

**EFFECT OF TECHNOLOGY CHANGE AND COMMERCIALISATION ON
INCOME EQUITY IN NIGERIA: THE CASE OF IMPROVED CASSAVA.**

by

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Introduction

Equitable distribution of development benefits, unlike pursuit of increased productivity objectives within Nigerian agriculture and the whole economy, has over the years, received very little attention. Although Nigerian policy makers show an appreciation of the importance of both productivity and equity objectives in the course of development planning the strategic measures, often adopted tended to favour productivity pursuit at the expense of income equity objective (Olopoenia 1983; Afolami, 1997; Oladeji and Abiola 1998).

Economic and political reasons can be adduced for this tendency. Firstly, a number of studies have highlighted the existence of a wide gap between potential and actual productivity in Nigerian agriculture (Are, 1970; Norman et al, 1982; Olayide 1983; Erinle, 1994). This posed a great challenge to policy makers.

Secondly, the problem of food shortage arising from a variety of factors such as stagnating productivity in the food sub-sector, rapid population growth, increased urbanisation, rapid growth of incomes and high income elasticity of demand for food has had to be combated since the 1970s.

Thirdly, productivity increase is regarded as the most dependable approach for raising rural incomes, employment, purchasing power and capacity to finance and maintain infrastructural

facilities in the context of integrated rural development. (Essang, 1977, FMANR 1988 ; FGN, 1997:Report of the Vision 2010 Committee: Main Report).

However, one of the most urgent and intractable issues of development policy in Nigeria is how to achieve an appropriate and widely acceptable balance between productivity and income equity objectives. The need for such a balance is very urgent because of the co-existence of low productivity with high inequality in the distribution of development benefits. Also, empirical fact has shown that approaches which tilt the allocation of resources in favour of large scale capital intensive projects contribute to growing income inequality in agricultural sector because they do not lead to raising productivity and they favour only a class of society, (Baldwin 1975; Wells, 1966; Idachaba 1977; Essang 1977; World Bank 1989; Akinyosoye 1993).

The scarcity of information on the distribution impact of some government development strategies to a large extent is another major reason why productivity objective over-rides the income equity objective. Availability of such information would therefore guide policy makers.

Arising from the persistent problem of food shortage in Nigeria, the option of increasing agricultural productivity which involves the use of improved high yielding varieties of crops, is now being popularised among farmers through extension services of Agricultural Development Programme (ADPs). In this process, scientific and technological research play significant role of producing appropriate innovations. Emphasis is placed on the cultivation of staple crops among the private agricultural producers with the goal of increasing agricultural output and increasing farm incomes among others [FMANR 1988; Vision 2010 Report].

Cassava is one of the crops on which extension services of ADPs is disseminating information on the use of high yielding, improved varieties. The crop is enjoying research and extension investments because it is perceived to have the ability to stave off hunger and provide household and national food security. It is the single most important source of calories for the majority of the population. It supplies about 70 percent of the daily calorie intake of over 50 million Nigerians (FACU, 1993; Ugwu,1996; Nweke et al.1997). Cassava is a typical subsistence crop in contrast to maize and rice which are supplemented with imports to meet domestic demand. Among the roots and tuber crops in Nigeria, cassava is the most widely cultivated in terms of land area and number of farmers growing it (Nweke et al, 1994; 1996). It is planted to about 1,143,000 hectares which represents 17 percent of total crop area (Gebremeskel & Oyewole 1987). Cassava therefore absorbs a major share of national resources devoted to agricultural production. It is important both as a traditional staple food and a major source of income to producers.

This study therefore examines the impact of cassava technology change and commercialisation on income distribution in Nigeria.

There are conflicting notions about the distributional impact of agricultural technology change and commercialisation in the literature.

A school of thought believes that agriculture, though a competitive industry does not have effective means of retaining any large portion of the reward from technology advancement

which it utilises. The gains are believed to be widely dispersed to consumers and processors who connect the farm-firm to the households. Proponents of this view cite instances in which the poor were unable to participate successfully in the adoption of new technology during green revolution in Asia and cases where workers were displaced by machinery. Commercialisation was seen to induce producers to sell their output as against eating them. It was feared that households that produced cash crops would not have access to purchase foods if their cash crops fail or if prices fall. (Heady, 1962; Olayide, 1983).

Another school of thought believes that economic gains brought by technology innovation and commercialisation in agriculture work their way to the poor. They contend that if technology is directed towards the crop produced and consumed by the poor, and the technology has the attribute of easy adoption with credit, marketing and extension facilities, it would make them enjoy the fruits of technology change [Hayami and Herdt, 1977; Binswanger and Braun, 1991].

There is therefore no universal view on whether the economic gains brought about by technology innovation and commercialisation work their way up to the poor. There are strong pessimistic and optimistic views on the subject matter. Lipton and Longhurst (1989) gave a comprehensive review of literature on pessimistic view on technology and commercialisation on subsistence agriculture.

Given the importance for economic development, of improving the lot of the nation's numerous small-scale agricultural producers who dominate the population, information on the distributional impact of cassava technology change to boost food output under the prevailing

commercialisation condition becomes essential for appropriate policy formulation in Nigeria. The view that technology change and commercialisation make the poor poorer is based on the inelastic demand that characterise primary agricultural commodities and the fact that the forces of increased output can interact with, or even induce institutional and market failure, with adverse consequences for the poor.

This study therefore focuses on the distributional impact of technology change and commercialisation in the production of cassava in Nigeria as a contribution to information and knowledge in this area.

2.0 Theoretical framework on distribution of technology benefit

Technology progress for a commodity implies that there is a downward shift in the cost function of the commodity. This in turn implies a right-ward shift in the commodity's supply function. The interaction of the supply curve with a downward sloping demand curve will result in an increase in economic welfare through consumption of a larger quantity at a lower cost. The distribution of the gains in economic welfare between producers and consumers depends on price elasticities of demand and supply for the commodity.

The producers of cassava in Nigeria (that is the users of technology progress results) are mainly numerous farmers who operate small-holdings. The demand curve is thus an infinitely elastic curve because the market can be approximated by perfect competition.

The crop cassava, is a necessary out of which the peasant farmers consume, and it is characterised by low elasticity of demand. Cassava producers necessarily consume some part of the crop in their house-holds while the remaining portion is sold to non-producers but consumers. This means that the producers are semi-subsistent. The non producing consumers are in all income groups of low, medium and high. Given this background, the paper considers inter-sectoral (distribution between producers and consumers) and intra-sectoral distribution (distribution among producers and consumers) of technology benefit in close economy (autarky) given that cassava is mainly domestically consumed. The attribute of semi-subsistence production is incorporated into the analysis of the relationship between technology change and income distribution given that cassava serves the dual purpose of subsistence and commerce to the producers.

2.1 Distribution of Technology Benefit under Complete Commercialisation in Close Economy

In a situation where farmers sell all their outputs and product's demand is price inelastic, consumers are the main beneficiaries of technology surplus. This is illustrated in Figure 1.

$D_m D_m$ is market infinite inelastic demand curve.

$S_o S_o$ is commodity supply curve prior to technology change.

S_1S_1 is commodity supply curve with technology progress. The technology which results in increased output from S_0S_0 to S_1S_1 lowers the commodity price from P_0 to P_1 . The surplus arising from technology progress which is approximated by consumers i.e. consumer surplus is area JKP_1P_0 . A situation like this traps farmers on technology 'treadmill', as they have no share in the surplus.

Fig. 1 here

2.2 Distribution of Technology Surplus between Producers and Consumers

When some fraction of the cassava produced is consumed in the households of producers, some of the surplus from technology progress is internalized by those producers.

If demand is price elastic and price adjust to market forces, the degree of consumers' surplus internalised by producers is directly related to the proportion consumed. If there is no difference in price prior to and after technology progress, the distribution of benefit which accrues to producers is in direct proportion to their sales since technology lowers cost of production.

If we assume constant household consumption for small and large producers, large producers will have more output for sale and with the assumption of no difference in price prior to technology progress, large producers would benefit more from the innovation and this will be in direct proportion to their sales.

In figures (2) and (3), the impact of technology change in semi-subsistence production in autarky is given for individual farm and market situation. The total demand for cassava is assumed to be $D_H D_M D$ (fig. 2) while the market demand curve for cassava is defined as $D_M D$. $D_H H$ is the demand curve of producers for home consumption which is assumed fixed irrespective of output level. The horizontal difference between $D_M D$ and $D_H H$ measures quantity, purchased by non-farm households.

OS_0 is the supply curve prior to technology change. OS_1 is commodity supply after technology change. Market equilibrium point prior to technology change and after are denoted by points A and B. Non-farm consumers enjoy the increase consumption from HQ_0 to HQ_1 at the reduced price from OP_0 to OP_1 (fig 2).

Figs. 2 & 3 here

The consumer surplus arising from technology change is area ACGB. The producers cash revenue changes from area $ACHQ_0$ to area $BGHQ_1$ and home consumption remains same as OH. The cost of production changes as a result of technology change from area AOQ_0 to BOQ_1 .

If we assume that the quantity consumed is the real income value of home consumption of cassava by producers, the income changes to producers are reflected in changes in their cash income. Whether producers' cash income (revenue-cost) is increased by technology change

depends on the demand and supply functions.

For quantification of relevant areas, let us assume that the demand curve is given by constant elasticity demand function.

$$q=ap^{-b} \quad \dots(1)$$

and the supply is given by

$$q=cp^n \quad \dots(2)$$

where q in equation (1) is quantity demanded and p is the price of cassava

In equation (2) q is the quantity supplied and p is the price.

c embraces the demand shifters

n is the price elasticity of demand

a is supply shifter except technology change

and b is the price elasticity of supply.

If we assume k percent shift in commodity supply due to technology progress, then the new supply function OS_1 can be expressed as

$$q = a (1 + k)p^b.$$

If the equilibrium quantity and price before technology progress are denoted q_0 and p_0 and those after by q_1 and p_1 , can be solved for in terms of the parameters. From equations (1) and (3), p_1 can be solved for in term of the parameters.

Using Taylor's expansion,

$$p_1 = p_0 [1-(nk)/(b+n)] \quad \dots(4)$$

By substituting equation (4) into equation (3) and using Taylor's expansion, we have

$$q_1 = q_0 [1 + nk] / (b+n) \quad \dots(5)$$

If t defines the rate of commercialisation, that is ratio of marketable surplus (total output minus home consumption) to total output,

$$t = HQ_0 / OQ_0$$

The consumers gain in terms of the increase in consumers' surplus is

$$\begin{aligned} \text{area ACGB} &= \text{area AP}_0\text{P}_1\text{B} - \text{area CP}_0\text{P}_1\text{G} \quad (\text{see fig.2}) \\ &= \int_0^{P_0} cp^{-n} dp - q_0(1-t)(p_0 - p_1) \\ &= p_0 q_0 (kt) / (b+n) \quad \dots (6) \end{aligned}$$

The cash revenue of producers will change by area BEQ_0Q_1 - area $ACGE$

$$\begin{aligned} &= p_1(q_1 - q_0) - q_0 t(p_0 - p_1) \\ &= p_0 q_0 k (n-t) / (b+n) \quad \dots(7) \end{aligned}$$

The cost production will change by area BOQ_1 - area AOQ_0

$$\begin{aligned} &= \int_0^{P_0} p_1 q_1 - \int_0^{P_0} (1+k) ap^b dp - (p_0 q_0 - \int_0^{P_0} ap^b dp) \\ &= P_0 q_0 \{k^b (n-1)\} [(1+b)(b+n)] \quad \dots(8) \end{aligned}$$

With technology progress thus, the cash income of producers i.e (income that will accrue to producers' own factors) will change by the difference between change in cash revenue and change in cost.

This is approximately

$$\frac{P_0 q_0 k [n-t] + b(1-n)}{[(1+b)(b+n)]} \quad \dots (9)$$

2.3 Distribution of Technology Benefit among Producers

Figure 3 illustrates changes in equilibrium points of two types of individual farm producers (a small and a large producer) corresponding to changes in market equilibrium point in figure 2.

The supply curves before technology change for small and large farmers is assumed same.

Given technology change, the equilibrium of small producer moves from A^s to B^s and that of large producers moves from A^L to B^L .

The changes in cash revenue of small producer is area $B_s E_s Q_o^s Q_1^s$ - area $A^s C^1 G^1 E^s$ and changes in cost is represented by area $B^s O^1 Q_1^s$ - area $A^s O^1 Q_o^s$.

The corresponding changes in cash revenue of large producer is area $B^L E^L Q_o^L$. The net effect according to Hayami and Herdt, (1977) depends on the relative changes in revenue and cost which in turn depends on price elasticities of supply of individual producers; relative to the aggregate demand elasticity.

The aggregate price elasticity of supply b , is the weighted average of the price elasticities of supply of individual producer ($i=L$ for large producers and $=s$ for small producers) and w_i is the share of the i th producer in total output. Likewise, the rate of shift in the aggregate supply is the average of the rates of supply shift of individual producers, i.e.

$$k = \sum w_i k_i.$$

In the same vein as for inter-sectoral income distribution, approximation formulae for analysing the impacts of a k% shift in the aggregate supply function on the ith producer according to Hayami & Herdt (1977) is:

$$\text{Change in cash revenue} \sim p_o q_{oi} \frac{(k_i - k) \frac{b_i - t_i}{b+n}}{b+n} \quad \dots(10)$$

$$\text{Change in production cost} \sim p_o q_{oi} \frac{b_i}{1+b_i} \frac{(k_i - k) \frac{1+b_i}{b+n}}{b+n} \quad \dots(11)$$

and change in income

$$= p_o q_{oi} \left(\frac{k_i - k}{1+b_i} \frac{b_i}{b+n} - \frac{kt_i}{b+n} \right) \quad \dots (12)$$

where q_{oi} and t_i are output and marketable surplus ratio of the ith producer before the shift in the supply function.

2.4 Distribution of technology benefit among consumers

If the income y of a household is either spent on staple food (s) and other commodities (x), then $y = p_s q_s + p_x q_x$ where p_s , p_x , q_s and q_x represent the prices and quantities of staple and other commodities.

The percentage change in real income due to a decline in the price of the staple is approximately.

$$\frac{\Delta Y}{Y} = \frac{e\Delta p_s}{y p_s} \quad \dots(13)$$

where $e = p_s q_s / y$ is the ratio of expenditure for staple food to total household income.

From equation 4, the percentage change in market price of the subsistence food crop corresponding to a $k\%$ shift in supply curve in $k/(b+n)$. The percentage increase in real income is therefore approximately

$$\frac{\Delta Y}{Y} = \frac{ek}{b+n} \quad \dots(14)$$

3.0 Research Methodology

For an estimation of the percentage change in consumers' and producers' income due to cassava technology progress in Nigeria, there is need to have the estimates of:

- (i) the annual percentage shift in the supply schedule of cassava (k)
- (ii) the rate of commercialisation (t) in cassava as characteristic of the producers
- (iii) the price elasticities of supply (b) and demand (n) for cassava, and
- (iv) the national outputs and prices P_1, Q_1 for cassava over the years.

3.1 Annual percentage shifts in cassava supply schedule (k)

The annual aggregate national cassava outputs were stratified between the improved and local varieties using partly the findings from Collaborative Study on Cassava in Africa (COSCA) on average yields of improved and local varieties on farmers' field and the extent of adoption of improved varieties on the field. The study found average yields of improved and local varieties

are respectively 19.44 ton/ha and 13.41 ton/ha (Nweke et al, 1994) and revealed that in the detailed field level survey of 1992, in the humid climate zone of Nigeria, about 60 percent of the cassava land area carried improved cassava varieties while 35% and 40% respectively of cassava land area carried the improved varieties in sub-humid and non-humid climate areas sampled. Based on the finding, this study assumed that the spread of the improved cassava varieties on the field in the 1990's is 60 percent of total area and systematically graduated this down to evolve the adoption rates in earlier periods as follows, 1970-75, 5 percent; 1976-1980, 10 percent; 1981-1985, 30 percent, 1986-1990, 40 percent. The assumed adoption rates were found to be consistent with some ad-hoc surveys carried out at different time periods as well as the monitoring and evaluation surveys reports of the IFAD-supported Cassava Multiplication Programme which was implemented in Nigeria between 1981 and 1997¹.

Based on these assumption together with the assumption of average yields of 19.44 t/ha and 13.41t/ha for improved and local varieties respectively, secondary data obtained on the stream of annual aggregate cassava outputs in Nigeria were disaggregated into two being (i) hectares H_1 on improved varieties, and (ii) hectares H_2 on local varieties.

The hectares obtained were multiplied by average yields of improved and local varieties to arrive at the annual contributions of improved and local varieties to total output.

The output difference between estimated output of improved variety in production and output of local varieties from the same hectare under improved varieties H_1 represent the contribution

from improved variety. This value expressed as percentage of total output represents percentage change in supply schedule (k) and it was estimated as an average value of 31 percent.

3.2 The rate of commercialisation (t)

This is defined as the ratio of the difference of total output less home consumption to total output. It is recalled that the objective of COSCA is to provide authoritative information over a wide area on production and consumption pattern of cassava in order to guide research. We rely on the report of COSCA and our survey of five randomly selected cassava producing States of Ogun, Imo, Anambra, Plateau and Cross Rivers in 1994 for this estimate. The survey result showed that large and small farms differ mainly in the proportion of output (t) which they sell. The dominant producers who are mainly peasant farmers (over 90 percent of sampled farmers) cultivated an average of 2.0 ha and sold 50 percent of their produce while the relatively large producers sold over 95 percent of their output. For the purpose of evaluation of the impact of technology progress in cassava on consumers' and producers' surpluses, this study parameterized the rate of commercialisation (t) to be between 0.30 and 0.90 and used the values of 0.30, 0.50 and 0.90. The ratio of marketable surplus of cassava to total output is thus noted to be distributed around the mean of 0.50. The analysis, however uses the boundary estimates of 0.30, 0.90 and the mean value of 0.50 for the investigation of the distributional impact of technology progress benefit thus presenting a sort of sensitivity analysis.

3.3 Price elasticities of demand (n) and supply (b).

For the price elasticity of demand n , this study relied on the estimate of 0.53 obtained in a study of tuber based food system with emphasis on yam and cassava in South East Nigeria (Nweke et al, 1992). The price elasticity of supply of 0.55 used in this study was estimated using national aggregate annual cassava output data and average annual cassava prices for the period 1970 to 1993. These data were obtained from Statistical Bulletin of Central Bank of Nigeria (CBN). The model relating supply and price was specified as

$$q=ap^bu$$

where p and q are price and quantity supplied, a includes supply shifters except technology change b , is the price elasticity of supply and u is the random disturbance. The model was transformed into linear function given by

$$\log q = \log a + b \log p + \log u.$$

Ordinary least square regression technique was employed in estimating b , which was obtained as 0.5509 with a standard error of 0.2279 which confirms its being significantly different from zero at 5 percent level.

3.4 National aggregate annual cassava outputs and annual average prices

The data on national aggregate annual cassava outputs and annual average prices for the period 1970-1995 were extracted from the agricultural data bank of the Planning, Research and Statistics Department of the Federal Ministry of Agriculture and Natural Resources and the annual reports of the Central Bank of Nigeria. The nominal (annual) prices were deflated by the consumer price index to obtain real prices.

4.0 **Empirical analysis of the distribution of cassava research benefit**

4.1 **Intersectoral distribution of benefit between consumers and producers.**

The results of applying the specified parameters in the estimators of consumers' and producers' surplus is summarized in Table 1. A 31 percent increase in supply function due to use of improved varieties in cassava resulted in a price decline of 28.70 percent and an increase in quantity by 51.21 percent. Consumers' surplus increased steadily between 6.60 and 25.8 percent for the varied rates of commercialisation. Consumers surplus increase for the representative $t = 0.50$ is 14.35 percent.

The corresponding increase in producers' revenue is between 0.86 and 9.05 percent for the rate of commercialisation t values of 0.30 and 0.50 but declined by 10.62 percent when it attained a value of 0.90. Production cost declined by 4.79 percent for the different levels of rate of commercialisation (t).

On the whole producers' cash income increased by 13.85 and 5.65 percent when the rate of commercialisation values are 0.30 and 0.50. It however, declined by 5.83 percent when it was 0.90. This observation confirms that, the greater the rate of commercialisation, the more of technology progress benefit of cassava that went to consumers as against the producers, who are the users of technology benefit (Afolami, 1997).

For the average situation that prevailed in Nigerian economy, i.e. $t=0.50$, the consumers' surplus increased by 14.35 percent while the producers' income increase by 5.63 percent, as a result of the semi-subsistence nature of the producers of cassava. This showed that 71.75 percent of total benefit of cassava technology progress went to consumers, while producers make do with only 28.25 percent.

Table 1 here

4.2 Intra-sectoral distribution of cassava research surplus among producers

In the theoretical framework discussed in section 3, the net effect of technology progress on producers' income depends on the relative changes in revenue and cost, which in turn depends on the price elasticities of supply of individual producer relative to the aggregate demand elasticity. The aggregate price elasticity of supply (b) which determines the market price, is the weighted average of the price elasticities of supply of individual producers (Hayami and Herdt, 1977), i.e.

$$b = \sum_i w_i b_i$$

where b_i is the price elasticity of the i th producer ($i=S$ for small producer and $i=L$ for large producer) and w_i is the share of the i th producer in total output. Likewise, the rate of shift in the aggregate supply is an average of the rates of supply shift to individual producers i.e.

$$k = \sum_i w_i k_i$$

Large and small farmers differ mainly in the proportion of output (t) which they sell².

There is no empirical evidence that there are differences in the adoption rate and thus percentage shift in supply function (k) in the price elasticity of cassava supply (9b) among small and large farmers. Evidence seems to support that there is no difference in the rate of diffusion of the improved cassava varieties and in the resulting increase in yield between the small and large producers. Considering the relatively low cost of improved cassava cutting, it seems reasonable to expect that the technology progress has been neutral with respect to farm scale.

However, in order to test the effect of differential rates of technology progress, an analysis was carried out based on two alternative assumptions.

The same shift in commodity supply curve from technology progress for the different producers i.e. ($k_s=k_L=k=31\%$) and (b) supply shift from technology progress of the large producers is twice that of the small producers ($k_s=20$, $k_L=40$ and $k=31\%$). There is also a possibility that large producers with a greater capacity for investment financing find it easier to adjust their production to the long-run equilibrium point. Based on this, two further alternative assumptions are specified. Both large and small farmers have the same price elasticity of supply ($b_s = b=0.55$ and b) the price elasticity of supply of the large producer reaches a long run level of 0.65 while that of the small farmers remained at a short-run level of 0.45 i.e ($b_s=0.45$, $b_L=0.65$ and $b=0.55$). Four cases are possible from the combinations of the values of t_i , k_i and b_i . The results are summarized in Table 2.

Table 2 here

In the various cases considered, one could say that technology progress in cassava research makes the income position of the small producers better than those of the large producers. In cases 1 and 2, cassava technology improved the income position of the small farmers. A 31 percent shift in the supply function increased the incomes of small producers by between 5.65 and 6.25 percent under the specified parameters. In these two cases, there was reduction in the income levels of large farmers by between 7.31 and 8.49 percent.

In cases 3, when the shift in supply function of large farmers is twice that of small producers, the incomes of both small and large producers declined by about the same magnitude.

In case 4, when the shift in supply curve of large farmers is twice that of small farmers, the incomes of both large and small farmers declined by 3.30 and 0.56 percent respectively. Improved technology can be said to be a force tending to bridge income inequity gap between cassava producers of different holding.

4.3 Intra-sectoral distribution of cassava research benefit among consumers

Section 4.1 showed that the major gains in economic benefit from the development of improved cassava varieties are enjoyed by consumers. Their gains vary with the fraction of total expenditure devoted to cassava and cassava products. Based on a stratified sample survey of 100 households by income, the share of cassava and cassava products in the total expenditure of the

households for different income classes in some cassava producing states in Nigeria is applied to equation (14), with $b = 0.55$ and $n = 0.53$. The differential impacts of technology change on the real incomes of the households were calculated and reported in Table 3.

Table 3 here

A 31 percent shift in cassava supply function resulted in 8.61 percent increase in real income of households with less than N2,000 annual income. The same shift in the supply function increased the incomes of consumers in income classes of (N2001-N4000) (N4001-N6000), (N6001-N8000), (N8001-N10,000), and N10,001 and above by 3.44, 2.30, 2.30, 2.01 and 0.57 percent respectively. The relative gain in real income is larger for the households of low income people. It could then be safely assumed that the benefits of improved cassava variety are not only enjoyed by rural non-farm workers but also urban dwellers for whom cassava products from major item of household expenditure.

5.0 Summary, Discussion and Policy Implications

The study examined the distribution of the surplus arising from cassava technology change and commercialisation on cassava producers and consumers using the Marshallian concept which measures social returns to technology change in terms of producers' and consumers' surplus. The attribute of semi-subsistence production was incorporated into an analysis of the relationship between technology change and income distribution.

Cassava supply curve was estimated to have shifted by an average of 31 percent between the period of 1970 and 1993. The rate of commercialisation was found to range between 0.30 and 0.95 and has a mean of 0.50.

The surplus generated as a result of using the improved cassava varieties was estimated to be shared in the proportion of 28.0 to 72.0 percent between producers and consumers respectively under the average situation in which producers' rate of commercialisation was 0.50 and cassava supply function shifted by 31 percent.

Parameterising producers' rate of commercialisation, the share of producers' benefit in technology surplus declined as more output is sold. This indicates that a fully commercial agriculture characterised by an inelastic demand would result in an income transfer from producers to consumers and technology progress has more positive distributional impact on producers in a semi-subsistence agriculture than in commercialised agriculture.

The examination of the intra-sectoral distribution of cassava technology benefit among producers showed improved technology to be a force bridging income inequity gap between cassava producers of different holdings as the large scale producers lose more of their benefit to consumers.

The examination of the intra-sectoral distribution of technology benefit among consumers showed that the relative gain in real income is larger for households of low income people because cassava and cassava products form major items of the households expenditure.

This technology change which generates surplus in a semi-subsistence crop allows farmers with small holding to internalize more of the surplus than large-scale farmers since the rate of commercialization is higher for the large scale farmers.

The study revealed that technology change on crops consumed by small-scale farmers ensures greater internalisation of economic surplus by them and promotes equitable income distribution since large-scale farmers produce more for the market.

The study showed that a crucial determination of developmental income equity is the strengthening of the research, extension and support system for a semi-subsistence crop, so that the rate of shift in supply can exceed that of demand.

¹ The objectives of the Cassava Multiplication Programme (CMP) were to (i) improve cassava yields and increase national output through the accelerated development and distribution of improved pest-resistant and higher-yielding cultivars; (ii) promote better agronomic practices through improved adaptive research and extension; and (iii) introduce improved processing technologies.

² Survey of five cassava producing states of Ogun, Imo, Anambra, Plateau and Cross River in 1994, showed that the predominant producers who are mainly peasant farmers (over 90 percent of sampled farmers) cultivated an average of 2.0 hectares and sold 50 percent of their produce, while the relatively large producers sold over 95 percent of their output. For the sake of producers' intra-sectoral benefit distribution, $t=0.50$ was assumed for small producers, while $t=0.95$ for large producers.