides a detailed discussion of the data collection procedures and the associated sampling method. The survey covered the period 1989/1991.

The COSCA survey data that are used include farm-level technical coefficients, processing costs, transformation rates of cassava root into processed products, sources of cassava roots and destination of cassava products, unit storage cost, unit transportation costs, product and input market prices, taxes and subsidy levels. In the case of green maize, data used were obtained not only from the COSCA survey but also from primary sources of earlier studies and from secondary sources such as the agricultural statistics report of the Office of Agricultural Statistics (Nigerian Ministry of Agriculture). In addition, macroeconomic data needed in the estimation of economic prices (i.e. import parity prices and shadow exchange prices) were obtained mostly from secondary sources such as the Nigeria Port Authority Statistical Reports (1989 through 1992) and the IMF.

3.3. Empirical Analyses

Cassava/maize production systems considered in this study can be represented by three separate activities. The first activity, farm production, consists of root and green maize production and transportation to the village. Green maize is either consumed on farm or sold. The second activity involves the processing of cassava into *gari*. Transportation of *gari* to be sold at regional markets is the third activity.

Information contained in the COSCA data base for Nigeria were used to classify households surveyed into four categories, based on production zones:

(i) Farmers who grow improved cassava varieties and produce *gari* using a mechanized grating method

(ii) Farmers who grow local landrace varieties and produce *gari* using a mechanized grating method

(iii) Farmers who grow local landrace varieties and produce *gari* using a manual grating method

(iv) Farmers who grow improved cassava varieties and produce *gari* using a manual grating method

Cluster analysis confirmed that, in Nigeria, many important technical factors (e.g soil texture, types of processing equipment available) affecting the choice of cassava production and processing technologies are highly correlated with production zones. Thus, the classification approach indeed grouped together households, most of which use similar technologies. However, some intra-zone variability was found; therefore, the results of the empirical analyses should be considered applicable to "average" households

in each production zone. Cassava/maize production systems under each technology combinations are examined in this section using a combination of financial analysis, economic analysis and policy analysis. The tasks involved are the following:

1. To develop enterprise budgets (financial and economic) for each technology combination under a "baseline scenario".

2. To construct a Policy Analysis Matrix (PAM) for each commodity system, using the information from the enterprise budget and estimate ratio indicators such as DRC, NPC, etc.

3. To undertake sensitivity analyses in order to contrast the comparative advantage of the four technology combinations.

3.3.1. Financial Profitability Analysis

The purpose of this sub-section is to estimate crop enterprise budgets, processed product (*gari*) enterprise budgets by production and processing technology, and thereby provide the information for establishing the relative profitability of alternative cassava production and processing technology combinations. Separate farm–level financial budgets were developed for each production technology. In addition, a post-farm level budget was constructed for each combination of production and processing technologies. The aim of input-output budget analysis is to derive farm recommendations, which are consistent with farmers' desires to increase expected income and to make the best possible use of the resources available to them. Furthermore, enterprise budgets are important in farm income analysis because they help to explain the internal structure of the farm as a whole and to show the relative contribution of each enterprise to the whole organization. Therefore, these enterprise studies are very instrumental in an attempt to:

(i) assess the profitability of each enterprise relative to the resources used; (ii) compare relative efficiency of various enterprises on the farm; and (iii) provide a basis for making rational decisions about the kind and size of enterprise to be expanded.

In the financial analysis, the main objective is to answer the question whether a particular enterprise under a given system of production will pay its way in strict monetary terms.(Are returns greater than monetary costs?) Towards this end, inputs are valued at the average market prices that farmers paid for each type of input, while output is valued at the average unit price received at harvest period by farmers in each country. For each enterprise budget, financial returns to family labor were computed. Other performance measures computed from the budget data include gross margin per hectare, net returns to family labor, net returns per day of family labor, total production cost per hectare and average cost of processing per kilogram of output in the post-farm analysis.

3.3.1.1. Farm level Analysis

Cassava/maize enterprise budgets were constructed for each production technology. These budgets are presented in tables A3-1 and A3-2 of appendix 3. Table 3-1 below summarizes the results of the "baseline" runs of the farm level financial profitability analysis. The summary focuses mainly on performance measures that can be used to identify the enterprise with the highest financial return and lowest cost of production. The results in table 3-1 indicate clearly that, on average, cassava/maize systems with the IITA's improved cassava variety are the most profitable systems. They generate the highest returns and the highest net profits.

Table 3-1: Summary Estimates (in naira) of Farm-Level Financial Budget Indicators for Cassava/Maize Production Systems, by Production Technologies: Nigeria, 1989/91

Technologies	Returns to Family Labor Per Ha	Returns to Family Labor Per Person-day	Total System Production Costs/ha	Net Enterprise Profits
IITA's Improved Varieties	12626	73	16357	9014
Local Landraces	8834	55	15361	5453

Source: tables A3-1 and A3-2 in appendix 3

When converted to a per person-day basis, the returns to family labor (RFL) are 73 nairas for IITA's improved varieties and 55 nairas for local landraces. Under both systems, the RFL per person-day is higher than the average wage rate paid to the hired labor, which is 21 nairas per person-day. Thus, there is no financial advantage of family members seeking wage employment in urban areas or other farms, when they are needed on their farms in the village.

To compute the net enterprise profits (NEP), opportunity costs were assigned to family labor and land. That is, family labor was valued at hired labor wage rate and land was attributed a value equal to net returns to land if farmers were growing green maize only. Both technologies realized positive NEPs of 9014 nairas for the IITA variety and 5453 nairas for the local landrace variety.

Unfortunately, the COSCA study did not record maize yields on its sample fields. Therefore, in computing the enterprise budgets developed in this study, it was assumed that those fields got the average maize yield for the country which was then converted to

the number of fresh corn ears using the "Ear-Weight Method" discussed in the appendix of chapter 2. The number of corn ears were subsequently valued at the fresh corn price.

3.3.1.2. Post-harvest Level Financial Analysis

It is assumed that green maize is harvested and consumed on farm or sold at the farm level. Therefore, only cassava roots harvested are taken to the next level (the village) to be processed. Cassava processing methods involve a combination of activities such as peeling, grating and toasting. Of these activities, grating is the most labor intensive. In this study, a process is defined as traditional if grating is performed manually. Mechanized grating involves the use of various types of mechanical cassava graters, which are driven by electrical, petrol, or diesel engines. The major form into which cassava roots are processed in Nigeria is *gari*, which is made of toasted cassava granules.

Transformation coefficients were computed and used to calculate actual *gari* yields under each technology combination. These yields were valued by the average consumer price of *gari* based on COSCA village survey data. It should be noted that prices vary a lot from season to season, mainly because of changing season conditions (e.g., abundance vs. hungry seasons). To account for this diversity, the weighted average price was estimated. Since farmers do not own processing machines, no fixed costs were assigned processing enterprises. Table 3-2 summarizes the results of the post farm-level budget analysis.

Table 3-2: Summary Estimates (in naira) of Post-farm-Level Financial Budget Indicators for Gari Production, by Technology Combinations: Nigeria, 1989/91

Technologies Combinations	Returns to Family Labor Per Ha	Returns to Family Labor Per Person-day	Total System Production Costs	Average Costs of Production Per Kg of Gari	Net Enterprise Profits
Impmech	2310	33	14120	2.96	840
Locmech	1127	20	8761	3.15	-28
Locman	1003	17	8891	3.23	-257
Impman	1094	13	15650	3.28	-691

Source: tables A3-3 through A3-6 in Appendix 3.

Results in table 3-2 show that only cassava/maize systems under the "*Impmech*" technology combination had a positive net enterprise profits (NEP). These results also show that mechanized processing methods have a definite cost-saving advantage over traditional processing methods. The "*Impmech*" technology combination has the lowest cost of production per kilogram of *gari* (2.97 nairas) followed by the "*Locmech*" technology combination (3.15nairas). This implies that farmers have incentives to adopt that technology combination. These findings are consistent with farmers' incentives behavior. In fact, COSCA data for Nigeria show that in the 65 villages representing cassava-growing areas, 56 percent of farmers grow the improved varieties. Of these farmers, 54 percent used mechanized processing method to produce *gari*.

However, it should be noted that the negative NEPs observed under the other technology combinations do not mean that farmers are losing money. Rather, they mean that the net margin is not enough to yield a positive return to the management factor when the costs of other factors are taken into account. In fact, the postfarm level financial

budgets presented in tables A3-3 through A3-6 in appendix 3 show that all the NEPs, assuming zero opportunity cost of labor, are positive.

This situation reflects the segmentation of the rural labor market for cassava farming systems in Nigeria. Women manage a very important part of cassava production systems: 1) they predominate in cassava processing and *gari* preparation and, 2) they devote a large amounts of time in obtaining the fuel and water required to make cassava processed products ready for sale or home consumption. Yet this analysis suggests that returns to women from these activities are below the rural wage rate, which is available mainly to men.

3.3.2. Economic Profitability Analysis

Two cassava root production technologies (IITA's improved variety and local landraces) were analyzed, with alternative combinations of *gari* (a cassava product) production with mechanized processing method or with manual processing method. This gives the four alternative production and processing technologies defined earlier. The COSCA data indicate that about 79 percent of farmers who produce *gari* are net sellers; therefore, this analysis focuses only on commercial cassava/maize systems.

The farm level economic returns were calculated using import parity prices (tables A3-7 and A3-8 in appendix 3) of cassava roots and financial prices of green maize at selected regional markets, Abeokuta and Onitsha. These two markets were selected because they are located in regions where farmers ranked cassava as the most important crop in the farming system (Nweke *et al.*, 1996).

The economic budgets are presented in tables A3-10, A3-12, A3-14 and A3-16 in Appendix 3. The tables show the returns to root (not *gari*) and maize production

assuming root was valued at the import parity price for each technology, as calculated in tables A3-7 and A3-8 in Appendix 3.

The estimation of the economic budgets required the following assumptions: 1) it is assumed that green maize is nontraded and that its price is not affected by government policies. Therefore, its financial price (the observed market price) reflects its shadow price; 2) *gari*, the main cassava product in Nigeria, is not traded internationally, but tapioca, another cassava product and the closest substitute of *gari*, is traded internationally. Consequently, the price of imported tapioca was used to estimate the import parity of cassava root; and 3) the official exchange rate (17 nairas for $1US) was adjusted to reflect its equilibrium value, by using a premium of 30% (Stryker, 1990). Table 3-3 summarizes the results of the economic analysis for commercial farmers.

Table 3-3: Summary Estimates (in nairas) of Farm-Level Economic Budget Indicators For Commercial Cassava/Maize Production Systems at Each Regional Output Market, by Production and Processing Technology Combinations, Nigeria: 1989/1991

Regional Markets/ Technology Combinations		Returns to Family Labor Per Ha	Returns to Family Labor Per Person-day	Total System Production Costs Per Ha	Net Social Profits Per Ha
Abeokuta	*Impmech*	10137	57	17473	6378
	Locmech	6666	52	14845	3978
	Locman	5174	40	14845	2486
	Impman	2470	14	17473	-1289
Onitsha					
	Impmech	18877	104	17225	15055
	Locmech	11088	67	15898	7602
	Locman	9239	56	15898	5753
	Impman	8627	47	17225	4805

Source: tables A3-10, A3-12, A3-14 and A3-16 in the appendix.

At this point it is important to make clear what is going on. Although these are returns to roots (not *gari*) production, the economic price of roots depends on the import parity price of tapioca and the assumed processing technology. The more efficient processing is assumed to bid up the price of the root, as more processed product (represented by tapioca) can be obtained from each kilogram of roots.

As the results from table 3-3 indicate, cassava/maize systems in Nigeria have positive net social profits (NSP) under each type of technology combination except for the "*Impman*" technology combination. The net social profit refers to the difference, valued in border and shadow prices, between the gross value of output and the total costs of all inputs (traded and nontraded intermediary and primary inputs). This implies that, from society's point of view, it pays to expand cassava/maize systems only under three technology combinations: "*Impmech*", "*Locmech*" and "*Locman*". However, the systems under the "*Impmech*" technology combination are the most efficient use of national resources. They generate significantly higher NSPs at both regional output markets (6,378 nairas in Abeokuta and 15,055 nairas in Onitsha). A more efficient use of resources means that one can produce more from what one has and attain a higher level of welfare

It should be noted that the results from table 3-3 are calculated using the weighted average of peak-season and off-peak season wage rate across cassava production zones. The off-peak season rate is half of the peak-season rate.

Overall, the rankings of technology combinations in order of decreasing profitability are as follows: "*Impmech*", "*Locmech*", "*Locman*" and "*Impman*". This

difference in the ranking order can be explained by the average processing cost used in the estimation of the import parity prices (tables A3-7 and A3-8 in appendix 3).

. Measures of NSP, like DRC, may give an idea of the comparative advantage in the agricultural commodity system. Thus NSP measures are very informative for decision-makers and allocators of research funds, if the technical changes they might introduce would attempt to break labor or other constraints in cassava/maize systems.

It should be noted that all technology combinations (except "*impman*" at the Abeokuta market) are more profitable financially than they are socially. That is, there are net transfers to farmers (see tables A3-1, A3-2 and A3-10 through A3-16 in appendix 3). The subsequent PAM analysis will help illustrate the sources of these transfers.

3.3.3.Policy Matrix Analysis

By completing a PAM for a production system, one can simultaneously determine the economic efficiency of the system, the degree of distortions on the input /output markets, and the extent to which resources are transferred among agents (Yao, 1997). First, the PAM was constructed using the information on costs and returns obtained from the financial and economic analyses. Second, the extent of policy-induced transfers was computed. Third, six PAM policy-parameters were derived for policy analysis. They are: the Domestic Resource Cost (DRC), the Nominal Protection Coefficient on Tradable Output (NPCO), the Nominal Protection Coefficient on Tradable Input (NPCI), the Effective Protection Coefficient (EPC), the Profitability Coefficient (PC), and the Subsidy to Producers (SP)[1].

[1] DRC= domestic factors in social prices/ (revenues in social prices – tradable inputs in social prices), NPCO = revenues in private prices / revenues in social prices, NPCI= tradable inputs in private prices/ tradable inputs in social prices, EPC= (revenues in private prices –tradable inputs in private prices)/ (revenues in social prices –tradable inputs in social prices), PC= private profits/ social profits, SP= (private profits- social profits)/ revenues in social prices.

3.3.3.1.Baseline Results

The PAM of cassava/maize production systems under each technology combination are presented in table A3-17 of Appendix 3. The policy-induced transfers (in the output and input markets) are summarized in table 3-4 below.

Table 3-4: Summary of the Net Effects (in nairas) of Policy-Induced Transfers For Commercial Cassava/Maize Systems in Nigeria: 1989/1991.

Markets/Technology Combinations	Output Transfers	Tradable Inputs Transfers	Domestic Factors Transfers	Net Policy Transfers
Abeokuta				
Impmech	2614	-500	-40	3154
Locmech	2630	-355	-28	3013
Locman	4121	-355	-28	4505
Impman	10282	-500	-40	10822
Onitsha				
Impmech	-6362	-470	-38	-5855
Locmech	-2367	-340	-27	-2000
Locman	-518	-340	-27	-151
Impman	3888	-500	-38	4396

Source: table A3-17 in Appendix 3.

Results from table 3-4 show the following: first, tradable inputs and domestic factors transfers are negative everywhere, suggesting that, through an overvalued exchange rate, the government provided some subsidies on all sales of inputs, whether they were imported or supplied domestically. Second, output transfers are positive under all the technology combinations when outputs are sold in Abeokuta. On the other hand, outputs transfers for the Onitsha market are all negative except for the "*Impman*" technology combination.

This is the result of farm-gate financial prices (0.57 nairas) for cassava root departing from the estimated import parity prices under each technology (tables A3-7 and

A3-8 in the appendix) depending on whether Abeokuta or Onitsha is used as the point of sale.

It should be emphasized that these differentials are relatively small. With this in mind, here are some plausible explanations of why market (financial) prices and economic prices (import parity prices) did not equal in both markets. The divergences between these two prices could be due to a combination of the effect of the ban on cereals import and the effect of the overvaluation of the naira. The indirect effect of the ban on cereals import will be an increase in the financial price of cassava root relative to the economic price in the two markets (Abekuta and Onitsha). On the other hand, the naira overvaluation will have the effect of lowering the financial price of tradables such as roots and transport in both markets.

However, the magnitude of the reduction in prices will be large in Onitsha and small in Abeokuta because the share of transport costs in the import parity price is relatively large for Onitsha (distant from the port city) and relatively small for Abeokuta (close to the port city). Transportation costs thus provide a natural protection to domestic producers who supply markets located far from the import point.

Thus, the net effect is as follows: 1) in Onitsha: an increase in the financial price of roots due to the import tariff and a relatively large decrease in the financial price of roots due to the currency overvaluation (via its impact on tradable goods such as cassava and transport costs); and 2) in Abeokuta: an increase in the financial price of roots due to the import tariff and a relatively small decrease in the financial price of roots due to the currency overvaluation.

This result indicates that: 1) cassava/maize farmers selling their product in Abeokuta enjoyed a subsidy; and 2) cassava/maize systems around the Onitsha market, except for systems under "*Impman*" technology combination, suffered a tax. Third, while net policy transfers are positive at the Abeokuta market, they are negative at the Onitsha market except for systems under the "*Impman*" combination. This suggests that when outputs and inputs were valued at their social (efficiency) prices, the effect of government price policy was: 1) some support to cassava/maize systems under each technology combination at the Abeokuta market. That is, the actual policy was a trade-restrictive policy that had an effect equivalent to that of an import tariff of of 11 to 64 percent as indicated by NPCO values in table 3-5. As mentioned earlier, the observed price for roots is higher than its shadow prices under different technology combinations when Abeokuta is the regional market. This difference in prices serves as an implicit tariff to reallocate resources in the economy. That is, consumers reduce their consumption of the commodity, production expands in response to the higher domestic price, consumers transfer parts of their surplus to producers; and 2) some tax on systems at the Onitsha market, except for systems under "*Impman*" combination. It is worth noting that the largest tax on producers occurs under the "*Impmech*" combination. In other words, this reflects the impact of the overvalued exchange rate, which taxes farmers in proportion to what they sell. Comparisons between commodity systems under alternative technologies are also possible through policy-impact ratios, which cancel all units of measure. These ratios are presented in the table 3-5 below.

Table 3-5: Ratio Indicators for *Commercial* Cassava/Maize Production Systems Under alternative production and processing combinations and by Distance in Nigeria, 1989-1991.

Mkts/Tech. Comb.	DRC	NPCO	NPCI	EPC	PC	SP
Abeokuta						
Impmech	0.71	1.11	0.77	1.14	1.49	0.13
Locmech	0.77	1.14	0.77	1.17	1.76	0.16
Locman	0.84	1.24	0.77	1.28	2.81	0.26
Impman	1.09	1.64	0.77	1.77	-7.39	0.67
Onitsha						
Impmech	0.50	0.80	0.77	0.80	0.61	-0.81
Locmech	0.65	0.90	0.77	0.91	0.74	-0.09
Locman	0.71	0.98	0.77	0.99	0.97	-0.01
Impman	0.76	1.18	0.77	1.22	1.91	0.20

Source: PAM Model constructed by the author

Note: **DRC**= Domestic Resource Cost, **NPCO**= Nominal Protection Coefficient on Tradable Output, **NPCI**= Nominal Protection Coefficient on Tradable Input, **EPC**= Effective Protection Coefficient, **PC**= Profitability Coefficient and **SP**= Subsidy to Producers

The domestic resource cost ratio (DRC) assesses social returns to domestic factors, and is the social cost of domestic resources required to produce a unit of value added to tradable goods and services. The DRC ratio indicates the efficiency of a domestic production as an export or as an import substitute. The computed values for the DRC ratios are consistent with the results of the net social profit (NSP) analysis. Even though cassava/maize production systems under the technology combinations "*Impmech*", "*Locmech*" and "*Locman*" all have a domestic cost ratio (DRC) less than unity, systems under "*Impmech*" have a clear comparative advantage over those under the other two technology combinations.

The results discussed above are based on output prices in specific markets; however, shadow prices vary (figures A3-1 and A3-2 in Appendix 3), depending on the point of sale. As figures 3-1 and 3-2 below demonstrate, the corresponding DRC ratios vary also over space. These figures indicate the following: 1) if the regional market is

Abeokuta, cassava/maize systems under technology combinations "*Impmech*", "*Locmech*", "*Locman*" and "*Impman*" are not competitive beyond 220 kilometers, 176 kilometers, 174 kilometers and 112 kilometers respectively, from Abeokuta; 2) if the output market is Onitsha, cassava/maize systems under technology combinations "*Impmech*", "*Locmech*", "*Locman*" and "*Impman*" are not competitive beyond 525 kilometers, 476 kilometers, 425 kilometers and 300 kilometers respectively, from Onitsha. These results imply that for cassava systems around Abeokuta, only local expansion may be socially profitable for sale in Abeokuta.

Figure 3-1: DRC Ratios Over Space for Commercial Cassava Root Production Systems under Alternative Technology Combinations - *Abeokuta is the Regional Output Market*, Nigeria:1989/1991

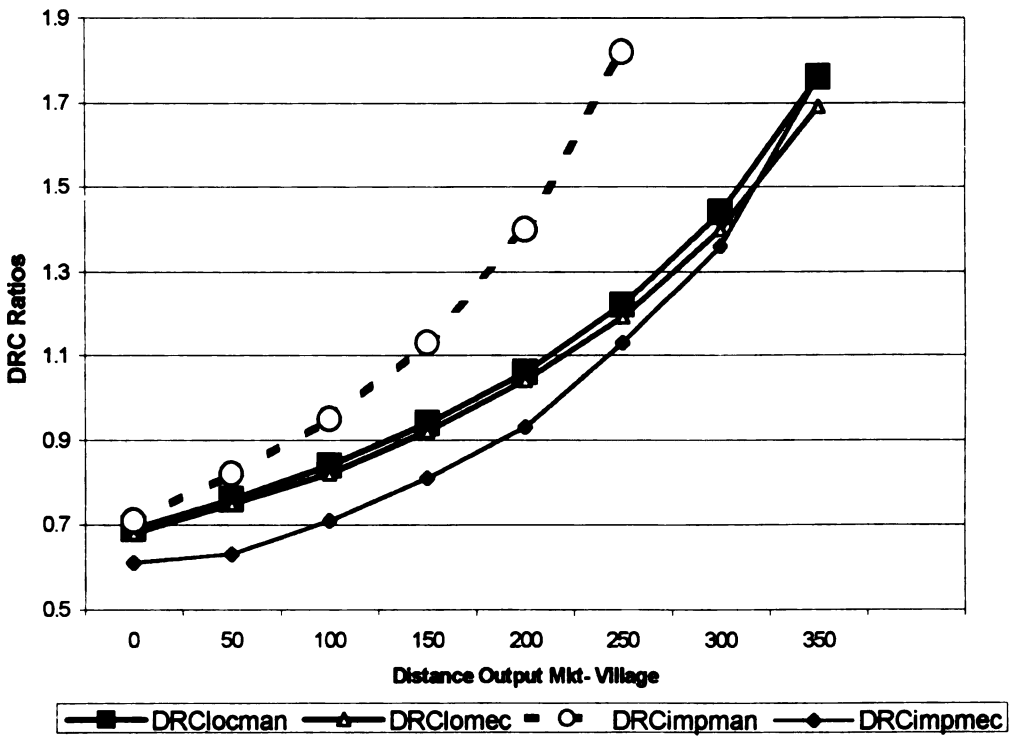
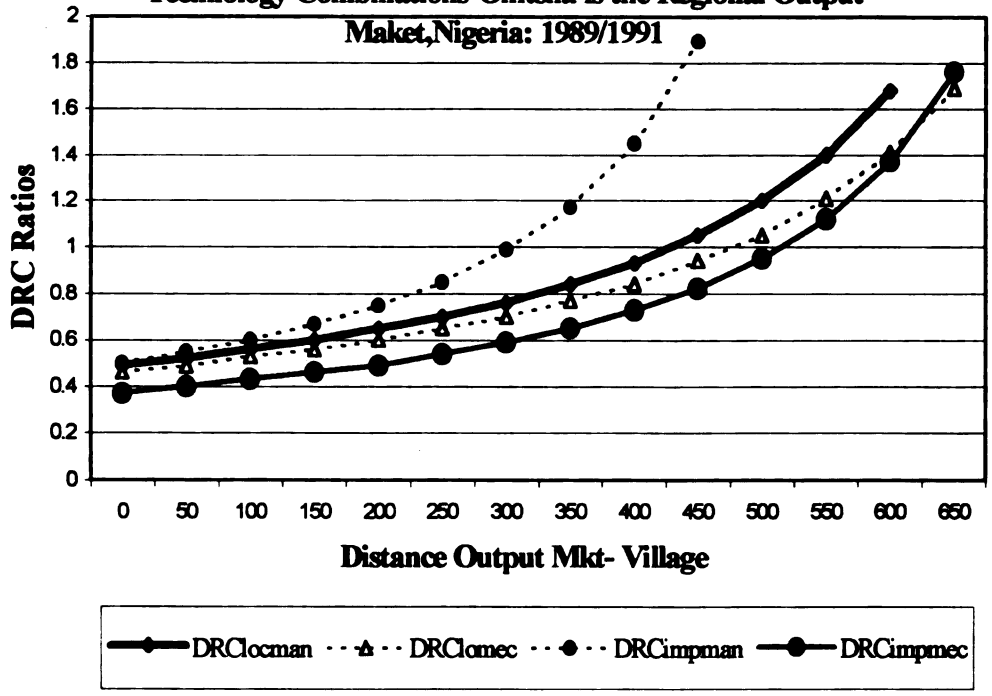


Figure 3-2: DRC Ratios Over Space for Commercial Cassava Root Production Systems Under Alternative Production-Processing Technology Combinations-Onitsha is the Regional Output Maket,Nigeria: 1989/1991



The nominal protection coefficient in the output/input markets (NPCO/NPCI) is a summary measure of incentives provided by government policy on outputs or inputs respectively. The computed NPCOs indicate that, in general, commercial farmers operating in the Abeokuta market have enjoyed a private price 12 to 40 percent higher than they would have received without government protection policy. On the other hand, at the Onitsha market, the NPCOs are less than unity, except for cassava/maize systems under the technology combination "*Impman*", implying that government policy is to some extent discriminating against farmers operating in that market. Computed NPCIs are lower than unity everywhere, suggesting that government policy has permitted input costs to be lower than they would be under open trade.

The effective protection coefficient (EPC) best measures the combined effects discussed earlier. The computed EPCs support the conclusions of the NPCO/NPCI analysis above. The other ratios shown in table 3-5 are the profitability coefficient (PC) ratio and the subsidy to producers (SP) ratio. The PC ratio shows the extent to which net transfers have caused private profits to exceed social profits, while the SP ratio shows the level of transfers from divergences as a proportion of the production system's social revenues (Monke and Pearson, 1989). The computed values of these two ratios lie between –7.39 and 2.81 for the PC ratios at both markets, whereas the computed values of SP ratios lie between 0.13 and 0.67 at the Abeokuta market and between -0.81 and 0.20 at the Onitsha market. These results indicate that overall, policy transfers have resulted in private profit exceeding social profits by 1.49 to 2.81 times for technology combinations "*Impmech*", "*Locmech*", "*Locman*" in Abeokuta.

3.3.3.2. Sensitivity Analysis

The sensitivity analysis carried out in this sub-section aims to test the robustness of the results under the "baseline" scenario. The simulation considers the effects of change in the shadow exchange rate.

Shadow Exchange Rates. In December 1985, the Nigerian government banned the importation of various foods such as wheat, rice and maize. At the time, the government put a ban on the export of certain foods, essentially yam and cassava products, which have alternative markets in neighboring West African countries (Nweke, 1999). The overall impact of such widespread protection is to create an overvalued exchange rate. In fact, in the late 1990's, the Nigerian government accepted to administer the Nigerian naira through the auction mechanism. From 1989 to 1991, the shadow exchange rate was

22 nairas for one US dollar. Since 1991, the shadow exchange rate has declined by 286 percent. This led to its devaluation in 1995 when one US dollar was worth 85 nairas.

The sensitivity analysis undertaken here is designed to examine the impact of the appreciation of the real exchange rate on net social profitabilities (NSP) and selected policy parameters (DRC and EPC) ratios. The import parity prices were recalculated using the post-devaluation exchange rate of 85 nairas to one US dollar, assumed to approximate the new equilibrium exchange rate. Furthermore, COSCA data collected in 1995 indicate that market prices changed with devaluation. The market price of roots rose to 1.72 nairas from 0.57 nairas in 1991. In addition, rural wages increased from 21 nairas to 200 nairas. It should be noted that these changes reflect overall inflation, which in turn affects the exchange rate. The post-devaluation market prices were used in carrying this analysis. Tables 3-6 and 3-7 present the results.

Table 3-6: Effects of a 286 % Change in the Shadow Exchange Rate on the Net Social Profit (NSP).

Market/Technologies		Baseline	Simulation	Profit Elasticity
Abeokuta	*Impmech*	6378	43306	2.02
	Locmech	3978	14017	0.88
	Locman	2486	1568	N.A
	Impman	-1289	943	N.A
Onitsha	*Impmech*	15055	49811	0.80
	Locmech	7602	18329	0.49
	Locman	5753	1670	N.A
	Impman	4805	-1399	N.A

Note: The profit elasticity is computed as follows: percentage changes in NSP/percentage change in exchange rate. It should be interpreted in absolute terms.

Table 3-7: Effects of a 286 % Change in the Shadow Exchange Rate on Selected Policy Parameters

Mkts/Techno. Combinations	Policy Impact Parameters					
	DRC Ratio			**EPC Ratio**		
Abeokuta	Baseline	% Change	Simulation	Baseline	% Change	Simulation
Impmech	0.71	-13	0.62	1.14	-59	0.47
Locmech	0.77	6	0.82	1.17	-51	0.57
Locman	0.84	17	0.98	1.28	-50	0.64
Impman	1.09	-10	0.98	1.77	-38	1.09
Onitsha						
Impmech	0.50	16	0.58	1.80	-76	0.43
Locmech	0.65	18	0.77	0.91	-45	0.50
Locman	0.71	37	0.97	0.99	-36	0.63
Impman	0.76	34	1.02	1.22	-70	0.36

The results from table 3-6 show that the 286 percent decline in the shadow exchange rate would increase substantially the social profitabilities especially of technology combinations "*Impmech*" and "*Locmech*" at the Abeokuta market. Clearly, increased tradable input costs at that market do little to decrease the benefits from the decline in the shadow exchange rate because such costs are a small proportion of total inputs costs. On the other hand, the decline in the equilibrium exchange rate has caused cassava/maize systems under "*Impman*" to become economically unprofitable at the Onitsha market. This is due to the fact that these are returns to roots (not *gari*) production, but the economic price of roots depends on the import parity price of tapioca and the assumed processing technology. The more efficient processing technology (the mechanized method) is assumed to bid up the price of the root, as more processed product (represented by tapioca) can be obtained from each kilogram of roots.

Results from table 3-7 indicate the following: First, at the Abeokuta market, the effective protection coefficients (EPC) for all technology combinations except "*Impman*" have become less than unity. This suggests that with the appreciation of the real exchange rate, farmers are receiving negative protection. That is, they could have received higher return if they faced border prices instead of domestic prices on both outputs and inputs. Second, the naira devaluation has not altered the ranking (in terms of comparative advantage) of the technology combinations at the Abeokuta market; however, it has caused the "*Impman*" technology to lose its comparative advantage at the Onitsha market. However, simulation should be interpreted as short-term changes in incentives.

3.4 Conclusions

The methodology used in this study is the policy analysis matrix (PAM). The purpose of the study was to evaluate the social profitability of cassava/maize systems, under alternative production and processing technology combinations, in Nigeria. The baseline results show that profitabilities of systems under "*Impmech*" technology exceed those of systems under other alternative technologies, namely "*Locmech*", "*Locman*" and "*Impman*".

The PAM analysis is a static partial equilibrium analysis (Nelson and Paggabean.1991); therefore, a sensitivity analysis carried out. The simulation results indicate the following: a 286 percent decline in the shadow exchange rate increases significantly the profitabilities of cassava/maize systems under the technology combinations "*Impmech*", and "*Locmech*", suggesting that the large growth in profitability should encourage use of improved inputs especially at the post farm level.

The financial incentives (at farm-level and post-farm level) for cassava/maize systems under the "*Impmech*" technology combination suggest that one reason so many farmers have adopted the new technology package is because it is profitable (return to family labor for *Impmech* is almost triple of that of *Impman*). COSCA data indicate that in Nigeria, most farmers are not only growing the IITA variety but also using mechanical grating at the processing stage. The results also clearly show the higher economic profits generated by the new IITA cassava variety in combination with mechanical processing technology.

REFERENCES

Adesina, A.A. and Coulibaly O. N., Policy and Competitiveness of agroforestry-based technologies for maize production in Cameroon: An application of policy analysis matrix, *Agricultural Economics*, 19:1-113,1998

Byerlee Derek and Heisey Paul. 1993. "Strategies for Technical Change in Small-Farm Agriculture, with Particular Reference to Sub-Saharan Africa" in Russell Nathan C. and Christopher R.Dowswell, *Policy Options For Agricultural Development in Sub-Saharan Africa*, CASIN/SAA/GLOBAL 2000.

IMF, 1989-1992. Various issues.

Jones, W.O., *Manioc in Africa*, Stanford University Press, Stanford, 1959.

Monke, E.A. and S. Pearson. 1989. *The Policy Analysis Matrix for Agricultural Development.* Baltimore: John Hopkins University Press.

Myint, H., (1979), Exports and Economic Development of Less Developed Countries in *Economic Growth and Resources*, vol. 4, edited by Irma Adelman.

Nwajiuba, C.U., Socioeconomic Impact of Cassava Postharvest Technologies on Smallholders in Southeastern Nigeria, *Farming Systems and Resource Economics in the Tropics*, Vol 20, 1995.

Nelson, G C and Panggabean, M (1991), The costs of Indonesian sugar policy: a policy analysis matrix approach, *American Journal of Agricultural Economics*, 73 (3) pp 703-712.

Nigerian Port Authority Statistical Reports, 1989- 1992, Various issues.

Nweke, F.I., Processing Potential for Cassava Production Growth in Africa, *Working Paper No. 11*, The Collaborative Study of Cassava in Africa, 1994.

Nweke, Felix I., B.O. Ugwu, C.L.A. Asadu, and P. Ay., Production costs in the yam-based cropping systems of southeastern Nigeria, *RCMP Research Monograph No. 6.*, Resource and Crop Management Program, International Institute of Tropical Agriculture (IITA), Ibadan, 1991.

Nweke, Felix I., B.O. Ugwu, and A.G.O. Dixon., Spread and performance of improved cassava varieties in Nigeria. *COSCA Working Paper No. 15.*, The Collaborative Study of Cassava in Africa, IITA, Ibadan, Nigeria. 1996.
Stryker J. Dirck, " Trade, Exchange Rate, and Agricultural Pricing Policies in Ghana," *World Bank Comparative Studies*, 1990.

Yao, Shujie, 1997. "Rice Production in Thailand Seen Through a Policy Analysis Matrix". *Food Policy*, 22(6):547-560.

APPENDIX 3

Table A3-1: Estimated Average Financial Budget for Cassava/Maize Systems *For Improved landraces* in Nigeria: 1989/1991

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)		
♦ Land Clearing	28	22
♦ Seedbed Preparation	23	21
♦ Weeding	23	18
♦ Planting		
Cassava	19	16
Maize	15	0
♦ Harvesting		
Cassava	41	31
Maize	23	0
Total	172	108
2. OUTPUTS	19210	
Average Root Yield (kg/ha)	9614	
Average Maize Yield (ears/ha)[1]	0.57	
Market Price of Root (nairas/kg)[2]	1.5	
Market Price of Green Maize (nairas/ears)[3]	14421	
Revenues from Green Maize (nairas/ha)	10950	
Revenues from Cassava Roots (nairas/ha)	25371	
Gross Revenues (nairas/ha)		
3. COSTS	0	
Fixed Costs (nairas/ha)[4]		
Operating costs (nairas/ha)	2268	
Hired Labor	1790	
Transportation field-to-home (nairas)	325	
Interest on Working Capital (8%)	4383	
Total Operating Costs (nairas/ha)	3612	
Family Labor (valued @ hired labor wage rate)	8362	
Opportunity Cost of land (nairas)		
4. PERFORMANCE MEASURES		
Gross Margin (nairas/ha)	20988	
Net Returns to family Labor (nairas/ha)	12626	
Net Returns per day of Family Labor (nairas/day)	73	
Total System Production Costs (nairas/ha)	16357	
Net Enterprise Profits (nairas/ha)	9014	

Source: COSCA survey data

[1] Estimated using the "Ear Weight Method" discussed in the appendix of chapter 2. In West Africa, maize, which has a short cycle, is harvested before cassava establishes. Hence competition between maize and cassava is minimized, while sole plant density is maintained for both crops. (COSCA Working Paper No.10, page 84)

[2] Weighted average farmgate price based on COSCA data

[3] Farmgate price based on secondary source of information (personal communication with IITA)

[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3 percent of harvest are saved for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

Table A3-2: Estimated Average Financial Budget for Cassava/Maize Systems *For Local Landraces,* Nigeria: 1989/1991

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)		
♦ Land Clearing	28	22
♦ Seedbed Preparation	23	21
♦ Weeding	23	18
♦ Planting		
Cassava	19	16
Maize	15	0
♦ Harvesting		
Cassava	30	22
Maize	23	0
Total	161	99
2. OUTPUTS	11215	
Average Root Yield (kg/ha)	9614	
Average Maize Yield (ears/ha)[1]	0.57	
Market Price of Root (nairas/kg)[2]	1.5	
Market Price of Green Maize (nairas/ears)[3]	14421	
Revenues from Green Maize (nairas/ha)	6393	
Revenues from Cassava Roots (nairas/ha)	20814	
Gross Revenues (nairas/ha)		
3. COSTS	0	
Fixed Costs (nairas/ha)[4]		
Operating costs (nairas/ha)	2079	
Hired Labor	1271	
Transportation (nairas)	268	
Interest on Working Capital (8%)	3618	
Total Operating Costs (nairas/ha)	3381	
Family Labor (valued @ hired labor wage rate)	8362	
Opportunity Cost of land (nairas)		
4. PERFORMANCE MEASURES		
Gross Margin (nairas/ha)	17196	
Net Returns to family Labor (nairas/ha)	8834	
Net Returns per day of Family Labor (nairas/day)	55	
Total System Production Costs (nairas/ha)	15361	
Net Enterprise Profits (nairas/ha)	5453	

Source: COSCA survey data

[1] Estimated using the "Ear Weight Method" discussed in the appendix 2 of chapter 2. In West Africa, maize, which has a short cycle, is harvested before cassava establishes. Hence competition between maize and cassava is minimized, while sole plant density is maintained for both crops. (COSCA Working Paper No.10, page 84)

[2] Weighted average farmgate price based on COSCA data

[3] Farmgate price based on secondary source of information (personal communication with IITA)

[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3 percent of harvest is used for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

Table A3-3: Estimated Average Financial Budget per hectare for *Gari* Production under Technology Combination "IMPMECH"[1], Nigeria, 1989/1991, *assuming 80% of root production goes into gari production*

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)[2]	70	12
Raw Material (kgs of roots)[3]	15368	
2. OUTPUTS		
Transformation Rate	0.31	
Kilograms of Processed Output per ha	4764	
Village Market Price of Processed Output (nairas/kg)[4]	3.14	
Gross Revenues (nairas/ha)	14959	
3. COSTS		
Fixed Costs (nairas/ha)[5]	0	
Operating costs (nairas/ha)		
Hired Labor and grating fees	450	
Raw material[6]	8760	
Bagging Materials	398	
Firewood	986	
Transportation [7]	1119	
Interest on Working Capital (8%)	937	
Total Operating Costs (nairas/ha)	12650	
Family Labor (valued @ hired labor wage rate) (nairas/ha)	1470	
4. PERFORMANCE MEASURES		
Gross Margin (nairas/ha)	2310	
Net Returns to family Labor (nairas/ha)	2310	
Net Returns per day of Family Labor (nairas/day)	33	
Total production Costs (nairas/ha)	14120	
Net Enterprise Profits (nairas/ha)	840	
Production Costs per Kg of gari (nairas/kg)	2.96	

Source: COSCA data

[1] Improved variety and mechanical processing

[2] This item includes labor for manual activities (washing, cleaning and roasting) as well as labor for mechanical processing operations such as grating.

[3] This represents 80% of the average root yield per hectare (see page 128 in COSCA Working Paper No.20)

[4] Weighted average village market price estimated from COSCA data

[5] Inputs used in the production process are external to the household. For example, cassava grating machines were available to individual farmers on custom basis (COSCA Working Paper No.14, page 15)

[6] Valued at its opportunity cost, which is the weighted average farmgate price computed from the COSCA data.

[7] This item includes home-to-market transportation costs only

Table A3-4: Estimated Average Financial Budget per hectare for *Gari* Production under Technology Combination "LOCMECH"[1], Nigeria, 1989/1991, *assuming 80% of root production goes into gari production.*

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)[2]	55	7
Raw Material (kgs of roots)[3]	8972	
2. OUTPUTS		
Transformation Rate	0.31	
Kilograms of Processed Output per ha	2781	
Village Market Price of Processed Output (nairas/kg)[4]	3.14	
Gross Revenues (nairas/ha)	8733	
3. COSTS		
Fixed Costs (nairas/ha)[5]	0	
Operating costs (nairas/ha)		
Hired Labor (person-days and grating fees)	242	
Raw material[6]	5114	
Bagging Materials	259	
Firewood	676	
Transportation[7]	752	
Interest on Working Capital (8%)	563	
Total Operating Costs (nairas/ha)	7606	
Family Labor (valued @ hired labor wage rate) (nairas/ha)	1155	
4. PERFORMANCE MEASURES		
Gross Margin (nairas/ha)	1127	
Net Returns to family Labor (nairas/ha)	112720	
Net Returns per day of Family Labor (nairas/day)	20	
Total production Costs (nairas/ha)	8761	
Net Enterprise Profits (nairas/ha)	-28	
Production Costs per Kg of gari (nairas/kg)	3.15	

Source: COSCA data

[1] Local variety and mechanical processing

[2] This item includes labor for manual activities (washing, cleaning and roasting) as well as fees for mechanical processing operations such as grating.

[3] This represents 80% of the average root yield per hectare (see page 128 in COSCA Working Paper No.20)

[4] Weighted average village market price estimated from COSCA data

[5] Inputs used in the production process are external to the household. For example, cassava grating machines were available to individual farmers on custom basis (COSCA Working Paper No.14, page 15)

[6] Valued at its opportunity cost, which is the weighted average farmgate price computed from the COSCA data.

[7] This item includes home-to-market transportation costs only.

Table A3-5: Estimated Average Financial Budget per hectare for *Gari* Production under Technology Combination "LOCMAN"[1], Nigeria, 1989/1991, *assuming 80% root production goes into gari production.*

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)[2]	60	17
Raw Material (kgs of roots)[3]	8972	
2. OUTPUTS		
Transformation Rate	0.31	
Kilograms of Processed Output per ha	2781	
Village Market Price of Processed Output (nairas/kg)[4]	3.14	
Gross Revenues (nairas/ha)	8733	
3. COSTS		
Fixed Costs (nairas/ha)[5]	0	
Operating costs (nairas/ha)		
Hired Labor (person-days)	357	
Raw material[6]	5114	
Bagging Materials	259	
Firewood	676	
Transportation[7]	752	
Interest on Working Capital (8%)	573	
Total Operating Costs (nairas/ha)	7731	
Family Labor (valued @ hired labor wage rate) (nairas/ha)	1260	
4.PERFORMANCE MEASURES		
Gross Margin (nairas/ha)	1003	
Net Returns to family Labor (nairas/ha)	1003	
Net Returns per day of Family Labor (nairas/day)	17	
Total production Costs (nairas/ha)	8891	
Net Enterprise Profits (nairas/ha)	-257	
Production Costs per Kg of gari (nairas/kg)	3.23	

Source: COSCA data

[1] Local variety and manual Processing
[2] This item includes labor for washing, cleaning, grating, pressing sieving and roasting.
[3] This represents 80% of the average root yield per hectare (see page 128 in COSCA Working Paper No.20)
[4] Weighted average village market price estimated from COSCA data
[5] No mechanical equipment was used in any processing activity. Grating was done manually (COSCA Working Paper No.14, page 15)
[6] Valued at its opportunity cost, which is the weighted average farmgate, price computed from the COSCA data.
[7] This item includes home-to-market transportation costs only.

TableA3-6: Estimated Average Financial Budget per hectare for *Gari* Production under Technology Combination "IMPMAN"[1], Nigeria, 1989/1991, *assuming 80% of root production goes into gari production.*

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)[2]	85	75
Raw Material (kgs of roots)[3]	15368	
2. OUTPUTS		
Transformation Rate	0.31	
Kilograms of Processed Output per ha	4764	
Village Market Price of Processed Output (nairas/kg)[4]	3.14	
Gross Revenues (nairas/ha)	14959	
3. COSTS		
Fixed Costs (nairas/ha)[5]	0	
Operating costs (nairas/ha)		
Hired Labor (person-days)	1575	
Raw material [6]	8760	
Bagging Materials	398	
Firewood	986	
Transportation[7]	1119	
Interest on Working Capital (8%)	1027	
Total Operating Costs (nairas/ha)	13865	
Family Labor (valued @ hired labor wage rate) (nairas/ha)	1785	
4. PERFORMANCE MEASURES		
Gross Margin (nairas/ha)	1094	
Net Returns to family Labor (nairas/ha)	1094	
Net Returns per day of Family Labor (nairas/day)	13	
Total production Costs (nairas/ha)	15650	
Net Enterprise Profits (nairas/ha)	-691	
Production Costs per Kg of gari (nairas/kg)	3.28	

Source: COSCA data

[1] Improved variety and manual processing

[2] This item includes labor for washing, cleaning, grating, pressing, sieving and roasting.

[3] This represents 80% of the average root yield per hectare (see page 128 in COSCA Working Paper No.20)

[4] Weighted average village market price estimated from COSCA data

[5] No mechanical equipment was used in any processing activity. Grating was done manually (COSCA Working Paper No. 14, page15).

[6] Valued at its opportunity cost, which is the weighted average farmgate price computed from the COSCA data.

[7] This item includes field-to-home and home-to-market transportation costs

Table A3-7: Economic Import Parity Price of Cassava Root, by Alternative Technology Combinations. *For Sale in the Regional Output Market of Onitsha*, Nigeria: 1989/1991.

Items	*Regional Output Market* Onitsha			
	Impmech	***Locmech***	***Locman***	***Impman***
1. World Price (FOB-$US/mt tapioca)	221	221	221	221
2. Freight and insurance ($US/mt tapioca)	48	48	48	48
3. CIF, port in Lagos ($US/mt tapioca) (1+2)	269	269	269	269
4. Shadow Exchange rate (nairas / $US)	22	22	22	22
5. CIF price at the port in Lagos (3*4)	5950	5950	5950	5950
6. Domestic costs (nairas/mt tapioca)				
a. Port charges (nairas/mt tapioca)	95	95	95	95
b.Transit and Transport (nairas/mt tapioca)	206	206	206	206
c. Storage and Handling (nairas/mt tapioca)	203	203	203	203
7.Lagos gate price (5+ 6a.c)(nairas/mt tapioca)	6454	6454	6454	6454
8. Importer marketing margin (%)	5%	5%	5%	5%
9. Wholesale price in Lagos (7* (1+ 8))	6777	6777	6777	6777
10. Lagos to Regional Market Center				
a Distance (km)	420	420	420	420
b. Transport cost (nairas/mt tapioca)	1512	1512	1512	1512
c. Handling (nairas/mt tapioca)	114	114	114	114
11. Regional Market Center (Reference Price) Farmgate price(nairas/mt tapioca) (9 + 10a..c)	8403	8403	8403	8403
12. Wholesale marketing margin (%)	5%	5%	5%	5%
13. Wholesale price in Regional Market (nairas/mt tapioca) (11* (1+12))	8823	8823	8823	8823
14.Regional Market Center to Village				
a. Distance (kms)	97	97	97	97
b. Transport and Handling cost (nairas/mt tapioca)	497	497	497	497
15.Village gate price (nairas/mt tapioca)13-14b)	8326	8326	8326	8326
16. Semi-wholesale marketing margin (%)	5%	5%	5%	5%
17.Village Level Semi-wholesale price((1-16)*15)/1000	8	8	8	8
18.Transformation rate (kg tap./ kg of root)	.50	.50	.50	.50
19. Processing cost (nairas/kg of root)	3.09	3.21	3.36	3.60
20. Import Parity Price in the Village (nairas /kg of root) (17*18) -19	0.89	0.77	0.61	0.38

Source: COSCA data, UNCTAD's Review of Maritime Transport 1989-1992, Nigerian Port Authority Statistical Reports (1989-1992), UN Economic and Social Commission For Asia and the Pacific, Reports of 1989 through 1991.

Table A3-8: Economic Import Parity Price of Cassava Root, by Alternative Technology Combinations. *For Sale in the Regional Output Market of Abeokuta,* Nigeria: 1989/1991.

Items	*Regional Output Market*			
	Abeokuta			
	Impmech	*Locmech*	*Locman*	*Impman*
1. World Price (FOB-$US/mt tapioca)	221	221	221	221
2. Freight and insurance ($US/mt tapioca)	48	48	48	48
3. CIF, port in Lagos ($US/mt tapioca) (1+2)	269	269	269	269
4. Shadow Exchange rate (nairas / $US)	22	22	22	22
5. CIF price at the port in Lagos (nairas/mt tapioca) (3*4)	5950	5950	5950	5950
6. Domestic costs (nairas/mt tapioca)				
a. Port charges (nairas/mt tapioca)	95	95	95	95
b. Transit and Transport (nairas/mt tapioca)	206	206	206	206
c. Storage and Handling (nairas/mt tapioca)	203	203	203	203
7. Lagos gate price (5+ 6a...c) (nairas/mt tapioca)	6454	6454	6454	6454
8. Importer marketing margin (%)	5%	5%	5%	5%
9. Wholesale price in Lagos (7* (1+ 8))	6777	6777	6777	6777
10. Lagos to Regional Market Center				
a Distance (km)	80	80	80	80
b. Transport cost (nairas/mt tapioca)	288	288	288	288
c. Handling (nairas/mt tapioca)	114	114	114	114
11. Regional Market Center (Reference Price) Farmgate price (nairas/mt tapioca) (9 +10a..c)	7179	7179	7179	7179
12. Wholesale marketing margin (%)	5%	5%	5%	5%
13. Wholesale price in Regional Market (nairas/mt tapioca) (11* (1+12))	7538	7538	7538	7538
14. Regional Market Center to Village				
a. Distance (kms)	34	34	34	34
b. Transport and Handling cost (nairas/mt tapioca)	176	176	176	176
15. Village gate price (nairas/mt tapioca) (13-14b)	7362	7362	7362	7362
16. Semi-wholesale marketing margin (%)	5%	5%	5%	5%
17. Village Level Semi-wholesale price (1-16)*15)/1000	6.99	6.99	6.99	6.99
18.Transformation rate (kg of tap./ kg of root)	0.50	0.50	0.50	0.50
19. Processing cost (nairas/kg of root)	3.05	3.14	3.26	3.41
20. Import Parity Price in the Village (nairas /kg of root) (17*18) -19	0.45	0.36	0.24	0.08

Source: COSCA data, UNCTAD's Review of Maritime Transport 1989-1992, Nigerian Port Authority Statistical Reports 1989-1992, UN Economic and Social Commission For Asia and the Pacific, Reports of 1989 through 1991.

Table A3-9: Estimated Financial Budget for *Commercial* Cassava/Maize Systems under Technology Combination "IMPMECH"[1], by Regional Output Markets, Nigeria, 1989/1991

Budget Items	*Regional Output Markets*	
	Abeokuta	**Onitsha**
1. OUTPUTS		
Average Root Yield (kg/ha)	21131	20171
Average Green Maize Yield (ears/ha)[2]	9614	9614
Market Price of root (nairas/kg)[3]	0.57	0.57
Market Price of Green Maize (nairas/ear)[4]	1.5	1.5
Revenues from Root (nairas /ha)	12045	11497
Revenues from Green Maize (nairas /ha)	14421	14421
Gross Revenues (nairas /ha)	26466	25918
2. COSTS		
Fixed Costs (/ha)[5]	0	0
Operating costs (/ha)		
Hired Labor	2373	2205
Transportation (nairas)		
Tradable	1666	1594
Nontardable	417	399
Interest on Working Capital (8%)	356	336
Total Operating Costs (nairas /ha)	4812	4534
Family Labor (@ hired labor wage rate) (nairas /ha)	3759	3822
Opportunity Cost of Land (nairas/ha)	8362	8362
3. PERFORMANCE MEASURES		
Gross Margin (nairas /ha)	21653	21384
Net Returns to family Labor (nairas /ha)	13291	13022
Net Returns per day of Family Labor (nairas /day)	74	72
Total production Costs (nairas /ha)	16933	16718
Net Enterprise Profits (nairas /ha)	9532	9200

Source: COSCA survey data

[1] Improved variety and mechanical processing
[2] Estimated using the "Ear Weight Method" discussed in Appendix 2.
[3] Weighted average farmgate price based on COSCA data.
[4] Farmgate price based on secondary source of information (personal communication with IITA).
[5] Farmers did not purchase planting materials of food crops but produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3% of the previous harvest is saved for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

Table A3-10: Estimated Economic Budget for *Commercial* Cassava/Maize Systems under Technology Combination "IMPMECH"[1], by Regional Output Markets, Nigeria, 1989/1991

Budget Items	*Regional Output Markets*	
	Abeokuta	**Onitsha**
1. OUTPUTS		
Average Root Yield (kg/ha)	21131	20171
Average Green Maize Yield (ears/ha)[2]	9614	9614
Import Parity Price of root (nairas/kg)[3]	0.45	0.89
Market Price of Green Maize (nairas/ear)[4]	1.5	1.5
Revenues from Root (nairas /ha)	8816	17840
Revenues from Green Maize (nairas /ha)	14421	14421
Gross Revenues (nairas /ha)	23851	32281
2. COSTS		
Fixed Costs (/ha)[5]	0	0
Operating costs (/ha)		
Hired Labor[6]	2373	2205
Transportation (nairas)		
Tradable	2166	2064
Nontardable	417	399
Interest on Working Capital (8%)	396	373
Total Operating Costs (nairas /ha)	5352	5041
Family Labor (@ hired labor wage rate) (nairas /ha)	3759	3822
Opportunity Cost of Land[7] (nairas/ha)		8362
3.PERFORMANCE MEASURES		
Gross Margin (nairas /ha)	18499	27239
Net Returns to family Labor (nairas /ha)	10137	18877
Net Returns per day of Family Labor (nairas /day)	57	104
Total production Costs (nairas /ha)	17473	17225
Net Social Profits (nairas /ha)	6378	15055

Source: COSCA survey data

[1] Improved variety and mechanical processing
[2] Estimated using the "Ear Weight Method" discussed in Appendix 2.
[3] Estimated Farm Level Import Parity Price of root
[4] Farmgate price based on secondary source of information.
[5] Farmers did not purchase planting materials of food crops but produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3% of the previous harvest is saved for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[6] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[7] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A3-11: Estimated Financial Budget for Commercial Cassava/Maize Systems under Technology Combination "LOCMECH"[1], by Regional Output Markets, Nigeria, 1989/1991

Budget Items	*Regional Output Markets*	
	Abeokuta	**Onitsha**
1. OUTPUTS		
Average Root Yield (kg/ha)	12337	11776
Average Green Maize Yield (ears/ha)[2]	9614	9614
Market Price of root (nairas/kg)[3]	0.57	0.57
Market Price of Green Maize (nairas/ear)[4]	1.5	1.5
Revenues from Root (nairas /ha)	7032	6712
Revenues from Green Maize (nairas /ha)	14421	14421
Gross Revenues (nairas /ha)	21453	21133
2. COSTS		
Fixed Costs (nairas/ha)[5]	0	0
Operating costs (nairas/ha)		
Hired Labor	1680	1995
Transportation (nairas)		
Tradable	1183	1132
Nontradable	296	283
Interest on Working Capital (8%)	253	273
Total Operating Costs (nairas /ha)	3412	3683
Family Labor (@ hired labor wage rate) (nairas /ha)	2688	3486
Opportunity Cost of Land[6] (nairas/ha)	8362	8362
3. PERFORMANCE MEASURES		
Gross Margin (nairas /ha)	18041	17450
Net Returns to family Labor (nairas /ha)	9679	9088
Net Returns per day of Family Labor (nairas /day)	76	55
Total production Costs (nairas /ha)	14462	15531
Net Enterprise Profits (nairas /ha)	6991	5602

Source: COSCA survey data

[1] Local variety and mechanical processing
[2] Estimated using the "Ear Weight Method" discussed in Appendix 2 of chapter 2.
[3] Weighted average farmgate price based on COSCA data.
[4] Farmgate price based on secondary source of information.
[5] Farmers did not purchase planting materials of food crops but produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3% of the previous harvest is used for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[6] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if the produce green maize only.

Table A3-12: Estimated Economic Budget for Commercial Cassava/Maize Systems under Technology Combination "LOCMECH"[1], by Regional Output Markets, Nigeria, 1989/1991

Budget Items	*Regional Output Markets*	
	Abeokuta	**Onitsha**
1. OUTPUTS		
Average Root Yield (kg/ha)	12337	11776
Average Green Maize Yield (ears/ha)[2]	9614	9614
Market Price of root (nairas/kg)[3]	0.36	0.77
Market Price of Green Maize (nairas/ear)[4]	1.5	1.5
Revenues from Root (nairas /ha)	4402	9079
Revenues from Green Maize (nairas /ha)	14421	14421
Gross Revenues (nairas /ha)	18823	23500
2. COSTS		
Fixed Costs (nairas/ha)[5]	0	0
Operating costs (nairas/ha)		
Hired Labor[6]	1680	1995
Transportation (nairas)		
Tradable	1538	1472
Nontradable	296	283
Interest on Working Capital (8%)	281	300
Total Operating Costs (nairas /ha)	3795	4050
Family Labor (hired labor wage rate) (nairas /ha)	2688	3486
Opportunity Cost of Land[7] (nairas/ha)	8362	8362
3. PERFORMANCE MEASURES		
Gross Margin (nairas /ha)	15028	19450
Net Returns to family Labor (nairas /ha)	6666	11088
Net Returns per day of Family Labor (nairas /day)	52	67
Total production Costs (nairas /ha)	14845	15898
Net Social Profits (nairas /ha)	3978	7602

Source: COSCA survey data

[1] Local Variety and Mechanical Processing

[2] Estimated using the "Ear Weight Method" in Appendix 2.

[3] Estimated Farm Level Import Parity Price of root

[4] Farmgate price based on secondary source of information.

[5] Farmers did not purchase planting materials of food crops but produced their own: for cassava, only one fifth of the stems from previous harvest are retained for planting and for maize, only 2 to 3% of the previous harvest is saved for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

[6] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).

[7] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if the produce green maize only.

Table A3-13: Estimated Financial Budget for Commercial Cassava/Maize Systems under Technology Combination "LOCMAN"[1], by Regional Output Markets, Nigeria, 1989/1991

Budget Items	*Regional Output Markets*	
	Abeokuta	**Onitsha**
1. OUTPUTS		
Average Root Yield (kg/ha)	12337	11776
Average Green Maize Yield (ears/ha)[2]	9614	9614
Market Price of root (nairas/kg)[3]	0.57	0.57
Market Price of Green Maize (nairas/ear)[4]	1.5	1.5
Revenues from Root (nairas /ha)	7032	6712
Revenues from Green Maize (nairas /ha)	14421	14421
Gross Revenues (nairas /ha)	21453	21133
2. COSTS		
Fixed Costs (nairas/ha)[5]	0	0
Operating costs (nairas/ha)		
Hired Labor	1680	1995
Transportation (nairas)		
Tradable	1183	1132
Nontradable	296	283
Interest on Working Capital (8%)	253	273
Total Operating Costs (nairas /ha)	3412	3683
Family Labor (@ hired labor wage rate) (nairas /ha)	2688	3486
Opportunity Cost of Land[6] (nairas/ha)	8362	8362
3. PERFORMANCE MEASURES		
Gross Margin (nairas /ha)	18041	17450
Net Returns to family Labor (nairas /ha)	9679	9088
Net Returns per day of Family Labor (nairas /day)	76	55
Total production Costs (nairas /ha)	14462	15531
Net Enterprise Profits (nairas /ha)	6991	5602

Source: COSCA survey data

[1] Local variety and manual processing
[2] Estimated using the "Ear Weight Method" in Appendix 2 of chapter 2.
[3] Weighted average farmgate price based on COSCA data.
[4] Farmgate price based on secondary source of information (personal communication with IITA).
[5] Farmers did not purchase planting materials of food crops but produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3% of the previous harvest is saved for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[6] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if the produce green maize only.

Table A3-14: Estimated Economic Budget for Commercial Cassava/Maize Systems under Technology Combination "LOCMAN"[1], by Regional Output Markets, Nigeria, 1989/1991

Budget Items	*Regional Output Markets*	
	Abeokuta	**Onitsha**
1. OUTPUTS		
Average Root Yield (kg/ha)	12337	11776
Average Green Maize Yield (ears/ha)[2]	9614	9614
Market Price of root (nairas/kg)[3]	0.24	0.61
Market Price of Green Maize (nairas/ear)[4]	1.5	1.5
Revenues from Root (nairas /ha)	2911	7230
Revenues from Green Maize (nairas /ha)	14421	14421
Gross Revenues (nairas /ha)	17332	21651
2. COSTS		
Fixed Costs (nairas/ha)[5]	0	0
Operating costs (nairas/ha)		
Hired Labor[6]	1680	1995
Transportation (nairas)		
Tradable	1538	1472
Nontradable	296	283
Interest on Working Capital (8%)	281	300
Total Operating Costs (nairas /ha)	3795	4050
Family Labor (@ hired labor wage rate) (nairas /ha)	2688	3486
Opportunity Cost of Land[7] (nairas/ha)	8362	8362
4. PERFORMANCE MEASURES		
Gross Margin (nairas /ha)	13536	17601
Net Returns to family Labor (nairas /ha)	5174	9239
Net Returns per day of Family Labor (nairas /day)	40	56
Total production Costs (nairas /ha)	14845	15898
Net Economic Profits (nairas /ha)	2486	5753

Source: COSCA survey data

[1] Local variety and manual processing
[2] Estimated using the "Ear Weight Method" discussed Appendix 2 of chapter 2.
[3] Estimated Farm Level Import Parity Price of root
[4] Farmgate price based on secondary source of information (personal communication with IITA).
[5] Farmers did not purchase planting materials of food crops but produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3% of the previous harvest is saved for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[6] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[7] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the Gross Margin that farmers would enjoy if the produce green maize only.

Table A3-15: Estimated Financial Budget for Commercial Cassava/Maize Systems under Technology Combination "IMPMAN"[1], by Regional Output Markets, Nigeria, 1989/1991

Budget Items	*Regional Output Markets*	
	Abeokuta	**Onitsha**
1. OUTPUTS		
Average Root Yield (kg/ha)	21131	20171
Average Green Maize Yield (ears/ha)[2]	9614	9614
Market Price of root (nairas/kg)[3]	0.57	0.57
Market Price of Green Maize (nairas/ear)[4]	1.5	1.5
Revenues from Root (nairas /ha)	12045	11497
Revenues from Green Maize (nairas /ha)	14421	14421
Gross Revenues (nairas /ha)	26466	25918
2. COSTS		
Fixed Costs (nairas/ha)[5]	0	0
Operating costs (nairas/ha)		
Hired Labor	2373	2205
Transportation (nairas)		
Tradable	1666	1594
Nontradable	417	399
Interest on Working Capital (8%)	356	336
Total Operating Costs (nairas /ha)	4812	4534
Family Labor (@ hired labor wage rate) (nairas /ha)	3759	3822
Opportunity Cost of Land[6] (nairas/ha)	8362	8362
3. PERFORMANCE MEASURES		
Gross Margin (nairas /ha)	21653	21384
Net Returns to family Labor (nairas /ha)	13291	13022
Net Returns per day of Family Labor (nairas /day)	74	72
Total production Costs (nairas /ha)	16933	16718
Net Enterprise Profits (nairas /ha)	9532	9200

Source: COSCA survey data

[1] Improved variety and manual processing

[2] Estimated using the "Ear Weight Method" discussed in Appendix 2 of chapter 2.

[3] Weighted average farmgate price based on COSCA data.

[4] Farmgate price based on secondary source of information (personal communication with IITA).

[5] Farmers did not purchase planting materials of food crops but produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3% of the previous harvest is saved for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

[6] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if the produce green maize only.

Table A3-16: Estimated Economic Budget for Commercial Cassava/Maize Systems under Technology Combination "IMPMAN"[1], by Regional Output Markets, Nigeria, 1989/1991

Budget Items	*Regional Output Markets*	
	Abeokuta	**Onitsha**
1. OUTPUTS		
Average Root Yield (kg/ha)	21131	20171
Average Green Maize Yield (ears/ha)[2]	9614	9614
Market Price of root (nairas/kg)[3]	0.08	0.38
Market Price of Green Maize (nairas/ear)[4]	1.5	1.5
Revenues from Root (nairas /ha)	1763	7609
Revenues from Green Maize (nairas /ha)	14421	14421
Gross Revenues (nairas /ha)	16184	22030
2. COSTS		
Fixed Costs (nairas/ha)[5]	0	0
Operating costs (nairas/ha)		
Hired Labor[6]	2373	2205
Transportation (nairas)		
Tradable	2166	2064
Nontradable	417	399
Interest on Working Capital (8%)	396	373
Total Operating Costs (nairas /ha)	5362	5041
Family Labor (@ hired labor wage rate) (nairas /ha)	3759	3822
Opportunity Cost of Land[7] (nairas/ha)	8362	8362
3. PERFORMANCE MEASURES		
Gross Margin (nairas /ha)	10832	16989
Net Returns to family Labor (nairas /ha)	2470	8627
Net Returns per day of Family Labor (nairas /day)	14	47
Total production Costs (nairas /ha)	17473	17225
Net Social Profits (nairas /ha)	-1289	4805

Source: COSCA survey data

[1] Improved variety and manual processing
[2] Estimated using the "Ear Weight Method" discussed in the appendix.
[3] Estimated Farm Level Import Parity Price of root
[4] Farmgate price based on secondary source of information (personal communication with IITA).
[5] Farmers did not purchase planting materials of food crops but produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3% of the previous harvest is saved for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[6] Although rural labor markets in West African are complex, it is reasonable to assume that market wages offers good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[7] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the Gross Margin that farmers would enjoy if the produce green maize only.

Table A3-17: Policy Analysis Matrix (PAM) for Commercial Cassava/Maize Systems in Nigeria under alternative production and processing combinations and by distance between output markets and the village/farm: Net Financial Profitability (nairas /ha), Net Social Profitability (nairas/ha), and Net Effects of Policy-Induced Transfers: 1989-1991.

	Regional Output Markets/							
	Abeokuta				Onitsha			
Technology	Revenues	Tradable Inputs	Domestic Factors	Profits	Revenues	Tradable Inputs	Domestic Factors	Profits
IMPMECH								
Financial Prices	26466	1666	15267	9532	25918	1594	15124	9200
Social Prices	23851	2166	15307	6378	32281	2064	15161	15055
Divergences	2614	-500	-40	3154	-6362	-470	-38	-5855
LOCMECH								
Financial Prices	21453	1183	13279	6991	21133	1132	14399	5602
Social Prices	18823	1538	13307	3978	23500	1472	14426	7602
Divergences	2630	-355	-28	3013	-2367	-340	-27	-2000
LOCMAN								
Financial Prices	21453	1183	13279	6991	21133	1132	14399	5602
Social Prices	17332	1538	13307	2486	21651	1472	14426	5753
Divergences	4121	-355	-28	4505	-518	-340	-27	-151
IMPMAN								
Financial Prices	26466	1666	15267	9532	25918	1594	15124	9200
Social Prices	16184	2166	15307	-1289	22030	2064	15161	4805
Divergences	10282	-500	-40	10822	3888	-470	-38	4396

Source: 1) PAM Model constructed by the author but not shown due to space limitation; and 2) Tables A3-9 through A3-16.
Note: Divergences are calculated as financial prices *minus* economic prices

Figure 3-1: Farm Level Economic Prices of Cassava Root Under Alternative Production and Processing Technology Combinations Over Space- *For Sale in the Regional market of Abeokuta,* Nigeria: 1989/1991

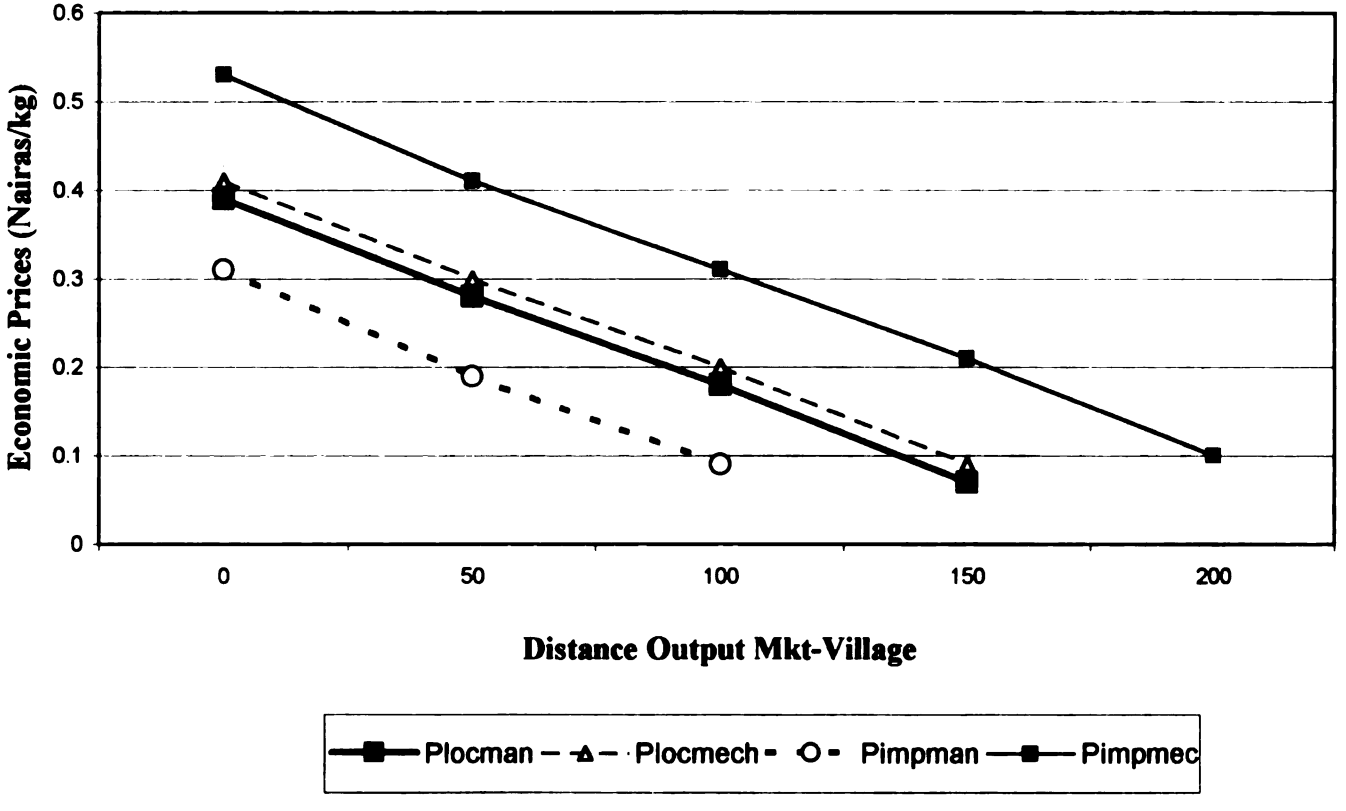
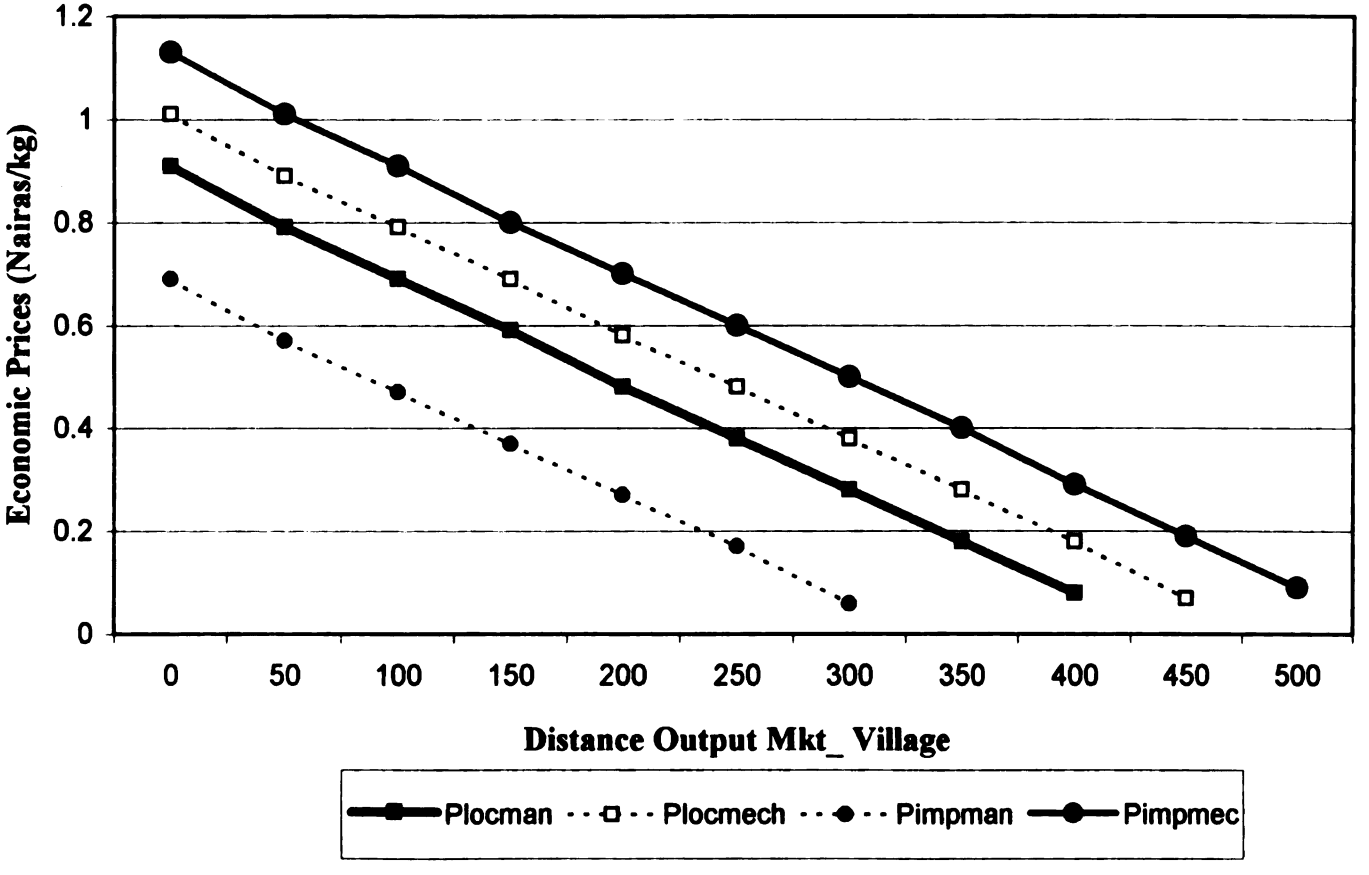


Figure 3-2: Farm Level Economic Prices of Cassava root Under Alternative Production and Processing Technology Combimations Over Space- *For Sale in the Regional Market of Onitsha,* Nigeria: 19989/1991



CHAPTER 4

COMPARING THE PROFITABILITY OF CASSAVA-BASED PRODUCTION SYSTEMS IN THREE WEST AFRICAN COUNTRIES: COTE D'IVOIRE, GHANA AND NIGERIA.

4.1. Introduction

In most Sub-Saharan African countries, the agricultural sector has always, and still accounts for the major share of GDP, foreign exchange, and employment. Yet, per capita food production has not been able to keep pace with a rapidly expanding demand for food. As a result, Sub-Saharan African (SSA) countries have become increasingly dependent on commercial imports and food aid (World Bank, 1996). To reverse this trend, most Sub-Saharan African (SSA) governments have been designing research programs and policy initiatives aimed at achieving national food security. One of the many food crops being considered currently in this effort in SSA is cassava, both in terms of its potential to ensure adequate food supply for all and generate rural household income, thereby increasing access to food. While this has led to a major expansion in cassava- based production systems in Nigeria and Ghana, there has been a slower growth in Côte d'Ivoire (Nweke, 1998).

Cassava is an important commodity in many farming systems in Sub-Saharan Africa (Nweke *et al.*, 1994). Its relative importance stems from its adaptability to a wide range of agro-ecologies, including marginal lands and erratic rainfall conditions (Nweke *et al.*, 1994). Regardless of the production environment, compared to other crops, cassava has lower production risks, and provides the possibility of maintaining a continuous food supply throughout the year (Nweke et al, 1994).

This study is based on the argument that the difference in various factors such as agricultural policies (i.e., trade and price policies, domestic production taxes or subsidies), location and technologies (production and processing) between Nigeria, Ghana and Côte d'Ivoire explains the difference in the level of growth in cassava-based production systems. The study uses the policy analysis matrix (PAM) model to examine the magnitude of the impact of these various factors on the private and social profitability of cassava/maize production systems in Nigeria, Ghana and Côte d'Ivoire.

The intent of this comparative essay is to use policy analysis matrix (PAM) approach to push analysis of the factors influencing profitability further than can be done within the context of a single country. The main advantage of carrying out similar policy studies in a number of countries is the scope presented for obtaining comparative insights.

4.2. Methodological Framework

As mentioned earlier, the Policy Analysis Matrix (PAM) is the analytical framework used in this essay. This methodology is presented in detail in the first chapter; therefore in this section, the focus is on how it is used in estimating comparative costs and incentives for farm activities or enterprises.

As an empirical framework, the PAM provides measures of economic efficiency and of transfer effects of policy on particular commodities, technologies, and regions. This information is used to explore several topics of interest to policymakers, such as the pattern of competitiveness and the potential for the government to exploit competitive advantage; the formulation of public investment policy to support particular commodities, regions and farm types; and the allocation of public research and development

expenditures within the agricultural sector. PAM results thus serve as an information baseline for monitoring and evaluating the effects of policy and for identifying policy-relevant research needs.

In this essay, first, private and social profitability of cassava/maize production systems in each country are presented and analyzed under a baseline scenario. This is followed by the discussion policy analysis matrix (PAM) results for each country. These results are organized by country to provide a basis for cross-country comparisons of technologies that dominate cassava/maize production in West Africa and comparisons of technologies within Nigeria. Comparisons between similar systems in different countries are also possible through a further extension of the PAM analysis, from which policy-impact ratios (e.g. DRC, EPC) are produced.

Finally, these "baseline" results are analyzed further by considering the implications of two scenarios for future change in selected technical parameters. The first scenario simulates increases in yields in Cote d'Ivoire and Ghana. The second scenario considers the effects of changes in the foreign exchange rates in the three countries.

4.3. Empirical Analyses

Cassava/maize production systems are examined in this section using a combination of financial analysis, economic analysis and policy analysis. The tasks involved are the following:

1. To identify and select relevant estimates of private profitability (farm level and post-farm level) and social profitability from the first two essays on Cote d'Ivoire and Nigeria.

2. To develop enterprise budgets (financial and economic) for cassava/maize systems in Ghana under a "baseline scenario".

3. To construct a Policy Analysis Matrix (PAM) for Ghana, using the information from the enterprise budgets and estimate ratio indicators such as DRC, NPC, etc.

4. To undertake sensitivity analyses in order to contrast the relative comparative advantage of each country in cassava/maize production.

4.3.1. Private Profitability (PP)

In this subsection, separate financial farm–level and post-farm level budgets are developed for Ghana, whereas estimates of private profitability (PP) indicators are taken from the previous essays on Cote d'Ivoire and Nigeria.This provides the database for establishing the relative profitability of cassava/maize production systems in each country. Previous chapters not only present a summary of the rationale that underlies farm budgets analysis, but also discuss in detail the construction of farm budgets. The PP indicator shows the incentives, for each production system, to alter the existing allocation of resources. If PP is positive, resources are encouraged to flow into the activity. If PP is negative, the direction of the flow is likely to be away.

4.3.1.1. Farm level Analysis

Cassava/maize enterprise budgets for the three countries are presented in tables A4-1 through A4-3 in appendix 4. Table 4-1 below summarizes the results of the baseline runs of the farm level financial profitability analysis for Cote d'Ivoire, Ghana and Nigeria. The summary focuses mainly on performance measures that can be used to identify the country where enterprises have the highest financial return and lowest cost of production.

Table 4- 1: Summary Estimates of Farm-Level Financial Budget Indicators (in US$ using prevailing Exchange Rates) for Cassava/Maize Production Systems, by Country,1989/91

Countries/Production Technologies	Returns to Family Labor Per Ha	Returns to Family Labor Per Person- day	Total Production Costs/ha	Net Enterprise Profits/ha
COTE D'IVOIRE				
Local/maize	804.56	6.00	755.49	487.20
IITA/maize	*NA*	*NA*	*NA*	*NA*
GHANA				
Local/maize	742.58	5.34	1266.50	419.33
IITA/maize	*NA*	*NA*	*NA*	*NA*
NIGERIA				
Local/maize	519.65	3.24	903.60	320.80
IITA/maize	742.70	4.29	962.18	530.24

Source: tables A4-1, A4-2 and A4-3 in Appendix 4
Note: in terms of prevailing exchange rates, 1US dollar= 266 fcfa (in Cote d'Ivoire) = 430 cedis (in Ghana) = 17 nairas (in Nigeria)

Results in table 4-1 clearly show that the production system that is common to the three countries is the local landrace variety /maize system. However, the PP estimates as shown in table 4-1 also clearly indicates that IITA's improved cassava varieties generate the highest net profits.

When converted to a per person-day basis, the returns to family labor for local land race variety/maize systems (RFL) are US $ 6.00 in Cote d'Ivoire, US $ 5.34 in Ghana and US $ 3.24 dollars in Nigeria. In the three countries, the RFL per person-day is higher than the average daily wage rate paid to the hired labor, which are $2.40 in Cote d'Ivoire, $2.33 in Ghana and $1.23 in Nigeria. Thus, there is no financial advantage to family members in any of these countries to seek wage employment in urban areas or other farms, when they are needed on their farms in the village. Furthermore, results in table 4-1 underline the remarkable stability of the RFL per person-day as a proportion of

agricultural wage rates across countries (ranging from 2.3 to 2.6 times the agricultural wage rates).

Results in table 4-1 also indicate that price incentives have enabled local landrace variety/maize systems to earn positive private profits per hectare that do not vary enormously across countries: US $ 487.20 in Cote d'Ivoire, US $ 419.33 in Ghana and US $ 320.80 in Nigeria.

Unfortunately, the COSCA study did not record maize yields on its sample fields. Therefore, in computing the enterprise budgets developed in this study, it was assumed that those fields got the average maize yield for the country which was then converted to the number of fresh corn ears using the "Ear-Weight Method" discussed in the appendix of chapter 2. The number of corn ears were subsequently valued at the fresh corn price.

4.3.1.2. Post-harvest Level Financial Analysis

It is assumed that green maize is harvested and consumed or sold at the farm level. Therefore, only cassava roots harvested are taken to the next level (the village) to be processed. Cassava processing methods involve a combination of activities such as peeling, grating and toasting. Of these activities, grating is the most labor intensive. In this study, a process is defined as traditional if grating is performed manually. Mechanized processing method involves the use of various types of mechanical cassava graters, which are driven by electrical, petrol, or diesel engines. The major form into which cassava roots are processed in Nigeria and Ghana is *gari*, which is made of toasted cassava granules. In Cote d'Ivoire, *attieke* (steamed cassava granules) is the major form into which roots are processed.

Transformation coefficients were computed and used to calculate actual *attieke* and *gari* yields under each technology combination. The technology combination common to the three countries was the "*Locman*"[1]. Yields were valued by the weighted average consumer price based on COSCA village survey data. It should be noted that prices vary a lot from season to season, mainly because of changing season conditions (e.g., abundance vs. hungry seasons). To account for this diversity, the weighted average price was estimated. Since farmers do not own processing machines, no fixed costs was assigned processing enterprises. Table 4-2 summarizes the results of the post-farm level budget analysis for the three countries under the technology combination "*Locman*". Table 4-3 summarizes the results of the post-farm level budget analysis for Nigeria under alternative technology combinations.

Table 4-2: Summary Estimates of Post-farm Level Financial Budget Indicators (in US$ using prevailing Exchange Rates) for Processed Products (*Attieke* in Cote d'Ivoire and *Gari* in Ghana and Nigeria) Production, by Country: 1989/91

Countries	Returns toFamily Labor Per Person-day	Average Costs of Production Per Kg of *Attieke/Gari*	Net Enterprise Profits Per ha
COTE D'IVOIRE	1.36	0.18	-57.20
GHANA	2.12	0.27	-6.65
NIGERIA	1.00	0.19	-15.12

Source: tables A4- 4, A4-5 and A4-6 in Appendix 4.
Note: using the prevailing exchange rates, 1 US dollar= 266 fcfa (in Cote d'Ivoire) = 430 cedis (in Ghana) = 17 nairas (in Nigeria)

1 The production and processing technology combination "*Locman*" is defined as follows: local cassava variety + manual grating method

Table 4-3: Summary Estimates of Postfarm-Level Financial Budget Indicators (inUS$ using prevailing Exchange Rates) for Gari Production, by Technology Combinations: Nigeria, 1989/91

Technology Combinations	Returns to Family Labor Per Person-day	Average Costs of Production Per Kg of *Gari*	Net Enterprise Profits Per ha
Impmech	1.94	0.16	49.41
Locmech	1.18	0.18	-1.65
Locman	1.00	0.19	-15.12
Impman	0.76	0.19	-40.65

Source: table 3-2 in chapter 3

Results in table 4-2 indicate that processing costs differ slightly between the three countries. *Attieke* production in Cote d'Ivoire is cheaper than *gari* production in Ghana or Nigeria. However, profits are negative in the three countries.

Results in table 4-3 show that in Nigeria, only cassava/maize systems under "*Impmech*" technology combination had a positive net enterprise profits (NEP). These results also show that mechanized processing methods have a definite cost-saving advantage over traditional processing methods. The "*Impmech*" technology combination has the lowest cost of production per kilogram of *gari* ($0.16 US/kg). This implies that farmers have incentives to adopt that technology combination. In fact, these findings are consistent with farmers' behavior in Nigeria. As mentioned earlier, COSCA data for Nigeria show that, in the 65 villages representing cassava-growing areas, most farmers (85 percent) grew the improved varieties. Of these farmers, 54 percent used mechanized processing method.

However, it should be noted that the negative NEPs observed under the other technology combinations do not mean that farmers are losing money. Rather, they mean that net margin is not enough to yield a positive return to the management factor when the

costs of other factors are taken into account. In fact, the post-farm level financial budgets presented in tables A4-4 through A4-6 in appendix 4 show that all the NEPs, assuming zero opportunity cost of labor, are positive.

The COSCA survey data indicate that women control post-harvest activities in the three countries and receive all the benefits from those activities. In addition, when asked why they were involved in this activity only, their answer was that there is no better alternative. That is, they have fewer or no opportunities for employment at the assumed "prevailing" rural wage.

This situation reflects the segmentation of the rural labor market for cassava farming systems in West Africa. Women manage a very important part of cassava production systems: 1) they predominate in cassava processing and *attieke and gari* preparation and, 2) they devote a large amounts of time in obtaining the fuel and water required to make cassava processed products ready for sale or home consumption. . Yet this analysis suggests that returns to women from these activities are below the rural wage rate, which is available mainly to men.

4.3.2. Social Profitability (SP)

The COSCA data indicate that, in Nigeria, about 79 percent of farmers who produce gari are net sellers, in Ghana about 70 percent of farmers who produce gari are net sellers, and in Cote d'Ivoire about 65 percent of farmers who produce attieke are net sellers. Therefore, this analysis focuses on commercial cassava/maize systems only.

The farm level economic returns for Ghana were calculated using import parity prices (tables A4-7 and A4-8 in appendix 4) of cassava roots and financial prices of green maize at selected regional markets, Koforidua and Kumasi. These two markets were

selected because they are located in regions where farmers ranked cassava as the most important crop in the farming system (Nweke *et al.*, 1998*)*. The estimates of social profitability (SP) indicators for Cote d'Ivoire and Nigeria are taken from previous essays. The economic budgets are presented in tables A4-10 through A4-15 in appendix 4.

As already discussed in previous essays, the economic budgets were estimated according to the following assumptions: 1) It is assumed that green maize is nontraded and that its price is not distorted by government policies. Therefore, its financial price (the observed market price) reflects its shadow price; 2) *Gari*, the main cassava product in Nigeria and Ghana, and *attieke*, the main cassava product in Cote d'Ivoire, are not traded internationally, but tapioca, another cassava product and the closest substitute of *attieke* and *gari* is traded internationally. Consequently, the price of imported tapioca was used to estimate the import parity of cassava root; and 3) the official exchange rates (266 francs cfa to $1US for Cote d'Ivoire, 430 cedis to $1US for Ghana and 17 nairas to $1US for Nigeria) were adjusted to reflect their equilibrium values net of distortions. The premium used for this adjustments were 48 percent for Cote d'Ivoire, 50 percent for Ghana and 30 percent for Nigeria respectively (Stryker, 1990).

Net social profit (SP), measured in world prices or their equivalent, in fact, diverges widely from the PP. The SP indicators shown in tables 4-4 and 4-5 below indicate that there is significant variation in SP among countries and between techniques. However, these SP indicators also suggest that all countries are able to substitute profitably local production of cassava/maize for imports. The only exceptions are systems under the technology combination "*Impman*" in Nigeria when outputs are sold in Abeokuta.

However, as already discussed in chapter 3, the systems under the "*Impmech*" technology combination in Nigeria, are clearly the most efficient use of national resources. They generate significantly higher net social profits (NSP) per hectare at both regional output markets (US$ 290.00 in Abeokuta and US$ 684.32 in Onitsha). The net social profit (NSP) refers to the difference, valued in border and shadow prices, between the gross value of output and the total costs of all inputs (traded and nontraded intermediary and primary inputs).

A more efficient use of resources means that one can produce more from what one has and attain a higher level of welfare. Measures of NSP, like DRC, may give an idea of the comparative advantage in the agricultural commodity system. In addition, measures of NSP may give an idea of the comparative advantage or efficiency in the agricultural commodity system. Thus, NSP measures are very informative for decision-makers and allocators of research funds, if the technical changes they might introduce would attempt to break labor or other constraints in cassava/maize systems.

It should be noted that all systems are more profitable financially than they are socially. That is, there are net transfers to farmers (see tables A4-11 through A4-15 in appendix 4). The subsequent PAM analysis will help illustrate the sources of these transfers.

Table 4-4: Summary Estimates of Farm-Level Economic Budget Indicators (in US$ using Shadow Exchange Rate) For Commercial Cassava/Maize Production Systems at Each Regional Output Market, by Country:1989/1991

Countries/Regional Markets		Returns to Family Labor Per Ha	Returns to Family Labor Per Person-day	Total System Production Costs Per Ha	Net Social Profits Per Ha
COTE D'IVOIRE	*Bonoua*	306.54	2.18	535.30	81.08
	N'douci	413.26	2.89	534.06	184.60
GHANA	*Koforidua*	417.36	2.87	846.62	192.56
	Kumassi	557.60	3.52	858.90	311.83
NIGERIA	*Abeokuta*	235.18	1.81	647.80	113.00
	Onitsha	420.00	2.51	722.64	261.50

Source: tables A4-10, A4-12 and A4-14 in Appendix 4.
Note: using the shadow exchange rates, 1US $ equals 394 fcfa (in C.I.), equals 645cedis (in Ghana), equals 22 nairas (in Nigeria)

Table 4-5: Summary Estimates of Farm-Level Economic Budget Indicators (in US$ using Shadow Exchange Rates) For Commercial Cassava/Maize Production Systems at Each Regional Output Market, by Production and Processing Technology Combinations, Nigeria: 1989/1991

Regional Markets/ Technology Combinations	Returns to Family Labor Per Ha	Returns to Family Labor Per Person-day	Total System Production Costs Per Ha	Net Social Profits Per Ha
Abeokuta				
Impmech	460.80	2.60	794.23	290.00
Locmech	303.00	2.40	674.80	180.82
Locman	235.20	1.81	674.80	113.00
Impman	112.30	0.64	794.23	-3.5
Onitsha				
Impmech	858.04	4.73	783.00	684.32
Locmech	504.00	3.05	722.64	345.60
Locman	420.00	2.54	722.64	261.50
Impman	392.14	2.13	783.00	218.41

4.3.3.Policy Matrix Analysis

By completing a PAM for a production system one can simultaneously determine the economic efficiency of the system, the degree of policy-induced transfers on the input

/output markets, and the extent to which resources are transferred among agents (Yao, 1997). First, the PAM was constructed using the information on costs and returns obtained from the financial and economic analyses. Second, the extent of policy-induced transfers is computed. Third, six PAM policy-indicators were derived for policy analysis. They are: the Domestic Resource Cost (DRC), the Nominal Protection Coefficient on Tradable Output (NPCO), the Nominal Protection Coefficient on Tradable Input (NPCI), the Effective Protection Coefficient (EPC), the Profitability Coefficient (PC), and the Subsidy to Producers (SP)[2].

4.3.3.1.Baseline Results

The PAM of cassava/maize production systems for each country is presented in tables A4-16 through A4-19 in Appendix 4. The policy-induced transfers (in the output and input markets) are summarized in tables 4-6 and 4-7 below. Results from these two tables indicate that there are substantial differences between countries in the magnitudes of public incentives offered to encourage cassava/maize production systems.

However, all countries display the same patterns. The baseline results indicated that, farmers operating at the Bonoua markets near urban centers (i.e., Bonoua in Cote d'Ivoire, Koforidua in Ghana and Abeokuta in Nigeria), benefited from a small implicit price support whereas farmers operating in markets distant from urban centers (N'douci in Cote d'Ivoire, Kumasi in Ghana and Onitsha in Nigeria) were subject a small implicit tax.

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[2] DRC= domestic factors in social prices/ (revenues in social prices – tradable inputs in social prices), NPCO = revenues in private prices / revenues in social prices, NPCI= tradable inputs in private prices/ tradable inputs in social prices, EPC= (revenues in private prices –tradable inputs in private prices)/ (revenues in social prices – tradable inputs in social prices), PC= private profits/ social profits, SP= (private profits- social profits)/ revenues in social prices

This is the result of farm-gate financial prices (15 fcfa in Cote d'Ivoire, 22 cedis in Ghana and 0.57 nairas in Nigeria) for cassava root departing from the estimated import parity prices in each country (tables A4-7 through A4-9b in the appendix) depending on the point of sale.

It should be emphasized that these differentials are relatively small. With this in mind, here are some plausible explanations of why market (financial) prices and economic prices (import parity prices) did not equal in markets close to port cities and markets distant from port cities. The divergences between these two prices could be due to a combination of the effect of the food import policies (i.e., ban on cereals import in Nigeria, rice import tariffs in Ghana and Cote d'Ivoire) and the effect of the overvaluation of each country's local currency. The indirect effect of such food import policies will be an increase in the financial price of cassava root relative to the economic price in all the markets. On the other hand, the currency overvaluation will have the effect of lowering the financial price of tradables such as roots and transport in both markets.

However, the magnitude of the reduction in prices will be large in markets far away from port cities and small in the ones close to port cities because the share of transport costs in the import parity price is relatively large for N'douci, Kumassi and Onitsha (distant from port cities) and relatively small for Bonoua, Koforidua and Abeokuta (close to port cities). Transportation costs thus provide a natural protection to domestic producers who supply markets located far from the import point.

Thus, the net effect is as follows: 1) in N'douci, Kumassi and Onitsha : an increase in the financial price of roots due to the import tariff and a relatively large decrease in the financial price of roots due to the currency overvaluation (via its impact on tradable goods

such as cassava and transport costs); and 2) in for Bonoua, Koforidua and Abeokuta: an increase in the financial price of roots due to the import tariff and a relatively small decrease in the financial price of roots due to the currency overvaluation.

It should be noted that the results from tables 4-6 and 4-7 are calculated using the weighted average of peak-season and off-peak season wage rate across cassava production zones. The off-peak season rate is two third of the peak-season rate in Cote d'Ivoire, half of the peak-season rate in Ghana and. half of the peak-season rate in Nigeria.

Table 4-6: Summary of the Net Effects (in US$ using Shadow Exchange Rates) of Policy-Induced Transfers For *Commercial* Cassava/Maize Systems, by Country: 1989/1991.

Regional Output Markets	Output Transfers	Tradable Inputs Transfers	Domestic Factors Transfers	Net Policy Transfers
COTE D'IVOIRE				
Bonoua	87.00	-5.00	-0.4	92.00
N'douci	-36.00	-5.00	-0.4	-31.00
GHANA				
Koforidua	129.00	-7.00	-1.00	137.00
Kumassi	-25.00	-7.00	-1.00	-17.00
NIGERIA				
Abeokuta	187.00	-16.00	-1.00	205.00
Onitsha	-24.00	-16.00	-1.00	-95.00

Source: tables A4-16, A4-17 and A4-18 in Appendix 4

Table 4-7: Summary of the Net Effects of Policy-Induced Transfers For Commercial Cassava/Maize Systems in Nigeria: 1989/1991.

Mkts/Technology Combinations	Output Transfers	Tradable Inputs Transfers	Domestic Factors Transfers	Net Policy Transfers
Abeokuta				
Impmech	119.00	-23.00	-2.00	143.00
Locmech	120.00	-16.00	-1.00	137.00
Locman	187.00	-16.00	-1.00	205.00
Impman	467.00	-23.00	-2.00	492.00
Onitsha				
Impmech	-289.00	-21.00	-2.00	-266.00
Locmech	-108.00	-15.00	-1.00	-91.00
Locman	-24.00	-15.00	-1.00	-7.00
Impman	177.00	-21.00	-2.00	200.00

Source: table A4-16 in Appendix 4

As for the tradable inputs and domestic factor transfers, they are negative everywhere. However, it should be noted that these transfers are relatively smaller compared with the transfers occurring in the outputs markets. The reason is that while the output (cassava roots) is assumed to be tradable, only 20 percent of the inputs (e.g., local transportation) used in its production process is treated as such. The key difference is that, compared with a nontradable commodity or resource, the domestic price formation of tradable commodity or resource is influenced to greater extent by the world market for that commodity or resource.

Thus, results in table 4-6 imply that, when outputs and inputs were valued at their social (efficiency) prices, the effect of government policy was: a) some type of support system to both cassava/maize systems in regional output markets closer capital cities, a tax to cassava/maize farmers selling at remote regional output markets; b) the provision of a subsidy, through an overvalued exchange rate, on sale of all inputs (imported and produced domestically).

Within Nigeria, some generalizations can be made concerning policy-induced transfers of different technology combinations. Results in table 4-7 suggest that when outputs and inputs were valued at their social (efficiency) prices, the effect of government policy was: 1) some support to cassava/maize systems under each technology combination at the Abeokuta market and 2) some tax on systems at the Onitsha market, except for systems under "*Impman*" combination. It is worth noting that the largest amount of negative transfers to producers occurs under the "*Impmech*" combination. In other words, farmers growing improved cassava varieties and producing *gari* using modern technology have been taxed more compared to other cassava/maize farmers. This difference can be

explained as follows: COSCA data indicate that the average farm-gate market price for cassava root was 0.57 nairas in Nigeria during the survey period. This price departs from the estimated import parity prices under each technology (tables A3-7 and A3-8 in Appendix 3 of chapter 3) of roots when Abeokuta or Onitsha is used as a point of sale. As already discussed above, overvalued large transportation costs combined with the cereals imports ban of 1985 explain this difference.

The calculation of domestic resource cost (DRC) coefficients for different countries permits a ranking of relative efficiencies in production. For example, given a desire to expand cassava/maize production systems in West Africa, the country with the lowest DRC is the most efficient avenue for expansion. Thus, DRC rankings indicate which country can expect the highest social rate return on its investment in farm and post farm technologies. Two main types of prices policy instruments can be used to alter prices of agricultural outputs and inputs. Quotas tariffs, or subsidies on imports and quotas, taxes, or subsidies on exports directly decrease or increase amounts traded internationally and thus raise or lower domestic prices. Domestic taxes or subsidies, in contrast, create transfers between the government treasury and domestic producers or consumers.

In addition to price and macro policies, governments influence their agricultural sectors through public investment policy. Government budgetary resources can be invested in agriculture to increase productivity and reduce costs (Monke and Pearson, 1989).

Table 4-8: Ratio Indicators for Commercial Cassava/Maize, by Country: 1989-1991.

Countries/ Regional Output	DRC	NPCO	NPCI	EPC	PC	SP
COTE D'IVOIRE						
Bonoua	0.86	1.14	1.00	1.15	2.14	0.15
N'douci	0.74	0.95	1.00	0.96	0.83	-0.04
GHANA						
Koforidua	0.81	1.12	0.67	1.13	1.71	0.13
Kumassi	0.73	0.98	0.67	0.98	0.95	-0.01
NIGERIA						
Abeokuta	0.84	1.24	0.77	1.28	2.81	0.26
Onitsha	0.71	0.98	0.77	0.99	0.97	-0.01

Source: PAM Model constructed by the author

Note: **DRC**= Domestic Resource Cost, **NPCO**= Nominal Protection Coefficient on Tradable Output, **NPCI**= Nominal Protection Coefficient on Tradable Input , **EPC**= Effective Protection Coefficient, **PC**= Profitability Coefficient and **SP**= Subsidy to Producers

Table 4-9: Ratio Indicators for *Commercial* Cassava/Maize Production Systems Under Alternative Production and Processing Combinations and by distance in Nigeria, 1989-1991.

Mkts/Tech. Comb.	DRC	NPCO	NPCI	EPC	PC	SP
Abeokuta						
Impmech	0.71	1.11	0.77	1.14	1.49	0.13
Locmech	0.77	1.14	0.77	1.17	1.76	0.16
Locman	0.84	1.24	0.77	1.28	2.81	0.26
Impman	1.09	1.64	0.77	1.77	-7.39	0.67
Onitsha						
Impmech	0.50	0.80	0.77	0.80	0.61	-0.81
Locmech	0.65	0.90	0.77	0.91	0.74	-0.09
Locman	0.71	0.98	0.77	0.99	0.97	-0.01
Impman	0.76	1.18	0.77	1.22	1.91	0.20

Source: PAM Model constructed by the author

Note: **DRC**= Domestic Resource Cost, **NPCO**= Nominal Protection Coefficient on Tradable Output, **NPCI**= Nominal Protection Coefficient on Tradable Input , **EPC**= Effective Protection Coefficient, **PC**= Profitability Coefficient and **SP**= Subsidy to Producers

The DRC coefficients presented in table 4-8 clearly show that, not only they are less than unity in all three countries, but also the three countries have similar comparative advantage in cassava/maize production in West Africa using local varieties. DRC

coefficients taken from the essay on Nigeria are presented in table 4-9 to push the efficiency comparisons further. They indicate that, cassava/maize systems under the "*Impmech*" technology have a greater comparative advantage when outputs are sold in Onitsha.

Given that governments in West Africa are involved extensively in their agriculture economies, it is of interest to describe how overvalued exchange rate policies create private incentives. An overvalued exchange rate is an implicit tax on producers of tradable products because too little domestic currency is earned by exports or paid out for imports. In the absence of commodity price policy, the world price of a tradable good determines its domestic price. When the exchange rate is overvalued, the domestic price is lower than its efficiency level and domestic producers are effectively taxed.

To examine the relationships between government policy and the cassava/maize economy in Cote d'Ivoire, Ghana and Nigeria, policy-impact ratios, which cancel all units of measure, were calculated. These ratios are presented in the tables 4-8 and 4-9 above. The analysis that follows will focus on the NPCO, the NPCI and the EPC.

Of the three countries, Cote d'Ivoire demonstrates the lowest level of government interference on both the input and the output sides in N'douci, a market located farther away from the capital city. The NPCO, the EPC and the NPCI all are close to unity unity. In all three countries, the NPCO and the EPC assume the same patterns in markets located closer to capital cities: they are greater than unity, suggesting a certain positive protection to cassava/maize farmers in those markets. However, in Ghana and Nigeria the NPCI are less than unity everywhere, implying government policies in those countries have permitted inputs prices to be lower than they would be under open trade.

4.3.3.2. Sensitivity Analysis

The sensitivity analysis carried out in this sub-section aims to test the robustness of the results under the baseline scenario. Two scenarios are considered: the first scenario simulates a change in yields of cassava and a change in processing costs; and the second considers the effects of change in the shadow exchange rate.

Yields and Processing Cost. This sensitivity analysis is broken into two parts: the first part investigates the effects of an increase in cassava yields in Cote d'Ivoire and Ghana on the DRC ratios. It is assumed that farmers in both countries have adopted the IITA variety; therefore cassava yields equal ITTA variety yields in Nigeria (19,210 kilograms of roots per hectare).

In the essay on Nigeria, post-farm budgets analyses show that mechanized processing technology decreases processing cost by 6 percent for farmers who grow local landrace cassava varieties, varieties that are common to all three countries. Therefore, in the second part of the sensitivity analysis, the impact of a decrease in processing costs is considered. The results are shown in table 4-10.

Table 4-10: Effects of Changes in Cassava Yields and Processing Costs on the DRC for Root Production in Cote d'Ivoire and Ghana: 1989/1991

Countries/ Markets	Effects of Increase (79% for CI and 43% for Ghana) in Cassava Yields			Effects of a 6% Decrease in Processing Costs		
	DRC Ratio					
	Baseline	Elasticity	Simulation	Baseline	Elasticity	Simulation
COTE D'IVOIRE						
Bonoua	0.86	-0.60	0.46	0.86	-1.94	0.76
N'douci	0.74	-0.57	0.41	0.74	-1.58	0.67
GHANA						
Koforidua	0.81	-0.57	0.61	0.81	-2.26	0.70
Kumassi	0.74	-0.63	0.54	0.74	-1.80	0.66

Source: PAM Model constructed by the author

To help in assessing comparative costs across the three countries, DRC elasticties were calculated. They are defined as the percentage change in DRC divided by percentage change in yield or processing costs. Results of table 4-10 show that DRC elasticity values with respect to yields and processing cost range from -0.57 to -0.60 and from -1.58 to -2.26 in Cote d'Ivoire and Ghana, respectively. The larger the value of the elasticity, the more effect the relevant parameter has on the DRC coefficient. However, the question is how much it costs get a 1 percent change in yield versus a 1 percent in processing cost in order to evaluate whether it would be better to invest in yields or processing method.

Shadow Exchange Rates. The sensitivity analysis undertaken here is designed to examine the effects of an appreciation of the real exchange rate on net social profitabilities (NSP) and selected policy-indicators (DRC and EPC) ratios. Previous studies (Babo, 1996; Barry, 1998; and Nweke, 1998) have shown that market prices in Cote d'Ivoire, Ghana and Nigeria have changed with a decline in the shadow exchange rate, which led to recent currency devaluation in all three countries. Therefore, these post-devaluation prices were used in carrying out this analysis. Tables 4-11 and 4-12 present the results.

Table 4-11: Effects of Change in the Shadow Exchange Rate on the Net Social Profit (NSP in $US using Shadow exchange rates), by Country: 1989/1991

Countries/Regional Mkts		Baseline	Simulation	Profit Elasticity
COTE D'IVOIRE				
	Bonoua	81.06	266.84	6.55
	N'douci	184.60	329.94	2.25
GHANA				
	Koforidua	192.55	-152.45	-0.85
	Kumasi	311.83	-250.63	-0.86
NIGERIA				
	Abeokuta	113.00	18.44	-0.29
	Onitsha	261.50	19.65	-0.32

Source: PAM Model constructed by the author
Note: it is assumed that the percentage changes in the equilibrium exchange rates are: 35% for Cote d'Ivoire, 210% for Ghana and 280% for Nigeria.

Table 4-12: Effects of Change in the Shadow Exchange Rate on Selected Policy Indicators, by Country: 1989/1991

Countries/Mkts	Policy Indicators					
	DRC Ratio			**EPC Ratio**		
	Baseline	% Change	Simulation	Baseline	% Change	Simulation
COTE D'IVOIRE						
Bonoua	0.86	-25	0.64	1.15	-32	0.78
N'douci	0.74	-20	0.59	0.96	-28	0.70
GHANA						
Koforidua	0.81	62	1.31	1.71	-18	1.40
Kumassi	0.73	119	1.60	0.97	64	1.59
NIGERIA						
Abeokuta	0.84	17	0.98	1.28	-50	0.64
Onitsha	0.71	37	0.97	0.99	-36	0.63

Source: PAM Model constructed by the author

Note: it is assumed that the percentage changes in the equilibrium exchange rates are:35% for Cote d'Ivoire, 210% for Ghana and 280% for Nigeria.

As the profit elasticities in table 4-10 indicate, social profitability levels are very sensitive to changes in the shadow exchange rates. Following 35 percent, 210 percent and 286 percent decline in the equilibrium exchange rate in Cote d'Ivoire, Ghana and Nigeria respectively, results from table 4-11 show that, while cassava/maize systems show considerable benefit from the exchange rate depreciation in Cote d'Ivoire, systems in Ghana suffered a huge loss. This result can be explained by the fact that in Ghana, farm level wage rates rose from 1000 cedis to 4000 cedis (a 300 percent increase) while output price rose from 22 cedis to 65cedis (a 195 percent increase).

The results of table 4-12 show the effect of changes in the exchange rates on the DRC, the EPC. The simulated values of the domestic resource cost (DRC) ratios are greater than unity in Ghana, suggesting that the decrease in the equilibrium exchange rate combined with the increased valued of domestic labor have caused that country to suffer a

comparative disadvantage. However, the EPC estimates are also greater unity, suggesting that farmers are receiving positive protection. That is, they could have received a lower return if they faced border prices instead of domestic prices on both outputs and inputs.

4.4. Conclusions

This essay is an application of the policy analysis matrix (PAM) for cassava/maize production systems in Cote d'Ivoire, Ghana and Nigeria. The purpose was to analyze and compare the competitiveness of cassava/maize systems in these three West African countries. The baseline results compared in this study demonstrate the narrow range of efficiencies of production. All three countries have almost similar comparative advantage in cassava/maize production systems, although labor input for Nigeria and Ghana is 15 to 30 percent higher than for Cote d'Ivoire.

However, PAM is a static model which cannot capture changes in prices and productivity (Yao, 1998); therefore, a sensitivity analysis was carried out. The simulation findings indicate that, in most instances, the decline in the equilibrium exchange rate has allowed the differences in efficiencies across countries to be maintained.

The results of this study have several implications for the three West African countries' goal of reaching regional self-sufficiency in food crops in West Africa. First, all cassava/maize systems under existing techniques are financially and socially profitable if the output substitutes for imports on-farm or in markets near the site of production. Second, the extent of divergences (especially for tradable inputs and factor prices) observed in the three countries is relatively small (see tables A4-16 through A4-18 in appendix 4); therefore, there is little scope for achieving easy improvements by removing

significant price distortions.

Third, the simulation results indicate that the potential for governments to assist in income growth lies in areas other than commodity market price policy. In Nigeria and Ghana, protectionism can be viewed as an expression of an inward-looking import-substitution strategy. Thus, the realization of income gains for cassava/maize farmers in Nigeria and Ghana depended in the 1980s and the early 1990s on a change in foreign exchange rate policy.

In Cote d'Ivoire and Ghana, simulation results indicate that cassava/maize farmers could benefit from growing IITA's variety and adopting mechanized processing methods. Baseline results for Nigeria clearly indicate that the *Impmech* technology combination reduces labor costs, which is good in case of labor constraints. The profitability of cassava/maize systems will encourage their expansion and the reduction of the area planted. One option is to invest in research and development programs that would facilitate the adoption of the ITTA's variety and mechanized processing methods.

REFERENCES

Babo, Alfred, Circuits de Commercialisation et de Transformation du Manioc dans la Region de Bouake. Memoire de Maitrise. Option: Socio-Economie du Developpement Rural. Universite de Bouake, 1996.

FAO, 1989-1992, Various issues

Monke, E.A. and S. Pearson. 1989. *The Policy Analysis Matrix for Agricultural Development.* Baltimore: John Hopkins University Press.

Nelson, G C and Panggabean, M (1991), The costs of Indonesian sugar policy: a policy analysis matrix approach, *American Journal of Agricultural Economics*, 73 (3) pp 703-712

Nweke, F.I., Cassava Distribution in Sub-Saharan Africa The Collaborative Study of Cassava in Africa, *Working Paper No. 12*, 1994

Nweke, Felix I., K. N'Goran, A.G.O. Dixon, B.O. Ugwu, O. Ajobo, and T. Kouadio. 1998, Cassava production and processing in Cote d'Ivoire. *COSCA Working Paper No. 23*, The Collaborative Study of Cassava in Africa, IITA, Ibadan, Nigeria.

Stryker J. Dirck, " Trade, Exchange Rate, and Agricultural Pricing Policies in Ghana," *World Bank Comparative Studies*, 1990

Yao, Shujie, 1997. "Rice Production in Thailand Seen Through a Policy Analysis Matrix". *Food Policy*, 22(6):547-560

World Bank. 1993. World Development Report 1996.

APPENDIX 4

Table A4-1: Estimated Average Financial Budget for Cassava/Maize Production Systems, Cote d'Ivoire: 1989/1991

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)		
Land Clearing	18	14
Seedbed Preparation	22	20
Weeding	12	14
Planting		
Cassava	17	15
Maize	15	0
Harvesting		
Cassava	27	11
Maize	23	0
Total	**134**	**74**
2. OUTPUTS		
Average Root Yield (kg/ha)	10737	
Average Maize Yield (ears/ha)[1]	6780	
Market Price of Root (fcfa/kg)[2]	15	
Market Price of Green Maize (fcfa/ears)[3]	25	
Revenues from Green Maize (fcfa/ha)	169500	
Revenues from Cassava Roots (fcfa/ha)	161055	
Gross Revenues (fcfa/ha)	330555	
3. COSTS		
Fixed Costs (fcfa/ha)[4]	0	
Operating costs (fcfa/ha)		
Hired Labor	46620	
Transportation field-to-home (fcfa/ton)	4960	
Interest on Working Capital (8%)	4126	
Total Operating Costs (fcfa/ha)	55706	
Family Labor (valued @ hired labor wage rate)	84420	
Opportunity Cost of land	60835	
4. PERFORMANCE MEASURES		
Gross Margin (fcfa/ha)	274849	
Net Returns to family Labor (fcfa/ha)	214014	
Net Returns per day of Family Labor (fcfa/day)	1597	
Total System Production Costs (fcfa/ha)	200961	
Net Enterprise Profits (fcfa/ha)	129594	

Source: COSCA survey data

[1] Estimated using the "Ear Weight Method" discussed in Appendix 2. In West Africa, maize, which has a short cycle, is harvested before cassava establishes. Hence competition between maize and cassava is minimized, while sole plant density is maintained for both crops (COSCA Working Paper No.10, page 84).
[2] Weighted average farmgate price based on COSCA data
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3 percent of the harvest is retained for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

Table A4-2: Estimated Average Financial Budget for Cassava/Maize Production Systems, Ghana: 1989/1991

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)		
Land Clearing	21	19
Seedbed Preparation	19	16
Weeding	17	21
Planting		
Cassava	20	18
Maize	17	0
Harvesting		
Cassava	22	31
Maize	23	0
Total	**139**	**105**
2. OUTPUTS		
Average Root Yield (kg/ha)	13042	
Average Maize Yield (ears/ha)[1]	11526	
Market Price of Root (cedis/kg)[2]	22	
Market Price of Green Maize (cedis/ears)[3]	38	
Revenues from Green Maize (cedis/ha)	437988	
Revenues from Cassava Roots (cedis/ha)	286924	
Gross Revenues (cedis/ha)	724912	
3. COSTS		
Fixed Costs (cedis/ha)[4]	0	
Operating costs (cedis/ha)		
Hired Labor	105000	
Transportation field-to-home (cedis/ton of roots)	10825	
Interest on Working Capital (8%)	9266	
Total Operating Costs (cedis/ha)	125091	
Family Labor (valued @ hired labor wage rate)	139000	
Opportunity Cost of Land (cedis)	280508	
4. PERFORMANCE MEASURES		
Gross Margin (cedis/ha)	599821	
Net Returns to family Labor (cedis/ha)	319313	
Net Returns per day of Family Labor (cedis/day)	2297	
Total System Production Costs (cedis/ha)	544599	
Net Enterprise Profits (cedis/ha)	180313	

Source: COSCA survey data

[1] Estimated using the "Ear Weight Method" described in Appendix 2 of chapter 2. In West Africa, maize, which has a short cycle, is harvested before cassava establishes. Hence competition between maize and cassava is minimized, while sole plant density is maintained for both crops. (COSCA Working Paper No.10, page 84)

[2] Weighted average farmgate price based on COSCA data

[3] Farmgate price based on secondary source of information : the Dept. of Planning, Monitoring and Evaluation (Ministry of Food and Agriculture, Accra, Ghana)

[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest is retained for replanting, and for maize only 2 to 3 percent of the harvest is retained for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

Table A4-3: Estimated Average Financial Budget for Cassava/Maize Systems *For Local Landraces*, Nigeria: 1989/1991

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)		
♦ Land Clearing	28	22
♦ Seedbed Preparation	23	21
♦ Weeding	23	18
♦ Planting		
Cassava	19	16
Maize	15	0
♦ Harvesting		
Cassava	30	22
Maize	23	0
Total	161	99
2. OUTPUTS	11215	
Average Root Yield (kg/ha)	9614	
Average Maize Yield (ears/ha)[1]	0.57	
Market Price of Root (nairas/kg)[2]	1.5	
Market Price of Green Maize (nairas/ears)[3]	14421	
Revenues from Green Maize (nairas/ha)	6393	
Revenues from Cassava Roots (nairas/ha)	20814	
Gross Revenues (nairas/ha)		
3. COSTS	0	
Fixed Costs (nairas/ha)[4]		
Operating costs (nairas/ha)	2079	
Hired Labor	1271	
Transportation (nairas)	268	
Interest on Working Capital (8%)	3618	
Total Operating Costs (nairas/ha)	3381	
Family Labor (valued @ hired labor wage rate)	8362	
Opportunity Cost of land (nairas)		
4. PERFORMANCE MEASURES		
Gross Margin (nairas/ha)	17196	
Net Returns to family Labor (nairas/ha)	8834	
Net Returns per day of Family Labor (nairas/day)	55	
Total System Production Costs (nairas/ha)	15361	
Net Enterprise Profits (nairas/ha)	5453	

Source: COSCA survey data

[1] Estimated using the "Ear Weight Method" discussed in the appendix 2 of chapter 2. In West Africa, maize, which has a short cycle, is harvested before cassava establishes. Hence competition between maize and cassava is minimized, while sole plant density is maintained for both crops. (COSCA Working Paper No.10, page 84)

[2] Weighted average farmgate price based on COSCA data

[3] Farmgate price based on secondary source of information (personal communication with IITA)

[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3 percent of harvest is used for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

Table A4-4: Estimated Average Financial Budget per hectare for *Attieke* Production[1] in Cote d'Ivoire, 1989-1991, *assuming that 45% of roots production goes into attieke production*

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)[2]	57	0
Raw Material (kgs of roots)[3]	4832	
2. OUTPUTS		
Transformation Rate	0.56	
Kilograms of Processed Output per ha	2706	
Village Market Price of Processed Output (fcfa/kg)[4]	47	
Gross Revenues (fcfa/ha)	127169	
3. COSTS		
Fixed Costs (fcfa/ha)[5]	0	
Operating costs (fcfa/ha)		
Hired Labor (persondays)	0	
Raw Material (roots)[6]	72475	
Bagging Materials	16234	
Firewood	2205	
Transportation[7]	7670	
Interest on Working Capital (8%)	7887	
Total Operating Costs (fcfa/ha)	106471	
Family Labor (valued @ hired labor wage rate) (fcfa/ha)	35910	
4. PERFORMANCE MEASURES		
Gross Margin (fcfa/ha)	20698	
Net Returns to family Labor (fcfa/ha)	20698	
Net Returns per day of Family Labor (fcfa/day)	363	
Total production Costs (fcfa/ha)	142381	
Net Enterprise Profits (fcfa/ha)	-15212	
Production Costs per Kg of attieke (fcfa/kg)	53	

Source: COSCA data

[1] There were forty-three (43) farmers using traditional techniques versus three (3) using modern techniques. Therefore, this budget includes only farmers using traditional (manual) processing techniques.

[2] This item includes labor for Peeling, Washing, Grating. Pressing, Sieving and Steaming.

[3] This represents 45% of the average root yield per hectare (see page 23 in COSCA Working Paper No 6)

[4] Weighted average village market price estimated from COSCA data

[5] No mechanical equipment was used in any processing activity. Grating was performed manually (COSCA Working Paper No.14, page 15).

[6] Valued at its opportunity cost which is the weighted average farmgate price computed from the COSCA data

[7] This item includes home-to-market transportation costs only.

Table A4-5: Estimated Average Financial Budget per hectare for *Gari* Production[1] in Ghana, 1989-1991, *assuming that 50% of roots production goes into gari production*

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)[2]	32	19
Raw Material (kgs of roots)[3]	6521	
2. OUTPUTS		
Transformation Rate	0.31	
Kilograms of Processed Output per ha	2022	
Village Market Price of Processed Output (cedis/kg)[4]	117	
Gross Revenues (cedis/ha)	236517	
3. COSTS		
Fixed Costs (cedis/ha)[5]	0	
Operating costs (cedis/ha)		
Hired Labor (persondays)	19000	
Bagging Materials	1738	
Raw Material (roots)[6]	143462	
Firewood	1961	
Transportation[7]	25855	
Interest on Working Capital (8%)	15361	
Total Operating Costs (cedis/ha)	207377	
Family Labor (valued @ hired labor wage rate) (cedis/ha)	32000	
4. PERFORMANCE MEASURES		
Gross Margin (cedis/ha)	29139	
Net Returns to family Labor (cedis/ha)	29139	
Net Returns per day of Family Labor (cedis/day)	911	
Average Total production Costs (cedis/ha)	239377	
Net Enterprise Profits (cedis/ha)	-2861	
Average Production Costs per Kg of gari (cedis/kg)	118	

Source: COSCA data

[1] There were thirty-six (36) farmers using traditional techniques versus six (6) farmers using modern techniques. Therefore, this budget includes only farmers using traditional (manual) processing techniques.
[2] This item includes labor for peeling, washing, grating, pressing, sieving and roasting.
[3] This represents 50% of the average root yield per hectare (see page 23 in COSCA Working Paper No 6)
[4] Weighted average village market price estimated from COSCA data
[5] No mechanical equipment was used in any processing activity. Grating was performed manually (COSCA Working Paper No.14, page 15)
[6] Valued at its opportunity cost which is the weighted average farmgate price computed from the COSCA data.
[7] This item includes home-to-market transportation costs only.

Table A4-6: Estimated Average Financial Budget per hectare for *Gari* Production under Technology Combination "LOCMAN"[1], Nigeria, 1989/1991, *assuming 80% root production goes into gari production.*

Budget Items		
1. INPUT USE	**Family**	**Hired**
Family/Hired Labor Use (person-days)[2]	60	17
Raw Material (kgs of roots)[3]	8972	
2. OUTPUTS		
Transformation Rate	0.31	
Kilograms of Processed Output per ha	2781	
Village Market Price of Processed Output (nairas/kg)[4]	3.14	
Gross Revenues (nairas/ha)	8733	
3. COSTS		
Fixed Costs (nairas/ha)[5]	0	
Operating costs (nairas/ha)		
Hired Labor (person-days)	357	
Raw material[6]	5114	
Bagging Materials	259	
Firewood	676	
Transportation[7]	752	
Interest on Working Capital (8%)	573	
Total Operating Costs (nairas/ha)	7731	
Family Labor (valued @ hired labor wage rate) (nairas/ha)	1260	
4.PERFORMANCE MEASURES		
Gross Margin (nairas/ha)	1003	
Net Returns to family Labor (nairas/ha)	1003	
Net Returns per day of Family Labor (nairas/day)	17	
Total production Costs (nairas/ha)	8891	
Net Enterprise Profits (nairas/ha)	-257	
Production Costs per Kg of gari (nairas/kg)	3.23	

Source: COSCA data

[1] Local variety and manual Processing

[2] This item includes labor for washing, cleaning, grating, pressing sieving and roasting.

[3] This represents 80% of the average root yield per hectare (see page 128 in COSCA Working Paper No.20)

[4] Weighted average village market price estimated from COSCA data

[5] No mechanical equipment was used in any processing activity. Grating was done manually (COSCA Working Paper No.14, page 15)

[6] Valued at its opportunity cost, which is the weighted average farmgate, price computed from the COSCA data.

[7] This item includes home-to-market transportation costs only.

Table A4-7: Economic Import Parity Price of Cassava Root *For Sale in Regional Output Markets*, Ghana: 1989/1991.

Items	*Regional Output Markets*	
	Koforidua	**Kumassi**
1. World Price (FOB-$US/mt tapioca)	221	221
2. Freight and insurance ($US/mt tapioca)	8	48
3. CIF, port in Accra ($US/mt tapioca) (1+2)	269	269
4. Shadow Exchange rate (cedis / $US)	645	645
5. CIF price at the port in Accra (cedis/mt tapioca) (3*4)	173666	173666
6. Domestic costs (cedis/mt tapioca)		
a. Port charges (cedis/mt tapioca)	47227	47227
b. Transit and Transport (cedis/mt tapioca)	7233	7233
c. Storage and Handling (cedis/mt tapioca)	15276	15276
7. Accra gate price (5+ 6a...c) (cedis/mt tapioca)	243402	243402
8. Importer marketing margin (%)	5%	5%
9. Wholesale price in Accra (7* (1+ 8))	255572	255572
10. Accra to Regional Market Center		
a Distance (km)	75	254
b. Transport cost (cedis/mt tapioca)	6828	23114
c. Handling (cedis/mt tapioca)	4233	4233
11. Regional Market Center (Reference Price) Farmgate price (cedis/mt tapioca) (9 + 10a..c)	266630	282919
12. Wholesale marketing margin (%)	5%	5%
13. Wholesale price in Regional Market (cedis/mt tapioca) (11* (1+12))	279962	297065
14. Regional Market Center to Village		
a. Distance (kms)	47	83
b. Transport and Handling cost (cedis/mt tapioca)	5076	8964
15. Village gate price (cedis/mt tapioca) (13-14b)	274886	288101
16. Semi-wholesale marketing margin (%)	5%	5%
17. Village Level Semi-wholesale price ((1-16)*15)/1000	261	274
18.Transformation rate (kg of tapioca / kg of root)	0.50	0.50
19. Processing cost (cedis/kg of root)	114	114
20. Import Parity Price in the Village (cedis /kg of root) (17*18) -19	16	23

Source: COSCA data, Ghana Yearly Statistical Digests (1989-1991), Economic and Social Commission for Asia and the Pacific, Reports of 1989 through 1991.

Table A4-8: Economic Import Parity Price of Cassava Root- *For Home Consumption*, Cote d'Ivoire: 1989/1991.

Items	*Production Zones*	
	Bonoua Zone	**N'douci Zone**
1. World Price (FOB-$US/mt tapioca)	221	221
2. Freight and insurance ($US/mt tapioca)	48	48
3. CIF, port in Abidjan ($US/mt tapioca) (1+2)	269	269
4. Shadow Exchange rate (fcfa / $US)	394	394
5. CIF price at the port in Abidjan (fcfa/mt tapioca) (3*4)	105998	105998
6. Domestic costs (fcfa/mt tapioca)		
a. Port charges (fcfa/mt tapioca)	700	700
b. Transit and Transport (fcfa/mt tapioca)	2000	2000
c. Storage and Handling (fcfa/mt tapioca)	2000	2000
7. Abidjan gate price (5+ 6a...c) (fcfa/mt tapioca) 8.	110698	110698
Importer marketing margin (%)	5%	5%
9. Wholesale price in Abidjan (7* (1+ 8))	116233	116233
10. Abidjan to Regional Market Center		
a Distance (km)	75	130
b. Transport cost (fcfa/mt tapioca)	2625	4550
c. Handling (fcfa/mt tapioca)	2000	2000
11. Regional Market Center (Reference Price)		
Farmgate price (fcfa/mt tapioca) (9 + 10a..c)	120858	122783
12. Wholesale marketing margin (%)	5%	5%
13. Wholesale price		
in Regional Market (fcfa/mt tapioca) (11* (1+12))	126901	128922
14. Regional Market Center to Village		
a. Distance (kms)	37	56
b. Transport and Handling cost (fcfa/mt tapioca)	3665	4520
15. Village gate price (fcfa/mt tapioca) (13+14b)	130566	133442
16. Semi-wholesale marketing margin (%)	5%	5%
17. Village Level Semi-wholesale price ((1+16		
)*15)/1000	137	140
18.Transformation rate (kg of tapioca / kg of root)	0.5	0.5
19. Processing cost (fcfa/kg of root)	46	43
20. Import Parity Price in the Village (cfaf /kg of root)		
(17*18) -19	22	27

Source: COSCA data. Institut de Documentaion de Recherches et d'Etudes Maritimes of the Ivorian Marine Ministry; UN Economic and Social Commission For Asia and the Pacific, Reports of 1989 through 1991.

Table A4-9a: Economic Import Parity Price of Cassava Root, by Alternative Technology Combinations. *For Sale in the Regional Output Market of Abeokuta,* Nigeria: 1989/1991.

Items	*Regional Output Market*			
	Abeokuta			
	Impmech	***Locmech***	***Locman***	***Impman***
1. World Price (FOB-$US/mt tapioca)	221	221	221	221
2. Freight and insurance ($US/mt tapioca)	48	48	48	48
3. CIF, port in Lagos ($US/mt tapioca) (1+2)	269	269	269	269
4. Shadow Exchange rate (nairas / $US)	22	22	22	22
5. CIF price at the port in Lagos (nairas/mt tapioca) (3*4)	5950	5950	5950	5950
6. Domestic costs (nairas/mt tapioca)				
a. Port charges (nairas/mt tapioca)	95	95	95	95
b. Transit and Transport (nairas/mt tapioca)	206	206	206	206
c. Storage and Handling (nairas/mt tapioca)	203	203	203	203
7. Lagos gate price (5+ 6a...c) (nairas/mt tapioca)	6454	6454	6454	6454
8. Importer marketing margin (%)	5%	5%	5%	5%
9. Wholesale price in Lagos (7* (1+ 8))	6777	6777	6777	6777
10. Lagos to Regional Market Center				
a Distance (km)	80	80	80	80
b. Transport cost (nairas/mt tapioca)	288	288	288	288
c. Handling (nairas/mt tapioca)	114	114	114	114
11. Regional Market Center (Reference Price) Farmgate price (nairas/mt tapioca) (9 +10a..c)	7179	7179	7179	7179
12. Wholesale marketing margin (%)	5%	5%	5%	5%
13. Wholesale price in Regional Market (nairas/mt tapioca) (11* (1+12))	7538	7538	7538	7538
14. Regional Market Center to Village				
a. Distance (kms)	34	34	34	34
b. Transport and Handling cost (nairas/mt tapioca)	176	176	176	176
15. Village gate price (nairas/mt tapioca) (13-14b)	7362	7362	7362	7362
16. Semi-wholesale marketing margin (%)	5%	5%	5%	5%
17. Village Level Semi-wholesale price (1-16)*15)/1000	6.99	6.99	6.99	6.99
18.Transformation rate (kg of tap./ kg of root)	0.50	0.50	0.50	0.50
19. Processing cost (nairas/kg of root)	3.05	3.14	3.26	3.41
20. Import Parity Price in the Village (nairas /kg of root) (17*18) -19	0.45	0.36	0.24	0.08

Source: COSCA data, UNCTAD's Review of Maritime Transport 1989-1992, Nigerian Port Authority Statistical Reports 1989-1992, UN Economic and Social Commission For Asia and the Pacific, Reports of 1989 through 1991.

Table A4-9b: Economic Import Parity Price of Cassava Root, by Alternative Technology Combinations. *For Sale in the Regional Output Market of Onitsha,* Nigeria: 1989/1991.

Items	*Regional Output Market* Onitsha			
	Impmech	***Locmech***	***Locman***	***Impman***
1. World Price (FOB-$US/mt tapioca)	221	221	221	221
2. Freight and insurance ($US/mt tapioca)	48	48	48	48
3. CIF, port in Lagos ($US/mt tapioca) (1+2)	269	269	269	269
4. Shadow Exchange rate (nairas / $US)	22	22	22	22
5. CIF price at the port in Lagos (3*4)	5950	5950	5950	5950
6. Domestic costs (nairas/mt tapioca)				
a. Port charges (nairas/mt tapioca)	95	95	95	95
b.Transit and Transport (nairas/mt tapioca)	206	206	206	206
c. Storage and Handling (nairas/mt tapioca)	203	203	203	203
7.Lagos gate price (5+ 6a.c)(nairas/mt tapioca)	6454	6454	6454	6454
8. Importer marketing margin (%)	5%	5%	5%	5%
9. Wholesale price in Lagos (7* (1+ 8))	6777	6777	6777	6777
10. Lagos to Regional Market Center				
a Distance (km)	420	420	420	420
b. Transport cost (nairas/mt tapioca)	1512	1512	1512	1512
c. Handling (nairas/mt tapioca)	114	114	114	114
11. Regional Market Center (Reference Price) Farmgate price(nairas/mt tapioca) (9 + 10a..c)	8403	8403	8403	8403
12. Wholesale marketing margin (%)	5%	5%	5%	5%
13. Wholesale price in Regional Market (nairas/mt tapioca) (11* (1+12))	8823	8823	8823	8823
14.Regional Market Center to Village				
a. Distance (kms)	97	97	97	97
b. Transport and Handling cost (nairas/mt tapioca)	497	497	497	497
15.Village gate price (nairas/mt tapioca)13-14b)	8326	8326	8326	8326
16. Semi-wholesale marketing margin (%)	5%	5%	5%	5%
17.Village Level Semi-wholesale price((1-16)*15)/1000	8	8	8	8
18.Transformation rate (kg tap./ kg of root)	.50	.50	.50	.50
19. Processing cost (nairas/kg of root)	3.09	3.21	3.36	3.60
20. Import Parity Price in the Village (nairas /kg of root) (17*18) -19	0.89	0.77	0.61	0.38

Source: COSCA data, UNCTAD's Review of Maritime Transport 1989-1992, Nigerian Port Authority Statistical Reports (1989-1992), UN Economic and Social Commission For Asia and the Pacific, Reports of 1989 through 1991.

Table A4-10: Estimated Economic Farm Level Budget for *Commercial* Cassava/Maize Production Systems, by Regional Output Markets, Ghana, 1989/1991

Budget Items	*Regional Output Markets*	
	Koforidua	**Kumassi**
1. OUTPUTS		
Average Root Yield (kg/ha)	14346	13694
Average Green Maize Yield (ears/ha)[1]	11526	11526
Market Price of root (cedis/kg)[2]	16	23
Market Price of Green Maize (cedis/ear)[3]	38	38
Revenues from Root (cedis /ha)	232278	317113
Revenues from Green Maize (cedis /ha)	437988	437988
Gross Revenues (cedis /ha)	670266	755101
2. COSTS		
Fixed Costs (/ha)[4]		
Operating costs (/ha)	0	0
Hired Labor[5]	95000	91000
Transportation (cedis/ton)		
Tradable	14256	13640
Nontradable	2376	2273
Interest on Working Capital (8%)	8931	8553
Total Operating Costs (cedis /ha)	120563	115466
Family Labor (@ hired labor wage rate) (cedis /ha)	145000	158000
Opportunity Cost of Land[6] (cedis/ha)	280508	280508
3. PERFORMANCE MEASURES		
Gross Margin (cedis /ha)	549703	639636
Net Returns to family Labor (cedis /ha)	269195	359128
Net Returns per day of Family Labor (cedis /day)	1857	2273
Total production Costs (cedis /ha)	546071	553974
Net Economic Profits (cedis /ha)	124195	201128

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2 of chapter.
[2] Estimated farm level import parity price of root.
[3] Farmgate price based on secondary source of information: the Dept. of Planning, Monitoring and Evaluation (Ministry of food and Agriculture, Accra, Ghana).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest is retained for replanting and for maize, only 2 to 3 percent of the harvest is retained for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[5] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[6] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

TableA4-11: Estimated Financial Farm Level Budget for Commercial Cassava/Maize Production Systems, by Regional Output Markets, Ghana, 1989/1991

Budget Items	*Regional Output Markets*	
	Koforidua	**Kumassi**
1. OUTPUTS		
Average Root Yield (kg/ha)	14346	13694
Average Green Maize Yield (ears/ha)[1]	11526	11526
Market Price of root (cedis/kg)[2]	22	22
Market Price of Green Maize (cedis/ear)[3]	38	38
Revenues from Root (cedis /ha)	315616	301270
Revenues from Green Maize (cedis /ha)	437988	437988
Gross Revenues (cedis /ha)	753604	739258
2. COSTS		
Fixed Costs (/ha)[4]		
Operating costs (/ha)	0	0
Hired Labor[5]	95000	91000
Transportation (cedis/ton)		
Tradable	9504	9093
Nontradable	2376	2273
Interest on Working Capital (8%)	8550	8189
Total Operating Costs (cedis /ha)	115430	110555
Family Labor (@ hired labor wage rate) (cedis /ha)	145000	158000
Opportunity Cost of Land[6] (cedis/ha)	280508	280508
3. PERFORMANCE MEASURES		
Gross Margin (cedis /ha)	638174	628703
Net Returns to family Labor (cedis /ha)	357666	348195
Net Returns per day of Family Labor (cedis /day)	2467	2204
Total production Costs (cedis /ha)	540938	549063
Net Economic Profits (cedis /ha)	212666	190195

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in appendix 2 of chapter 2.
[2] Weigthed average farmgate price based on COSCA data.
[3] Farmgate price based on secondary source of information: the Dept. of Planning, Monitoring and Evaluation (Ministry of food and Agriculture, Accra, Ghana).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest per hectare and for maize only 1 to 2 percent of harvest. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[5] Given that available labor in West African rural areas are mostly unskilled, it is assumed that financial labor cost per day reflects the economic cost of labor.
[6] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the return to land that farmers would enjoy if they produced green maize only.

Table A4-12: Estimated Economic Farm Level Budget for Commercial Cassava/Maize Production Systems, by Regional Output Markets, Cote d'Ivoire, 1989-1991

Budget Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. OUTPUTS		
Average Root Yield (kg/ha)	11811	11274
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of root (fcfa/kg)[2]	12	16
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Root (fcfa /ha)	142989	183303
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	242839	283153
2. COSTS		
Fixed Costs (/ha)[4]	0	0
Operating costs (/ha)		
Hired Labor[5]	49140	47880
Transportation field-to-home (fcfa)		
Tradable	6460	6166
Nontradable	1091	1042
Interest on Working Capital (8%)	4535	4247
Total Operating Costs (fcfa /ha)	61226	57335
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	88830	90090
Opportunity Cost of Land[6] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	181613	223658
Net Returns to family Labor (fcfa /ha)	120778	162823
Net Returns per day of Family Labor (fcfa /day)	857	1139
Total production Costs (fcfa /ha)	210891	210420
Net Social Profits (fcfa /ha)	31948	72733

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2 of chapter 2.
[2] Estimated farm level import parity price of root
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest is retained for replanting and for maize, only 2 to 3 percent of the harvest is retained for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted
[5] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).
[6] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A4-13: Estimated Financial Farm Level Budget for *Commercial* Cassava/Maize Production Systems, by Regional Output Markets, Cote d'Ivoire, 1989-1991

Budget Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. OUTPUTS		
Average Root Yield (kg/ha)	11811	11274
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of root (fcfa/kg)[2]	15	15
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Root (fcfa /ha)	177161	169108
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	277011	268958
2. COSTS		
Fixed Costs (/ha)[4]	0	0
Operating costs (/ha)		
Hired Labor	49140	47880
Transportation (fcfa)		
Tradable	4365	4166
Nontradable	1091	1042
Interest on Working Capital (8%)	4368	4247
Total Operating Costs (fcfa /ha)	58964	57335
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	88830	90090
Opportunity Cost of Land[5] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	218047	211623
Net Returns to family Labor (fcfa /ha)	157212	150788
Net Returns per day of Family Labor (fcfa /day)	1115	1054
Total production Costs (fcfa /ha)	208629	208260
Net Enterprise Profits (fcfa /ha)	68382	60698

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2 of chapter 2.
[2] Weighted average farmgate price based on COSCA data.
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest is retained for replanting and for maize, only 2 to 3 percent of harvest. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[5] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A4-14: Estimated Economic Budget for Commercial Cassava/Maize Systems under Technology Combination "LOCMAN"[1], by Regional Output Markets, Nigeria, 1989/1991

Budget Items	*Regional Output Markets*	
	Abeokuta	**Onitsha**
1. OUTPUTS		
Average Root Yield (kg/ha)	12337	11776
Average Green Maize Yield (ears/ha)[2]	9614	9614
Market Price of root (nairas/kg)[3]	0.24	0.61
Market Price of Green Maize (nairas/ear)[4]	1.5	1.5
Revenues from Root (nairas /ha)	2911	7230
Revenues from Green Maize (nairas /ha)	14421	14421
Gross Revenues (nairas /ha)	17332	21651
2. COSTS		
Fixed Costs (nairas/ha)[5]	0	0
Operating costs (nairas/ha)		
Hired Labor[6]	1680	1995
Transportation (nairas)		
Tradable	1538	1472
Nontradable	296	283
Interest on Working Capital (8%)	281	300
Total Operating Costs (nairas /ha)	3795	4050
Family Labor (@ hired labor wage rate) (nairas /ha)	2688	3486
Opportunity Cost of Land[7] (nairas/ha)	8362	8362
4. PERFORMANCE MEASURES		
Gross Margin (nairas /ha)	13536	17601
Net Returns to family Labor (nairas /ha)	5174	9239
Net Returns per day of Family Labor (nairas /day)	40	56
Total production Costs (nairas /ha)	14845	15898
Net Economic Profits (nairas /ha)	2486	5753

Source: COSCA survey data

[1] Local variety and manual processing

[2] Estimated using the "Ear Weight Method" discussed Appendix 2 of chapter 2.

[3] Estimated Farm Level Import Parity Price of root

[4] Farmgate price based on secondary source of information (personal communication with IITA).

[5] Farmers did not purchase planting materials of food crops but produced their own: for cassava, only one fifth of the stems from previous harvest are retained for replanting and for maize, only 2 to 3% of the previous harvest is saved for seed. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.

[6] Although rural labor markets in West Africa are complex, it is reasonable to assume that market wages offer good approximations to shadow wages (Humphreys in Rice in West Africa, p. 80, 1981).

[7] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the Gross Margin that farmers would enjoy if the produce green maize only.

Table A4-15: Estimated Financial Farm Level Budget for *Subsistence* Cassava/Maize Production Systems, by Regional Output Markets, Cote d'Ivoire, 1989-1991

Budget Items	*Regional Output Markets*	
	Bonoua	**N'douci**
1. OUTPUTS		
Average Root Yield (kg/ha)	11811	11274
Average Green Maize Yield (ears/ha)[1]	3994	3994
Market Price of root (fcfa/kg)[2]	15	15
Market Price of Green Maize (fcfa/ear)[3]	25	25
Revenues from Root (fcfa /ha)	177161	169108
Revenues from Green Maize (fcfa /ha)	99850	99850
Gross Revenues (fcfa /ha)	277011	268958
2. COSTS		
Fixed Costs (/ha)[4]	0	0
Operating costs (/ha)		
Hired Labor	49140	47880
Transportation (fcfa)		
Tradable	4365	4166
Nontradable	1091	1042
Interest on Working Capital (8%)	4368	4247
Total Operating Costs (fcfa /ha)	58964	57335
Family Labor (valued @ hired labor wage rate) (fcfa /ha)	88830	90090
Opportunity Cost of Land[5] (fcfa/ha)	60835	60835
3. PERFORMANCE MEASURES		
Gross Margin (fcfa /ha)	218047	211623
Net Returns to family Labor (fcfa /ha)	157212	150788
Net Returns per day of Family Labor (fcfa /day)	1115	1054
Total production Costs (fcfa /ha)	208629	208260
Net Enterprise Profits (fcfa /ha)	68382	60698

Source: COSCA survey data

[1] Estimated Farmgate price using the "Ear Weight Method" discussed in Appendix 2.
[2] Weighted average farmgate price based on COSCA data.
[3] Farmgate price based on personal communication with Centre Ivoirien de Recherches Economiques et Sociales (CIRES).
[4] Farmers did not purchase planting materials of food crops; they produced their own: for cassava, only one fifth of the stems from previous harvest is retained for replanting and for maize, only 2 to 3 percent of harvest. Therefore, the opportunity cost of planting materials, which is relatively insignificant, is not counted.
[5] Land is very rarely sold or rented. In this budget, the opportunity cost of land is estimated as the net return to land that farmers would enjoy if they produced green maize only.

Table A4-16: Policy Analysis Matrix (PAM) for *Commercial* Cassava/Maize Systems in Nigeria under alternative production and processing combinations and by distance between output markets and the village/farm: Net Financial Profitability (nairas /ha), Net Social Profitability (nairas/ha), and Net Effects of Policy-Induced Transfers: 1989/1991.

	Regional Output Markets/							
	Abeokuta				**Onitsha**			
Technology	Revenues	Costs		Profits	Revenues	Costs		Profits
		Tradable Inputs	Domestic Factors			Tradable Inputs	Domestic Factors	
IMPMECH								
Financial Prices	26466	1666	15267	9532	25918	1594	15124	9200
Social Prices	23851	2166	15307	6378	32281	2064	15161	15055
Divergences	2614	-500	-40	3154	-6362	-470	-38	-5855
LOCMECH								
Financial Prices	21453	1183	13279	6991	21133	1132	14399	5602
Social Prices	18823	1538	13307	3978	23500	1472	14426	7602
Divergences	2630	-355	-28	3013	-2367	-340	-27	-2000
LOCMAN								
Financial Prices	21453	1183	13279	6991	21133	1132	14399	5602
Social Prices	17332	1538	13307	2486	21651	1472	14426	5753
Divergences	4121	-355	-28	4505	-518	-340	-27	-151
IMPMAN								
Financial Prices	26466	1666	15267	9532	25918	1594	15124	9200
Social Prices	16184	2166	15307	-1289	22030	2064	15161	4805
Divergences	10282	-500	-40	10822	3888	-470	-38	4396

Source: 1) PAM Model constructed by the author but not shown due to space limitation;
2) Tables A3-9 through A3-16.

Note: Divergences are calculated as financial prices *minus* economic prices

Table A4-17: **Policy Analysis Matrix (PAM) for Commercial Cassava/Maize Production Systems in Ghana: Net Financial Profitability ($US /ha), Net Social Profitability ($US/ha), Comparative Advantage and Net Effects of Policy-Induced Transfers, 1989-1991.**

	Regional Output Markets							
	Koforidua				**Kumassi**			
	Revenues	Costs		Profits	Revenues	Costs		Profits
		Tradable Inputs	Domestic Factors			Tradable Inputs	Domestic Factors	
Financial Prices	1168	15	824	330	1146	14	837	295
Social Prices	1039	22	825	193	1171	21	838	312
Divergences	129	-7	-1	137	-25	-7	-1	-17

Source: PAM Model constructed by the author but not shown due to space limitation

Following Monke and Pearson (1989), for each production system, let A= revenues in private prices, B= tradable inputs at private prices, C= domestic factors valued at private prices, E= revenues valued at social prices, F= tradable inputs valued at social prices, G= domestic factors valuedat social prices. Then:

D = A - (B+C) = private profits which indicate competitiveness under existing policies

H = E - (F+G) = social profits which measure efficiency or comparative advantage

I = A - E = output transfers

J = B - F = input transfers

K = C - G = factors transfers

L = D - H = I - (J+K) = net transfers

Table A4-18: **Policy Analysis Matrix (PAM) for *Commercial* Cassava/Maize Production Systems in Cote d'Ivoire: Net Financial Profitability ($US /ha), Net Social Profitability ($US/ha), and Net Effects of Policy-Induced Transfers, 1989-1991.**

	Regional Output Markets							
	Bonoua				**N'douci**			
	Revenues	Costs		Profit	Revenues	Costs		Profit
		Tradable Inputs	Domestic Factors			Tradable Inputs	Domestic Factors	
Financial Prices	703	11	518	92	683	11	518	154
Social Prices	616	16	519	81	719	16	518	185
Divergences	87	-5	-0.4	92	-36	-5	-0.4	-31

Source: PAM Model constructed by the author but not shown due to space limitation
Note: Divergences calculated as financial prices *minus* economic prices

CHAPTER 5

CONCLUSIONS AND EXTENSIONS

Sub-Saharan Africa (SSA) cassava- producing countries such as Nigeria, Ghana, and Côte d'Ivoire have developed, in recent years, an interest in cassava as an alternative food crop. This has led to a major expansion in cassava- based production systems in Nigeria and Ghana, whereas there has been a slower growth in Côte d'Ivoire (Nweke et al., 1998).

This study was based on the argument that the difference in various factors such as agricultural policies (i.e., trade and price policies, domestic production taxes or subsidies), location and technologies (production and processing) between Nigeria, Ghana and Côte d'Ivoire explain the difference in the level of growth in cassava-based production systems.

The main objective of this study was to examine the magnitude of the impact of these factors on the private and social profitability of cassava production and post-production processing in Côte d'Ivoire, Ghana and Nigeria.

The topic has not been examined in previous studies. The study relied primarily on data for Côte d'Ivoire, Ghana and Nigeria from the Collaborative Study of Cassava in Africa (COSCA) survey. The data were collected between 1989 and 1992.

5.1. Regarding the Impact of Various Factors (e.g., agricultural policies, location and technologies) on the Profitability of Cassava-based Production Systems in West Africa

In the preceding chapters, the policy analysis matrix (PAM) model was used in three essays: 1) to evaluate the effects of government policies (i.*e., outputs and inputs pricing policies and trade policies)* and location of production on the relative profitability and comparative advantage of cassava/maize and rainfed rice/maize systems in the humid lowland zones of Cote d'Ivoire; 2) to examine the relative profitability (financial and social) and comparative advantage of cassava/maize production systems under four alternative production and processing technology-combinations in Nigeria: "*Impmech*", "*Locmech*", "*Locman*", and "*Impman*" defined as follows: a) *Impmech* refers to IITA's improved cassava variety processed using a mechanized grating method, b) *Locmech* refers to local cassava variety processed using a mechanized grating method, c) *Locman* refers to local cassava variety processed using a manual grating method), d) *Impman* refers to IITA's improved cassava variety processed using a manual grating method.; and 3) to compare the magnitude of the impact of agricultural policies, technologies (production and processing) and location of production on the private and social profitability of cassava/maize production systems in three West African countries (Côte d'Ivoire, Ghana and Nigeria). The intent of this comparative essay was to use the PAM approach to push the profitability analysis further than can be done within the context of a single country. A summary of the principal conclusions presented in each essay follows. However, at this point, it is worth noting the limitations of this study:

1. The economic import parity prices of cassava roots used in the analyses were estimated, based on the import parity price of *tapioca*, a close substitute of *attieke*,

which is not internationally traded. This was considered more appropriate than valuing cassava as a nontraded good, based on the domestic market price. However, these import parity prices may not reflect the true economic price of cassava roots in Cote d'Ivoire.

2. Unfortunately, the COSCA study did not record maize yields on its sample fields. Therefore, in computing the enterprise budgets developed in this study, it was assumed that those fields got the national average maize yield, which was then converted to the number of fresh corn ears using the "Ear-Weight Method" discussed in the appendix of chapter 2. Corn ears were subsequently valued at the fresh corn price per ear.

3. At the market level, the PAM does not consider supply and demand interactions involving changes in input and output prices. Furthermore, it is assumed that market prices are given. This assumption implies that changes in the scale of the productive activity have no effect on either price paid or received.

The baseline results in essay 1 (chapter 2) showed that cassava/maize systems have a competitive advantage over their competitors in Cote d'Ivoire. That is, profitabilities (financial and social) of cassava/maize systems significantly exceed those of rainfed rice/maize systems. These results indicated that cassava/maize production systems were efficient given current technologies. In addition, the baseline results indicated that, farmers operating at the Bonoua market (near urban center) benefit from a small implicit price support whereas farmers operating in N'douci (distant from urban center) were subject to a small implicit tax (table 5.1).

Table 5.1: Financial and Economic Prices (in francs CFA) of cassava roots by Output markets, Cote d'Ivoire, 1989/1991

Prices \Markets	**Bonoua**	**N'douci**
Financial Prices	15	15
Economic Prices	12	16
Differentials	+3	-1

Source: COSCA data and table A2-3 in Appendix 2

Table 5.2: Financial and Economic Prices (in francs CFA) of paddy, Cote d'Ivoire, 1989/1991

Prices \Markets	**Bonoua** (Close to the port city)	**N'douci** (Distant from the port city)
Financial Prices	60	60
Economic Prices	59	65
Differentials	+1	-5

Source: COSCA data and table A2-4 in Appendix 2

On the other hand, the farm-gate market financial price of paddy is 60 fcfa which departs from its estimated import parity price by +1 fcfa per kilogram when Bonoua is used as a point of sale and –5 fcfa per kilogram when N'douci is used as a point of sale (table 5.2).

It should be emphasized that these differentials are relatively small. With this in mind, here are some plausible explanations of why market (financial) prices and economic prices (import parity prices) did not equal in both markets. The divergences between these two prices could be due to a combination of the effect of the rice import tariff and the effect of the overvaluation of the franc CFA. The indirect effect of the rice import tariff will be an increase in the financial price of cassava root relative to the economic price in the two markets (Bonoua and N'douci). On the other hand, the currency overvaluation will have the effect of lowering the financial price of tradables such as roots and transport in both markets.

However, the magnitude of the reduction in prices will be large in N'douci and small in Bonoua because the share of transport costs in the import parity price is relatively large for N'douci (distant from the port city) and relatively small for Bonoua (close to the port city). Transportation costs thus provide a natural protection to domestic producers who supply markets located far from the import point.

Thus, the net effect is as follows: 1) in N'douci: an increase in the financial price of roots due to the import tariff and a relatively large decrease in the financial price of roots due to the currency overvaluation (via its impact on tradable goods such as cassava and transport costs); and 2) in Bonoua: an increase in the price of roots due to the import tariff and a relatively small decrease in the financial price of roots due to the currency overvaluation.

During the period of the survey, Ivorian farmers only grew local landrace cassava variety. To test the robustness of the baseline results, a sensitivity analysis was carried out under the assumption that farmers would adopt the IITA improved variety. The simulation findings indicated that: 1) a 5 to 15 percent increase in yields per hectare of cassava and rainfed rice would not only further enhance the comparative advantage of cassava/maize systems but also cause rice/maize systems, which were unprofitable at the baseline, to become socially profitable; and 2) a 35% depreciation of the equilibrium exchange rate (more fcfa per $US) also increased the profitability of both systems.

The second essay (chapter 3) dealt with the evaluation of the social profitability of cassava/maize systems, under alternative production and processing technology combinations, in Nigeria. The baseline results show that the net social profitabilities (NSP) of systems under "*Impmech*" technology exceed those of systems under other

alternative technologies, namely "*Locmech*", "*Locman*" and "*Impman*". That is, systems under "*Impmech*" are the most efficient use of national resources. This is an important finding in the sense that it indicates clearly that returns to both the better cultivars (IITA's variety) and the better processing method (mechanical graters) are higher than adopting either one separately.

Baseline results were reestimated under alternative scenarios. The simulation results indicated that a depreciation of the real exchange rate (more nairas per US dollar) would increase significantly the profitabilities of cassava/maize systems under the technology combinations "*Impmech*" and "*Locmech*". The lack of profitability of "*Impman*" and "*Locman*" is due to the fact that these are returns to roots (not *gari*) production, but the economic price of roots depends on the import parity price of tapioca and the assumed processing technology. The more efficient processing technology (the mechanized method) is assumed to bid up the price of the root, as more processed product (represented by tapioca) can be obtained from each kilogram of roots. With a higher economic value of output (in local currency terms), the returns to the more technically efficient mechanical processing increases.

The final essay (chapter 4) borrowed results from the first two essays and constructed a PAM for Ghana to compare the competitiveness of cassava/maize systems in Cote d'Ivoire, Ghana and Nigeria. The baseline results compared in this study demonstrated the similarity in efficiencies of production in these West African countries. The difference between the DRCs (table 4-8) of the three countries is minimal, although labor input (in monetary terms) for Nigeria and Ghana is 15 to 30 percent higher than for Cote d'Ivoire. This is due to the fact that higher output prices in Nigeria and Ghana

overcome the high labor inputs cost (higher wages). Overall, the baseline results showed that the extent of divergences between financial and economic prices (especially for tradable inputs and domestic factors prices) observed in the three countries is relatively small.

Again, a sensitivity analysis was carried out. The simulation findings indicated that, in Cote d'Ivoire, farmers benefited from the depreciation of the equilibrium exchange rate while farmers in Ghana and Nigeria suffered losses. The impact of this change in shadow exchange rates was of greater magnitude in Ghana, causing cassava production systems to become inefficient (tables 4-11 and 4-12 in Chapter 4). This counter-intuitive result can be explained by the fact that in Ghana, farm level wage rates rose from 1000 cedis to 4000 cedis (a 300 percent increase) while output price rose from 22 cedis to 65cedis (a 195 percent increase). Simulation results also indicated that Ivorian and Ghanaian cassava/maize farmers could benefit from growing IITA's improved variety and adopting mechanized processing methods.

5.1.1. Agricultural Policies

The results of this study have several implications for the three West African countries' goal of reaching regional self-sufficiency in food crops in West Africa.

First, the simulation results indicated that the potential for governments to assist in income growth lies in areas other than commodity market price policy. In Nigeria and Ghana, protectionism can be viewed as an expression of an inward-looking import-substitution strategy. Thus, the realization of income gains for cassava/maize farmers in Nigeria and Ghana depended in the 1980s and the early 1990s on a change in foreign exchange rate policy.

Second, in Cote d'Ivoire and Ghana, simulation results indicated that cassava/maize farmers could benefit from growing IITA's variety and adopting mechanized processing methods. Baseline results for Nigeria clearly indicated that the "*Impmech*" technology combination reduces labor costs, which is good in case of labor constraints. The greater profitability of cassava/maize systems compared to rainfed rice/maize systems should encourage their expansion and the reduction of the area planted.

Another policy implication that can be drawn from this study relate to the finding that in Cote d'Ivoire, the cost of kilocalorie production is considerably lower via cassava/maize systems than it is via rainfed rice/maize systems. What this conclusion means is that, in terms of food security, cassava/maize systems have a huge potential to help the poor. Therefore, Ivorian policymakers could capitalize on this potential. One option is to invest in research and development programs that would facilitate the adoption of the ITTA's variety and mechanized processing methods.

However, as already discussed in chapter 1, various policy outcomes may be efficient given policy-makers' definition of different economic agents' property rights at that point of time. Policies are instruments of action that governments employ to effect change in a given period (often one year) for a given situation. Thus policy outcomes are situation-specific and time-specific. The point being that an efficiency objective is relevant given the structure of property rights that underlie it. A change in property rights will result in a change in what is efficient.

5.1.2. Technologies

Simulation results in essay 3 (chapter 4) indicated that cassava farmers in Cote d'Ivoire and Ghana could benefit from growing IITA's improved variety and adopting mechanized processing methods. However, COSCA data indicate that mechanized processing methods were available in Cote d'Ivoire but Ivorian farmers made very little use of them. Farmers claim, according to the survey, that the wet paste obtained from manual grating resulted in better quality *attieke* (called *Agbodjama*) than the *attieke* from the paste obtained from motorized graters.

This suggests that improved processing technologies are needed but they must fit easily into farmers crop and food production systems and consumer preferences. For example, graters must meet local post-harvest requirements in terms of cooking quality. The question that arises for technology generation and transfer institutions is whether national research institutions in Cote d'Ivoire are working on the production of an adequate stream of processing technologies that meet the characteristics above.

Although, the development of appropriate technology is necessary, it is not a sufficient condition for ensuring its adoption. One must design a system of technology transfer that provides farmers with inputs and information they need to enhance productivity. The adoption of mechanized graters, for example, will be conditioned by the elasticity of supply of cassava roots, the availability of farm credit, and price policies. There is ample evidence that small-scale farmers in Africa do accept well-adapted technologies, once these are made available, along with appropriate institutional support (Byerlee and Heisey, 1992).

5.2. Extensions

There are three other areas of interest for further research. One important issue is the marketing systems for processed cassava products. The marketing system for these products is defined here as a distribution system from processors to consumers. The performance of this system needs to be evaluated in term of its efficiency with respect to various factors such as time, space and its capacity and flexibility to handle varying quantities of outputs. The internal marketing system transmits world prices to domestic cassava markets and allocates cassava production among its various domestic and international uses. The efficiency of the marketing system helps to determine incentives to cassava producers and costs to consumers of cassava products. Particularly important would be to examine how cassava marketing has changed since the end of the COSCA studies in 1991, with the increase in the export of cassava chips to Europe for livestock feed.

The second issue, that needs to be studied, is the lack of adoption of improved production and processing technologies in Cote d'Ivoire and Ghana. COSCA data indicate that new IITA production technologies have not been widely introduced to farmers in both countries. As already mentioned, in Nigeria, production systems under the "*Impmech*" technology (IITA's improved cassava variety processed using mechanized grating) generate returns far higher than systems under the other technologies. The incentives for farmers to adopt technology are determined in large part by the expected profitability of the innovation. Therefore, there is a need for a study that will examine the relationship between markets and incentives for technology adoption in Cote d'Ivoire and Ghana.

The third and final area for further research concerns the effect of currency devaluation and market liberalization policies on the cassava sub-sector in West Africa. The COSCA survey took place between 1989 and 1992. Since then, a number of policy reforms have occurred. For example, in January 1994, the CFA franc was devalued from 1 French franc= 50 franc cfa to 1 French franc= 100 franc cfa .As Staatz (1994) put it, "the devaluation was a dramatic event, but is part of much longer process of structural change in the Francophone West African economies". Therefore, Francophone West African policy-makers, producers and consumers could benefit greatly from empirical information and analyses about the effects of devaluation on a very important source of sustenance in the region such as cassava and cassava products.

5.3. Conclusions

Recent impact simulations indicate that roots and tubers will play important and increasingly diversified roles in developing –country food systems over the next two decades (Scott et al., 2000). Furthermore, simulation results indicate that in Sub-Saharan Africa, continued high rates of population growth and urbanization, combined with comparatively low level of per capita income and limited economic growth, will promote growth in the use of cassava as food and catalyze its sustained penetration in urban markets.

It is hoped that the results of this study can help guide national investment decisions in agricultural research and extensions to make cassava roots and cassava processed products more marketable in the region of West Africa. An example of such investments would the financing of national or regional research programs that involve

market appraisals and the identification of linkages between producers, processors and policy-makers that capitalize on cassava's potential for expanded use in processed form.

REFERENCES

Byerlee Derek and Heisey Paul. 1993. "Strategies for Technical Change in Small-Farm Agriculture, with Particular Reference to Sub-Saharan Africa" in Russell Nathan C. and Christopher R. Dowswell, *Policy Options For Agricultural Development in Sub-Saharan Africa,* CASIN/SAA/GLOBAL 2000.

Nweke, Felix I., K. N'Goran, A.G.O. Dixon, B.O. Ugwu, O. Ajobo, and T. Kouadio. 1998. Cassava production and processing in Cote d'Ivoire. The Collaborative Study of Cassava in Africa, *Working Paper No. 23,* IITA, Ibadan, Nigeria.

Scott G. J., Rosegrant M. W., Ringler C., 2000. Roots and Tubers for the 21st Century: Trends, Projections, and Policy Options, *Food, Agriculture, and the Environment Discussion Paper 31,* International Food Policy Research Institute, Washington, D.C., USA.

Staatz, John. " Designing Food Security Strategies in a Rapidly Changing Social, Political, and Economic Environment: Challenges for the Sahel (with special emphasis on the CFA devaluation)." Presentation to AID/W-Africa Bureau, Sahel/West Africa Office and ARTS/FARA. February 17, 1994.