Comparative Economic Advantage Analysis of Alternative Agricultural Production Options in Tanzania

Mbiha*, E.R., F.M. Turuka[1], A.E. Temu[1], N.S.Y. Mdoe[1] and M.E. Mlambiti[1]

[1]Department of Agricultural Economics and Agribusiness, Sokoine University of Agriculture, P.O. Box 3007, Morogoro, Tanzania

Abstract

The objective of this paper was to analyze the comparative agricultural economic advantage and extent of policy distortion in alternative agricultural production activities in various agro-ecological zones and farming systems, in Tanzania. The Domestic Resource Cost (DRC) ratio derived from the Policy Analysis Matrix (PAM) was used to evaluate comparative economic advantage. The methodology was also used to evaluate effects of policy in the production and trade patterns using Nominal Protection Coefficient (NPC) and Effective Protection Coefficient (EPC) as measures of policy distortion. Data was collected from selected locations in a number of agro-ecological zones and farming systems in Tanzania. Domestic Resource Costs for Southern Highlands coffee (DRC = 0.91), Western zone cotton (DRC = 0.60) and Morogoro rice (DRC = 0.97) were less than one. On the other hand DRCs for Northern highlands coffee (DRC = 1.98) and Morogoro maize (DRC = 1.47) were greater than one. These results suggest that Tanzania possesses comparative advantage in the production of Southern Highlands coffee, Western Zone cotton and Morogoro rice. The country has comparative disadvantage in production of northern highlands coffee and Morogoro maize. Wide variations in comparative advantage shown emanate from differences in resource and biophysical conditions, farming systems, technology levels and tenure arrangements. In general the measures of distortion (NPCs and EPCs) indicate that government price policy protected food crops while cash crops (except northern zone coffee) were taxed. Given these results, effective measures toalleviate production constraints and improve gross margins must be instituted in order to motivate farmers to increase resource allocation to the crops for which specific locations have comparative disadvantage.

Keywords: Comparative advantage, Domestic resource cost, Policy analysis matrix, Agricultural production and trade, Coffee, Cotton, Maize, Rice, Tanzania

Introduction

Agriculture is the foundation of the Tanzania's economy, as it supports employment for a very large percentage of the population, provides food and exports. About 84% of the employed population work in agricultural related activities, producing 61% of both GDP and merchandise exports. On the average, agriculture accounts for no less than 50% of the total GDP. Within agriculture, the crop sub-sector (made up of exports and domestic crops) accounts for 60% of agricultural production on average (World Bank, 1994; URT, 1995; Mlambiti and Isinika, 1997). Since agriculture is of paramount importance for Tanzania's economy, the performance of the sector has been the subject of intense debate and scrutiny. Of the domestic crops, cereals are dominant, whereas the major export crops are cotton, coffee, tea, tobacco and pyrethrum.

The performance of the sector has remained poor for a number of years (Mlambiti and Isinika, 1997). Though the situation improved since the inception of the economic reform policies in the early 1980s, generally the performance is still low. In order to take full advantage of the economic reform policies in

*Corresponding author

stimulating agricultural growth and development, strategies which take into account the differences in comparative advantage of agro-ecological zones in the country are important. Apart from the environmental differences (weather, rainfall, etc.), the administrative aspects of the fiscal system, especially the costs of implementing policies, are most likely to vary from one agro-ecological zone to another. There are also variations in the infrastructure. In the simple case where due to good infrastructure an area has better access to government subsidised inputs than others, the distortions from such government policy will affect farmers in that particular area differently from those in the other areas.

Moreover, there exist different production (farming) systems and technologies for each agricultural sub-sector (crop) even within the same agro-ecological zone. Maize for example, has a range of production systems and technologies: maize/legume using hand hoe; maize/legume using oxen; maize/millet using hand hoe etc. Formulated policies on oxen use or farm output will affect these systems differently. Policy distortions will depend on which system is prominent in the area.

In the long term, sustainable agricultural growth and food security requires sustained access to international markets. This argument hinges on comparative advantage between countries. This is of particular significance with the growing emphasis on economic integration among southern and eastern African countries. Unfortunately not much is known as to the extent and magnitude of inter-regional trade taking place. For example, it is argued that cross border trade among the eastern and southern African countries is overwhelming but there is inadequate knowledge of its magnitude, determinants and consequences (Ackello-Ogutu and Echessah, 1997). The lack of knowledge leads to under-valuation of figures in the national accounts and inhibits formulation of appropriate policies and strategies to exploit comparative advantage between countries. Furthermore, the comparative advantage which exists within the country can neither be exploited. The lack of facts on the comparative advantage within the country and between Tanzania and her trading partners is an apparent gap in economic literature.

Given this background, the objective of this study was to analyse the comparative economic advantage of alternative agricultural production activities in various agro-ecological zones, under different levels of technology.

The specific objectives of the study were to:

1. evaluate the comparative economic advantage of alternative agricultural production activities in various ecological zones, under different levels of technology and land tenure systems;
2. analyze the potential impacts of removing existing price and policy distortions on the economic efficiency of alternative productive uses of the country's resources;
3. identify points of policy, technology, and institutional interventions to enhance economic efficiency and direct agricultural resources to their most productive uses;
4. build Tanzania's data component needed for conducting regional analyses of comparative economic advantage in agricultural commodities for southern Africa.

Methodology

Analytical approach

The study was guided by the comparative advantage analytical concept. Comparative advantage is best assessed by comparing current levels of domestic opportunity costs, relative to market prices in trade. Empirically, comparative economic advantage analysis can have two meanings: the first is the comparison of efficiency of production among two or more trading nations. Theoretically nations with the lowest opportunity costs are relatively more efficient and have therefore a comparative advantage (Tsakok, 1990; Masters, 1995; Masters and Winter-Nelson, 1995). The second meaning of comparative advantage is to compare the efficiency of different kinds of production within the domestic economy. These are compared in terms of earning or saving foreign exchange. The two meanings nevertheless relate to each other. If domestic production costs are less than in other countries, then the economy gains in efficiency terms, in producing the trad-

able goods. The principle of comparative advantage is therefore anchored on the assertion that countries will respond to increased opportunity to trade by exporting more of those commodities which they are able to produce relatively cheaply, and import more of those commodities which are expensive to produce at home (Evans, 1997). For example, a country with a higher labour to land ratio than its trading partners is expected to specialise in the production of labour intensive commodities and import most of its land intensive commodities from those countries which have higher land-labour ratio (Deordorff, 1984).

The Policy Analysis Matrix (PAM) developed by Monke and Pearson (1989) is used as a formal way to derive determinants of comparative economic advantage. The PAM is typically organised as shown in Table 1 and it has become a popular way of presenting policy-analysis and project-appraisal data (Byerlee, 1989; Nelson and Panggabean, 1991; Masters, 1994)

A number of economic ratios can be derived from the PAM (Table 1). These economic ratios are useful indicators for the comparison of unlike outputs. Common measures directly calculated from the PAM table are as follows:

The Private Cost Ratio (PCR) = C/A-B.
Net Social Profit (NSP) = E-F-G = H
The Domestic Resource Cost Ratio (DRC):
DRC = G/E-F.
The Nominal Protection Coefficient (NPC)
- On tradable outputs (NPCO) = A/E
- On tradable inputs (NPCI) = B/F.
The Effective Protection Coefficient (EPC):
EPC = A-B/E-F.
The Profitability Coefficient (PC):
PC = (A-B-C)/(E-F-G) or D/H
Subsidy Ratio to Producers (SRP):
SRP = L/E or (D-H)/E.
Social Cost Benefit Ratio = (F + G)/E

For the purpose of this study, the NPC and EPC were used to evaluate the effects of current policies or market failures and the DRC was used to measure comparative economic advantage (Monke and Pearson, 1989; Masters and Winter-Nelson, 1997). The NPC is a ratio that contrasts the observed commodity (private) price with a comparable world (social) price. This ratio indicates the impact of policy (and of market failures not corrected by efficient policy) that causes a divergence between the two prices. The EPC is the ratio of value added in private prices to value added in world prices. The EPC ratio measures the degree of policy transfer from product market – output and tradable input policies.

Two conditions need to be met for a production option to be an efficient user of the country's resources: First, the foreign exchange cost of the domestically produced product must be less than its import price at the same foreign exchange value, i.e., the cost of producing the product domestically must be less than the cost of importing the same product.

Table 1: Measures of economic efficiency and policy distortions: The policy analysis matrix (PAM)

Measure		Tradable	Non-tradable domestic resources	
Profits	Revenues	Inputs		
1 Private prices	A	B	C	D
2 Social prices	E	F	G	H
3 Effects of divergences and efficient policy	I	J	K	L

Notes:
D = Private profits = A-B-C.
H = Social profits = E-F-G.
I = Output transfers = A-E.
K = Factor transfers = C-G.
J = Input transfers = B-F
L = Net transfer = D-H or I-J-K.
source: Adapted from Monke ans Pearson (1989).

Secondly, the net foreign exchange gain from producing that product must exceed the net economic gain foregone from using the same amount of domestic resources to produce alternative products; i.e., the gains from using resources such as land, labour, capital and water must be greater than the opportunity cost of using these resources in other production activities.

The DRC ratio generated from the PAM can be interpreted as follows:

DRC ratio = Value added domestically in terms of opportunity costs/ Value added in border prices

The ratio can take on values equal to 1, 1, or if DRC ratio is 1, then comparative disadvantage exists in that, since the DRC coefficient shows the domestic resource costs incurred per unit of foreign exchange earned or saved, the cost of producing a good domestically is greater than that associated with importing the good. If DRC ratio is 1, this implies a comparative advantage, since the good can generate foreign exchange at a lower resource cost than can direct purchase of foreign exchange.

Results obtained from DRC ratio analysis offer useful information to policy makers in directing resources to their most productive use. Furthermore, it enables one to determine the contribution to net social gains and the economic efficiency of competing crops under various policy and technological scenarios.

Comparative economic advantage is influenced by biological and climatic conditions, level of technology and production systems; markets and infrastructure and resource endowments such as land , labour and water. These factors were taken into account and the following convention was adopted to group commodities according to these factors:

1. The agro-ecological zonation approach has been used as the framework for classifying production environments according to biophysical conditions
2. Differences within agro-ecological zones (AEZ) due to variations in technology, tenure, etc., have been captured by coding every production system as a distinct activity.
3. Variations in market and infrastructure factors are reflected in prices and transportation costs. These variations are captured by defining a central market node for every commodity at which all trade will be assumed to take place. Consequently, prices and transport costs between these market centres (nodes) reflect the opportunity cost of producing a commodity locally versus importing it from another region/zone or from another country.
4. Variations in resource endowments is reflected in the relative rental values of those resources in the different market centers.

Policy distortions are captured by measuring the divergence between market and social prices of goods and services on the input and product sides.

It is worthy to note of the vastness and complexity of Tanzania in terms of climate, soils, and topography. According to the Land Resources Development Centre (LRDC) classification there are 6 major agro-ecological zones in Tanzania: Coast, Arid lands, Semi-arid lands, Plateaux, Southern and Western Highlands, Northern Highlands and isolated granitic mountains (LRDC, 1987). In terms of agricultural potential the regions of Tanzania are divided into three broad categories: (1) High potential areas - the highlands and plateaux; (2) intermediate potential areas - coastal and semi-arid lands and (3) low potential areas - arid lands.

The geographical locations of the high potential areas in Tanzania are far away from the port and main consumption areas, thus diminishing their expected high response to improved prices and marketing incentives. On the other hand, low potential areas may have been disadvantaged by the policy framework. Several places could fall under the same agro-ecological zone but differ in production system depending on interaction among climatic, soil, technical, economic, social and cultural factors. The farming systems classification adopted follows the work by Ruthenberg (1971). Six farming systems have been identified for Tanzania (FAO Food Security Programme, 1991; ADIS, 1992):

Coffee/banana/horticulture;
Maize/legumes;

Pastoralist & agro-pastoralist system;
Livestock/sorghum-millet;
Wetland paddy/sugarcane;
Cassava/cashew/coconut.

Ideally each major zone and farming system could be represented by the important enterprises produced there. Furthermore, it is necessary to include under each enterprise any other variations based on location, enterprise size and any other important variations. However, the task of assembling such an amount of data so as to take into consideration all of the above variations would have been very costly indeed. Therefore the crops studied were selected according to data availability within the time and cost dimension. Table 2 shows the enterprises that were considered in this study.

Table 2: Location and type of agricultural products included in the study

Agro-ecological zone	Farming system considered	Crop enterprise considered	Technology in use	Location of data sources
Semi Arid lands	-Livestock, Sorghum & millets, maize/legume	1. Cotton (WCGA)	Hand hoe and oxen	Mwanza & Kahama
		2. Maize	Hand hoe	Morogoro
Northern highlands & isolated granitic mountains	Coffee/banana/horticulture	Nothern arabica coffee	Hand hoe	Kilimanjaro
South western Highlands and Alluvial Plains	Maize/legume	1. Southern arabica coffee	Hand hoe	Mbozi
	Coffer/banana/horticulture	2. Maize	Hand hoe	Mbinga
	Paddy/rice, sugarcane	Paddy	Hand hoe	Morogoro

Description of the crop enterprises studied

Cotton production

Cotton is grown in two major producing areas, i.e. the WCGA and the ECGA. Most of the cotton, however, is produced in the WCGA and within this zone only two regions, Mwanza and Shinyanga constitute the main producers contributing about 75% of the total cotton output in the country. Almost all the cotton produced in the country is by smallholder farmers. The cotton production system under smallholder agriculture depends largely on a simple cultivation tool, the hand hoe. In Mwanza and Shinyanga regions, some farmers use oxen or hired tractor for cultivation. Most other operations are done by family and/or hired labour.

Lint is the major export product from cotton. Oil and cake are mainly consumed domestically. The appropriate price of these two by-products is the FOB border price at the DSM port. On the other hand FOB prices for lint is the CIF price at the port of destination minus insurance and freight from Dar-es-Salaam to that port. Data was obtained from Mwanza cotton farmers using hand hoe, Kahama farmers using hand hoe and those using ox-plough technology.

Coffee production

In the coffee growing areas of Tanzania there are two main smallholder production systems: the coffee-banana system and the coffee mono-crop system. In the coffee banana system of Kilimanjaro and Arusha, coffee is intercropped with bananas. In this zone the major competing enterprise is dairy. In the coffee mono-crop system found in the Southern Zone coffee competes mainly with maize.

Paddy production

Paddy production is dominated by small-scale farmers. Production is dependent on rainfall or traditional irrigation systems in the lowlands. Where rainfall is the dominant source of water supply, paddy production has also varied a great deal in such areas. Generally the use of purchased inputs seem to have decreased under

small holder farming, labour demands are generally high particularly for weeding and harvesting tasks. Small scale trading and marketing dominates from production points to consumption points. Local traders buy small quantities of paddy and transport it to mills, from where it can be traded inter-regionally. Most of the trade routes end up in Dar-es-Salaam or Zanzibar. Rice imports and exports are not uncommon in commercial or aid form. Exports (both official and unofficial) occur in most cases along the border regions of the southern highlands and western zone of Tanzania.

Maize production

Maize is cultivated by the largest number of small holders in Tanzania. Small holders produce maize with low to medium technology. Mechanisation is limited Maize production in Morogoro is generally low input when compared to areas such as southern highlands. The marketing system is dominated by small traders operating locally or regionally. Morogoro maize has close proximity to the major consumption area, Dar-es-Salaam. Export volumes are extremely low as compared to imports.

Data sources and transformation

The data collection methodology used was based on commodity chain studies which involves the tracing of the commodity from production to the final consumption point. In doing so, all costs involved from production, marketing, processing to consumption are taken into account. The secondary data collected included standard coefficients, prices and tax rates (MDB, 1992; 1993; 1995; 1995; 1996; NEI, 1994, CMU, 1996; Mbiha and Yao, 1996; 1997; Mdoe and Yao, 1996). The data collected were entered in Lotus 123 spreadsheet templates. A total of five tables were constructed for each crop. The five tables are meant to generate the private and social prices and the tradable and non-tradable components of the various activities from production to consumption. The spreadsheet templates are constructed in such a way that values in the PAM tables are automatically calculated from the other tables.

Results and Discussion

Table 3 gives a summary of the PAM results obtained for the four enterprises studied.

The measures of distortion and comparative advantage generated by the PAM for Mwanza cotton indicate that producers received prices which are below the parity price for their product. The NPC is less than one with a value of 0.91. The value of the EPC is 0.91 which indicates that producers are negatively protected in the input market. The value of the DRC on the other hand indicates that Tanzania has a comparative advantage in cotton production. Similar results are shown for Kahama cotton as indicated in Table 3.

In the case of Morogoro rice, NPC=1.53, while the EPC = 1.69. It means that paddy producers received 53 percent more than the import parity price for their product. By taking price distortion in both the product and input markets into account, the rice farmers received 69 percent above the value-added created by the employment of domestic factors. On the other hand the PAM for Morogoro rice generated DRC=0.97, which means that the country earned $1 of net value at a cost of $0.97 of expenditures on domestic factors. The country had a comparative advantage in rice production in 1994/95.

Morogoro maize production was also protected in the 1994/95 season (NPC = 1.55). Maize producers received 55 percent above the import parity price for their product. By taking price distortion in both the product and input

Table 3: Summary of the PAM results for the northern and southern highland arabica coffee zones

	NPC	EPC	DRC
Northern Zone	1.19	1.13	1.98
Southern Zone	1.03	0.91	0.91

markets into account, the maize farmers received 73 percent above the value-added created by the employment of domestic factors. The country had a comparative disadvantage in maize production in 1994/95 since the DRC was greater than 1 (DRC = 1.47). Maize producers earned $1 of net value at a cost of $1.47 of expenditures on domestic factors.

The PAM results for the two coffee production zones are shown in Table 3. In both zones farmers received producer prices above comparable parity prices as indicated by the NPC results. If both the output and input markets are considered, farmers in the Northern Zone are positively protected while those in the Southern Zone are negatively protected. The DRC results show that the country has a comparative disadvantage in the production of Northern Zone coffee. For every $ earned the country spends $1.98. On the contrary the country possesses a comparative advantage in the production of coffee in the Southern Zone. The differences in results for the two zones are accounted for by yield differences due to inter-cropping with bananas, relatively older trees and lower tree count per unit area in the northern zone.

In summary therefore, Morogoro rice, Morogoro maize and northern highlands arabica coffee had Nominal Protection Coefficients (NPCs) of greater that 1 while southern highlands arabica coffee and cotton from the western growing area had NPCs less than 1. It means that those enterprises with NPCs greater than 1 were protected by the prevailing government price policy while the other enterprises were taxed. On the other hand the Effective Protection Coefficients generated from the data indicate that by taking price distortion in both the product and input markets, southern highlands arabica coffee and cotton were subsidized on their value added while Morogoro rice and maize, northern arabica coffee were taxed on their value added. The study also found out that the country possessed comparative advantage in all enterprises except Morogoro maize and northern highlands coffee whose DRC values are greater than one (Table 4).

Conclusions

The DRC results derived from the PAM indicate comparative economic advantage of producing cotton in WCGA, coffee in the southern zone and rice in Morogoro. Production of maize in Morogoro and arabica coffee in the northern zone indicate comparative economic disadvantage, implying inefficient use of resources to produce the commodities in these areas. Effective measures to improve production efficiency and consequently improve farm gross margins are necessary if farmers are to increase resource allocation in these crops.

The measures of distortion (NPC and EPC) suggest that food crops were protected by government price policy while cash crops (with the exception of coffee in the northern zone) were

Table 4: Summary of PAM results for the considered enterprises

Prouct	Location	Measures of policy distortions and comparative advantage		
		NPC	EPC	DRC
1. Nothern arabica coffee	Kilimanjaro	1.19	1.13	1.98
2. Southern arabica coffee	Mbozi	1.03	0.91	0.91
3. Mwanza cotton - Hand hoe	Mwanza	0.91	0.91	0.06
4. Kahama cotton - Hand hoe	Kahama	0.61	0.53	0.60
5. Kahama cotton Ox-plough	Kahama	0.61	0.47	0.70
6. Morogoro rice	Morogoro	1.53	1.69	0.97
7. Morogoro Maize	Morogoro	1.55	1.73	1.47

Source: Own calculations from survey data

taxed. Government protection policy on food crops may be desirable due to some social and political objectives such as food security or poverty alleviation which cannot be easily quantified.

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