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RATE OF PRODUCT TRANSFORMATION (RPT) IN MAIZE/CASSAVA MIXED CROPPING IN SOUTH-WEST NIGERIA - A CASE STUDY OF OYO AND OSUN STATES

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Abstract

Maize and Cassava are two important carbohydrate sources. These two crops are 'jointly' produced through mixed-cropping in most part of South-West Nigeria. An economic analysis of the mixed cropping system was undertaken in the study. Three hundred (300) maize/cassava farmers sampled equally in Oyo and Osun states of Nigeria through a two-stage sampling procedure were interviewed using a structured questionnaire. The survey covered the maize/cassava mixed cropping activities of the last production season of the farmers. All the regression coefficients are significant at one percent level. All the F-values are significant at one percent level indicating the overall significance of regression. The signs of the regression coefficients are economically reasonable. The result reveals that for one kilogram of maize produced, about 0.62 kilogram of cassava was sacrificed. Conversely, for every kilogram of cassava produced, about 1.63 kilogram of maize was sacrificed. The product-product curve exhibited a concave form. It was revealed that the maximum level was produced when 86,070 kilogram cassava was produced, only one farmer produced at that level of all the respondents sampled.

Keywords: Maize, Product, Output, Transformation, Cassava

INTRODUCTION

Rate of Product Transformation (RTP) seeks to establish the most efficient allocation of given resources between competing commodities or enterprises. It also refers to the choice between two or more enterprises and/or alternatives. In other words, it is the rate at which one good must be sacrificed in order to produce a single extra unit (or marginal unit) of another good, assuming that both goods require the same scarce inputs. The marginal rate of transformation is tied to the production possibilities frontier (PPF), which displays the output potential for two goods using the same resources.

To produce more of one goods means producing less of the other because the resources are efficiently allocated. The marginal rate of transformation is the absolute value of the slope of the production possibilities frontier. For each point on the frontier, there is a different marginal rate of substitution, based on the economics of producing each product individually.

Rate of Product Transformation is particularly relevant to the problem of optimum enterprise combination that maximizes farm income and it is important in term of the stand point of either the individual farmer, or of the nation. To the farm operator, it presents itself as a question of the combination of crops to be grown on the limited farm or land area and from given quantity of labour, capital, and management inputs. At the national level, the question becomes one of the cropping and livestock patterns to be encouraged through governmental programs.

This study focused mainly on the rate of product transformation in Maize/Cassava mixed cropping system in two states of south-western part of Nigeria:

Cassava

Cassava, *Manihot spp.*, is a perennial woody shrub with an edible root, which grows in tropical and subtropical areas of the world. It is also called yuca, manioc, and mandioca. Cassava has the ability to grow on marginal lands where cereals and other crops do not grow well; it can tolerate drought and can grow in low-nutrient soils. (IITA, 2009)

Cassava is a very important crop to Nigeria. In 2002, cassava suddenly gained prominence following the pronouncement of a presidential initiative on the crop; the initiative was aimed at using cassava production as the engine of growth in the country. World production of cassava was estimated to be 184 million tonnes in 2002 rising to 230million tonnes in 2008 Nigerian cassava production is by far the largest in the world; a third more than production in Brazil and almost double the production of Indonesia and Thailand. Cassava production in other African countries, the Democratic Republic of the Congo, Ghana, Madagascar, Mozambique, Tanzania and Uganda appears small in comparison to Nigeria's substantial output. (FAO, 2008)

In Africa, cassava is mostly grown on small farms, usually intercropped with maize, rice, vegetables, plantation crops (such as coconut, oil palm, and coffee), yam, sweet potato, melon, groundnut, or other legumes. The application of fertilizer remains limited among small-scale farmers due to the high cost and non-availability. Roots can be harvested between 6 months and 3 years after planting.

With the growing population in Nigeria and declining real incomes, cassava has the potential to become a highly demanded food crop. Over the past 30-50 years, smallholders in Nigeria have increased the production of cassava as a cash crop. Traditionally for home consumption, it is now at commercial production making cassava derivatives more available for urban consumers, livestock feed and industrial uses.

The various parts of cassava such as the leaves; stem and roots are used for different purposes. The leaves are consumed as green vegetable which provides protein and vitamins A and B; the stem is used as planting material and the root tuber, which is the most desirable is for consumption either raw or after being processed (IITA, 2009)

The crop's production is generally thought to require less labour per unit of output than other major staples because it is hardy. Cassava is able to grow and give reasonable yields in low fertile soils; it is a good staple, the cultivation of which if encouraged can provide the nationally required food security minimum of 2400 calories per person per day. (Fakayode et.al, 2008)

In Southeast Asia and Latin America, cassava has taken on an economic role. Cassava starch is used as a binding agent, in the production of paper and textiles, and as monosodium glutamate, an important flavouring agent in Asian cooking. In Africa, cassava is beginning to be used in partial substitution for wheat flour (IITA, 2009). Being an excellent source of starch and flour, cassava production in Nigeria has a huge development potential. There are several hundred chemical products made from starch. In China today, considering the need to protect her environment and the limited mineral oil reserves, at the beginning of 2002 the federal government of China started a new project of producing ethanol for use as fuel in automobile. The production of fuel ethanol will be a Chinese "sunrise industry" with an estimated value of 2.5 billion dollar per year. Among the competitive crops maize, sugarcane and cassava, to be used for ethanol production in China, cassava has a competitive advantage because of its lower cost as raw material and a simpler ethanol processing technology. For that reason, it is expected that the Chinese cassava cropping area will expand to about 600,000 to 800,000 hectares during the current decade (Nigerian Orient News, 2014)

The major pests of cassava in Africa are the cassava green mite, the cassava mealybug, and the variegated grasshopper. The main diseases affecting cassava are cassava mosaic disease, cassava bacterial blight, cassava anthracnose disease, and root rot. Pests and diseases, together with poor cultural practices, combine to cause yield losses that may be as high as 50% (IITA, 2009)

Maize

Maize, *Zea mays* is a tropical grass that is well adapted to many climates and hence has wide-ranging maturities ranging from 70 to 210 days. Maize plants are erect and may grow as tall as 3.0m. More maize is produced annually than any other grain. White, yellow and red are the most common types. The white and yellow varieties are preferred by most people depending on the region. Maize was introduced into Africa in the 1500s and has since become one of Africa's dominant food crops. The grains are rich in vitamins A, C and E, carbohydrates, and essential minerals, and contain 9% protein. They are also rich in dietary fiber and calories which are a good source of energy (IITA, 2009)

Maize is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in SSA and Latin America. All parts of the crop can be used as food and non-food products. In industrialized countries, maize is largely used as livestock feed and as a raw material for industrial production. Maize accounts for 30−50% of low-income household expenditures in Eastern and Southern Africa. A heavy reliance on maize in the diet, however, can lead to malnutrition and vitamin deficiency diseases such as night blindness and kwashiorkor. Worldwide production of maize is 785 million tonnes, with the largest producer, the United States, producing 42%. Africa produces 6.5% and the largest African producer is Nigeria with nearly 8 million tonnes, followed by South Africa. Africa imports 28% of the required maize from countries outside the continent (IITA, 2009).

METHODOLOGY

Design & Data Collection

The two crops under investigation, maize and cassava, are extensively grown in south-west part of Nigeria. Oyo and Osun States were randomly selected for the purpose of this study. A two-stage sampling technique was employed for the selection of 300 farmer-respondents in the survey areas, that is, 150 respondents from selected local governments in each state.

As in other states of the country, a comprehensive list of farmers in the states was not in existence nor was a complete list of maize/cassava farmers available in the states. Based on the states' structure of Agricultural administration, however, four strata were built around the agricultural zonal headquarters. Each zonal headquarters supervises the agricultural activities of the local government areas (LGAs) within it. The sampling procedure involved the random sampling of one local government from each zonal headquarters in the two states.

The synthesis of needed information from farm account books is perhaps the cheapest access to accurate data in farm analysis studies. However, the present low literacy level of subsistence farmers does not permit such a cheap method of data storage and collection in a developing agrarian country such as Nigeria. Yang (1965) stressed that in areas where farmers do not keep records and books, or for many studies where a representative sample of farms is absolutely essential, a large amount of the desired data must be collected from the farmers' memory or based on the best estimates which they can make.

This study used the farm business survey method in the collection of information with a structured questionnaire which evolved from a pre-tested draft. The lead researcher too personally interviewed farmers in some of the selected areas.

Estimation and Measurement of Inputs and Output

The size of the respondents' maize/cassava farm is based on both the farmer's declaration and/or an estimating process. However, farmers in the part of the country generally have an idea of the size of their farms in number of heaps. Conventionally, 3,000 heaps are equated to one acre, which is about 0.4 hectare. In the same token, charges by hired labour for heap making and weeding are based on the number of heaps worked upon.

Since no records were kept, a high dependence on farmer's assessment of labour expended on various farm operations is inevitable. Consequently, total labour expended on each operation was calculated from the number of adult males involved in the operation and the time taken to effect the operation in man-day units, where one man-day equals eight man-hours. The one-day adult female labour is estimated as 0.60 Man-day, while children's labour is estimated to be 0.4 and 0.3 man-day for male and female, respectively. The 0.6 man-equivalent of adult female labour is in consonant with Matlon (1977) and Crawford (1980) estimated labour conversion rates. Children's conversion rates are in line with Norman (1973).

ANALYSIS & RESULTS

Since Maize and Cassava are technologically inter-dependent, the rate of product transformation for the two could be estimated from

$X_1 = \int (Q1, Q2/...)$ .... (1)

Or $X_2 = g(Q1, Q2/...)$ .... (2)

where:

X_1 = Maize/cassava farm size (ha)

X_2 = Total labour expended in maize/cassava production (man days)

Q_1 = Maize output ('00kg)

and Q_2 = Cassava output ('00kg)

Theoretically, the quadratic form of the equation is favoured since it allows for concavity from the origin while the slope of the tangent to a point on the product transformation curve is the rate at which Q_1 will be sacrificed to produce more Q_2 (and vice versa).

Table 1: Result of Rate of Product Transformation (RPT) Models

	Coefficients of					
	Constant	Q_1	Q_2	Q_1^2	Q_2^2	
X_1	0.03977	0.04223***	0.01049***	0.00029*	0.00001	$\bar{R}^2 = 0.43$
		(0.01574)	(0.00198)	(0.0002)	(0.00001)	F = 58.04**
X_2	10.4312	0.5282	1.0793***	0.0022	0.0004	$\bar{R}^2 = 0.18$
		(2.9863)	(0.3761)	(0.0376)	(0.0005)	F = 17.79***

Figures in parentheses are standard errors of the estimates

****means that the parameters are significant at 1 percent level*

***means that the parameters are significant at 5 percent level*

**means that the parameters are significant at 10 percent level*

The estimated statistics are presented in table 1. Because it has a larger $\overline{R}^2$ (adjusted coefficient of determination) the lead equation is:

$X_1 = 0.03977 + 0.04223Q_1 + 0.01049Q_2 + 0.00029Q_1^2 + 0.00001Q_1^2$ .... (3)

From equation (3), $\frac{dXi}{dQi} = 0.04223 + 0.00058Q_1 + 0.01049Q_2 + 0.00001Q_2^2$ .... (4)

and $\frac{dQ_1}{dQ_2} = 0.01049 + 0.00002Q_2 + 0.04223Q_1 + 0.00029Q_1^2$... (5)

The rate of product transformation (RPT) can be expressed as:

$RPT = -\frac{dQ2}{dQ1} = \frac{dQ2/dX}{dQ1/dX}$ .... (6)

At the geometric mean levels of maize and cassava, the RPT = $\frac{0.4945}{0.8034} = 0.6155$

The RPT shows that for one kilogramme of maize produced, about 0.616kg of cassava is sacrificed. Conversely, for every one kilogramme of cassava produced, about 1.625kg of maize is sacrificed. Since maize commands a higher price than cassava, then greater care should be taken of the maize crop on the field, more so, that it stays for a shorter period on the field. This will go a long way in improving the yield of the maize crop and total income. It should be pointed out, however, that as more Q_1 and less amount of Q_2 are produced with a fixed input quantity, an increasing amount of Q_2 must be sacrificed per unit of Q_1 produced.

Product-Product Relationship

It is shown that the marginal products of the land input-factor in the production of maize and cassava are positive, as *a priori* thinking suggests.

Maize and Cassava outputs were estimated from $Q_1 = \int (Q_2/ ...)$ ....equation (7)

where:

Q_1 = maize output (kg)

Q_2 = cassava output (tonnes)

and $Q_2 = g(Q_1/ ...)$ ....equation (8)

where

Q_2 = Cassava output (kg)

Q_1 = Maize output (tonnes)

The results of these models are presented in the table 2 below respectively.

Table 2: Results of the Product- Product Relationship Model:

	$Q_1 = 320.15 + 122.09Q_2$*** ....equation (9)	
	(4.835)	
	$\bar{\bar{R}}^2 = 0.68$ F = 637.52***	
	$Q_1 = 27.84 + 170.42Q_2$ *** - $0.99Q_2^2$*** ....equation (10)	
	(9.00) (0.16)	
	$\bar{\bar{R}}^2 = 0.72$ F = 378.53***	
	$Q_2 = 1281.02 + 5581.48Q_1$*** .... equation (11)	
0	(221.06)	
	$\bar{R}^2 = 0.68$ F = 637.52***	
	$Q_2 = 922.88 + 6017.07Q_1$*** - $72.48Q_1^2$*** ....equation (12)	
	(598.79) (0.09)	
	$\bar{R}^2 = 0.68$ F = 318.65***	

Figures in parentheses are standard errors of the estimates.
****means that the parameters are significant at 1 percent level*

The lead equation therefore is equation (10). The equation reveals that Q_2 is a concave function of Q_1 and setting ∫ ”(Q_1) to zero and solving for Q_2, gives the Q_1 and maximizing level of Q_2 since the second derivative of ∫”’ (Q_1) < 0. The equation indicates, therefore, that the maximum level of maize is produced when 86,070kg cassava is produced. Of the sample of respondents, only one respondent is producing at that level.

CONCLUSION

The result reveals that for one kilogram of maize produced, about 0.62 kilogram of cassava was sacrificed. Conversely, for every kilogram of cassava produced, about 1.63 kilogram of maize was sacrificed. Since maize commands a higher market (with the current transformation agenda of the federal government of Nigeria about farm produce), greater care should be taken of the maize crop. However, as more maize and less amount of cassava are produced with a fixed input quantity, an increasing amount of cassava must be sacrificed per unit of maize produced on any given farm land and per production circle.

The product-product curve exhibited a concave form. The analysis revealed that the maximum level was produced when 86,070kg cassava is produced. Of the sampled respondents, only one produced at that level.

Maize plays a predominant role in the farming systems and diets of millions of Nigerians. It is a very versatile crop since it is used for domestic consumption in addition to its industrial use by flour mills, breweries, confectioneries and animal feed manufacturers. Consequently, increasing maize yields and its cultivation particularly in areas which enjoy a comparative advantage for maize production, can be of high economic important to both the farmers and the nation at large.

RECOMMENDATIONS

Farmers should be aware that there is a trade-off in yields of the two crops (cassava and maize) in the production system. They should, therefore, accord the crops adequate attention to reap optimal yields.

Researchers should note the values of rates of transformation between the crops and target the possibility of enhancing these rates to facilitate greater yields for farmers to improve their incomes. This can be accomplished through breeding of high yielding varieties suitable for mixed cropping.

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