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THE ECONOMICS OF RESEARCH-INDUCED QUALITY-CHANGE: AN APPLICATION TO THE PHILIPPINE COCONUT INDUSTRY*

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THE ECONOMICS OF RESEARCH-INDUCED QUALITY-CHANGE: AN APPLICATION TO THE PHILIPPINE COCONUT INDUSTRY

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A framework is developed for measuring the changes in economic surplus to quality-improving research in segmented markets and multi-production stages. The model illustrates one approach to assessing the gains to research that enhances the characteristics of a commodity. It is used to evaluate the benefits of research-induced technology designed to improve the quality of Philippine copra.

INTRODUCTION

The Philippines has the distinction of being the largest exporter of coconut products, providing on average 66% of world trade for coconut oil and 29% for copra in the years 1986-1989. However, it has been alleged that the country's coconut products carry aflatoxin because of mould that thrives in high moisture copra (PCCP, 1992). High levels of aflatoxin in copra is a major problem confronting the country's coconut industry. The aflatoxin reduces the amount of coconut oil and lowers quality. Extra purification is needed to improve the coconut oil (PCRDF, 1986). Aflatoxin in copra also affects the quality of copra meal produced. A high level of aflatoxin is considered to be one of the major reasons attributed to the decreasing competitiveness of the Philippines' coconut products. For example, the tolerable level of aflatoxin in copra meal has been lowered (from 200 parts per billion to 50 ppb and recently, to 20 ppb) by the EEC (EEC 1986, 1991).

Improper drying of copra using the traditional methods of sun-drying and direct smoke-drying (**Tapahan**) and the lack of quality control at the farm level cause high moisture content, scorched and dark coloured copra (PD, 1979; NEDA, 1985). As a solution to the problem of high aflatoxin, the Philippine Coconut Authority (PCA) emphasises improved drying of copra. Improved drying reduces moisture level and aflatoxin contamination; the amount and quality of coconut oil recovered, and copra meal produced are eventually improved (PCA, 1991). Based on findings of a RP-UK Aflatoxin Project, mold formation can be reduced if copra is dried immediately to 10% moisture or below, and kept at its minimum at 8% moisture before storing (Grouthes and Gupta, 1991). In this paper, improving the quality of copra means reducing its moisture content and hence, its aflatoxin level.

Research on improved procedures of drying copra is being undertaken by the public and private sectors. One of the technological developments that has progressed are indirect hot-air dryers such as the modified Kukum dryer and the Lozada multi-purpose dryer. The PCA recommends the proper use of the traditional smoke-dryers as a short-term solution to the aflatoxin problem. However, it recognises the vital importance of hot-air dryers in the future development of the copra drying process (PCA, 1991).

The PCA embarked on a quality improvement program in late 1989 which include the dispersal of improved copra dryers. As an incentive to farmers in improving their drying procedures, the PCA issued a new copra classification standard. Premiums and discounts under the new standard are based on a 12% basic moisture level (i.e., semi-resecada copra) compared with the previous baseline of 14% moisture level. Moreover, an additional criterion is introduced in the grading and pricing of copra; that is, the presence of Aflatoxin Related Mold (ARM).

The aim of this paper is to present a framework for assessing the gains to research on improved dryers that enhances the quality of copra. Attention is given to the significance of different qualities of copra, and the effects of research are traced between producers and consumers from the copra farm sector to the coconut industrial processing sector. There are similarities in the analytical approach of the present paper to that of Freebairn, Davis and Edwards (1982) and Alston (1990) in the context of multistage production, and to Brennan, Godyn and Johnston's (1989) study of disaggregated markets. The present paper integrates the segmented market and multistage production approaches. An earlier study of the benefits to quality-improving research in copra by Mangabat and Edwards (1992) was confined to the farm production level and disregards the different grades of copra.

SOME CONCEPTUAL ASPECTS IN QUALITY-IMPROVING RESEARCH

Most studies on research that changes the characteristics of a commodity depict its effects as a rise in the demand curve (for example in Unnevehr, 1986; Lemieux and Wohlgenant, 1989; Voon and Edwards, 1991b). The justification of the upward shifting demand curve can be traced to the "new" or "characteristics" theory of demand now associated with Lancaster (1971), and adapted in a consumer goods characteristics model by Ladd and Suvannunt (1976). The new theory of demand emphasises the role of characteristics of a commodity to consumer utility and preference. In essence, consumers prefer better quality attributes because of higher utility provided (Deaton and Maulbauer, 1980). The shift in the demand curve represents higher consumer valuations and hence, their willingness to pay for higher valued characteristics.

Some authors have also modelled research-induced quality change in a multi-product setting, using equilibrium displacement models as in Mullen, Wohlgenant and Farris (1988) and Mullen, Alston and Wohlgenant (1989). Displacement from an initial equilibrium can occur through exogenous shifts of supply and demand curves in product or input markets. Alston (1991) provides a review of the multi-product approach.

In studies of quality-improvement caused by technological change, the characteristics of a commodity are viewed in two ways. First, characteristics are considered as commodities such that "quality" is continuously variable. This concept is adopted in Unnevehr (1986), Lemieux and Wohlgenant (1989), Quilkey and Gunawardana (1990), Voon and Edwards (1991, 1992). Alternatively, different qualities of a commodity can be interpreted as heterogeneous commodities in which case "quality" becomes discretely variable. The study of Brennan, Godyn and Johnston (1989) on wheat varieties builds on the latter approach. Improved wheat varieties resulting from research are considered as different commodities because of their varied uses. For analytical purposes, wheat varieties are classified into two segmented markets --- low and high quality wheat. The effects of quality and productivity research are analysed through a shift of the supply curve. The framework in this study also looks at the inter-regional effects of research as adapted from the model of Edwards and Freebairn (1981, 1984).

The literature on measuring the economic effects of quality-enhancing research has not been fully developed . This situation has been attributed to the conceptual and measurement difficulties in analysing research-induced quality change. Some of these difficulties are: substitution in production and consumption, and determining whether the effect of research is a shift on the supply or demand curve. On the latter issue, Alston (1991) suggests the following:

> "Technical change that leads to a change in product quality is a change is supply conditions, and it would be better to model it as such".

A FRAMEWORK OF ANALYSIS

For analytical purposes, the various types of copra are divided into different markets. The flow of copra from the farm sector to the coconut oil processing sector is represented in multiproduction systems. The technical change in the quality of copra and its effects at each production stage of coconut oil is specified as a supply shift for outputs and inputs. The ex-ante effects of research are measured by the economic surplus approach using partial equilibrium analysis. Although most coconut products are traded in the external market, the analysis looks only at a closed economy. The cost of research investment is excluded in the analysis as in previous studies (Freebairn, Davis and Edwards, 1982; Lemieux and Wohlgenant, 1989; Quilkey and Gunawardana, 1990; Voon and Edwards, 1991a,b). The model is specified as annual static (Edwards and Freebairn, 1981, 1984; Brennan, Godyn and Johnston, 1989).

Segmented Markets

There are seven types of copra as classified by the PCA, with moisture levels ranging from less than 6% to a maximum of 28% (Appendix Table A1). These classifications reflect the different types of copra produced and sold by farmers. At the wholesale/export sector, copra is graded into three (Philippine Fair Grade, Philippine Fair

Merchandise, Philippine Domestic) based on the following characteristics: moisture and oil content, presence of free fatty acid (as oleic), colour of copra meat and oil, extraneous matter, and mould infection (Appendix Table A2).

The two market segment approach of Brennan, Godyn and Johnston is extended, the aggregate market for copra is segregated into three components: low, medium and high quality markets. Each of the three copra markets produces a different quality of coconut oil (CNO) also divided into three markets: low, medium and high quality CNO. Non-substitution in production and demand between markets in the copra and CNO sectors is assumed.

Research is seen as having its effect through changing the proportions of the different types of copra produced within the three markets. There is limited information on the percentage distribution of the types of copra sold by farmers. The following approximation of the distribution of copra illustrates the 'without' and 'with' research supply conditions.

	'Without' research	'With research'
High quality	20%	40%
Medium quality	30%	35%
Low quality	50%	25%
Total	100%	100%

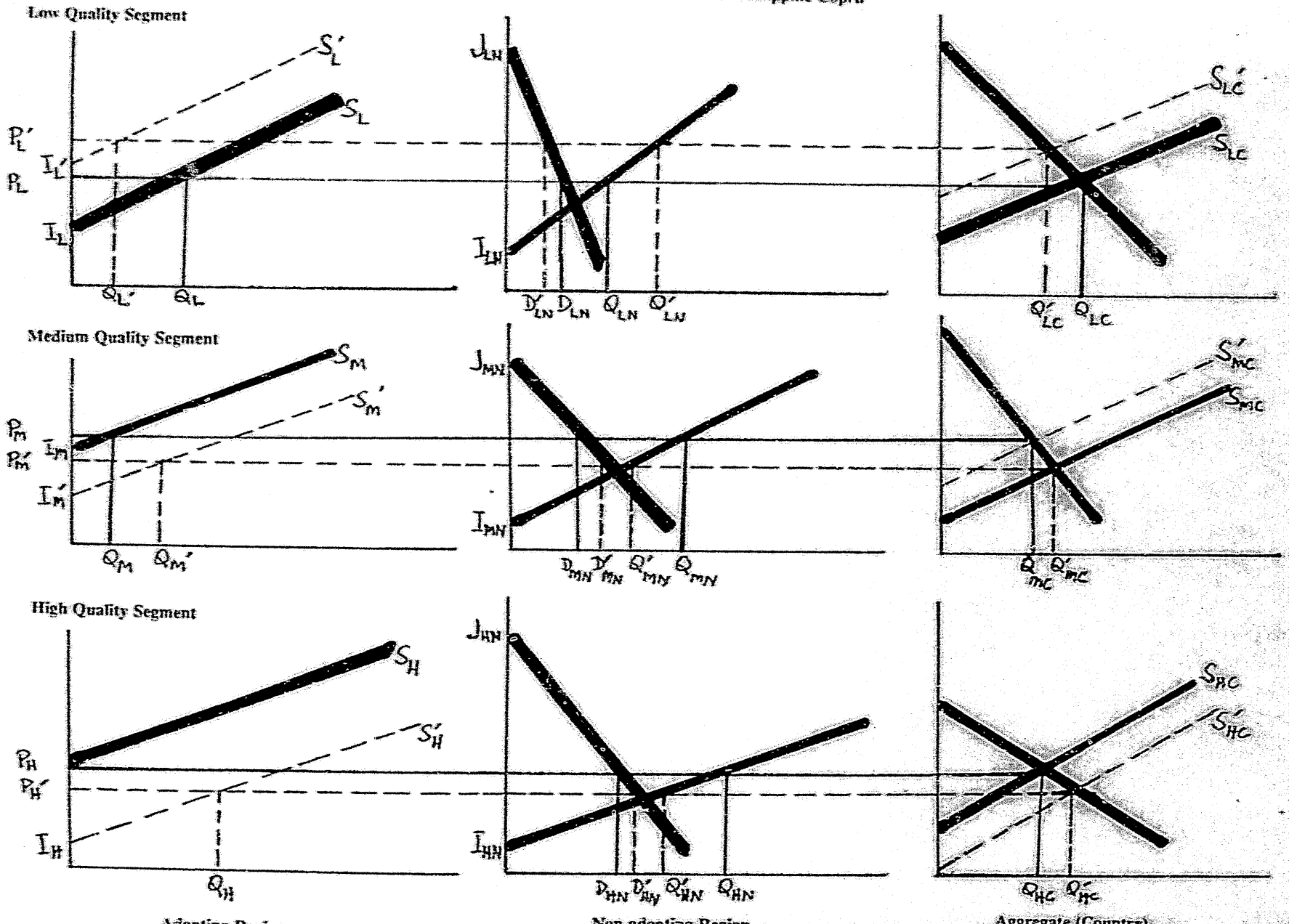
The above distribution implies that the aggregate supply and demand for copra remain constant. Research has not created a new commodity; there is only a change in supply conditions. Hence, a research-induced change in the quality of copra is depicted as a shift in supply between the three markets.

The effects of quality-enhancing research in the copra farm sector is analysed first. Copra producers are distinguished between "adopters" and "non-adopters" (Edwards and Freebairn, 1982) segregating further the copra market into "Adopting" and "Non-adopting" regions. The adoption lag however is not considered in the analysis.

The three markets for the copra farm sector model are illustrated in Figure 1. The 'without' and 'with' research conditions are represented by straight and broken lines, respectively. The supply and demand curves are assumed to be linear. The demand curve for the adopting region is infinitely elastic.

Low quality segment. With research, producers in the adopting region shift either to the medium or high quality segments. With lesser number of producers of low quality copra, the commodity is produced at higher costs. At higher production costs, less low quality copra is produced. The supply curve rises (from S_L to S_L'). The supply curve shifts upwards until its intercept is just below new equilibrium price (P_L'). Quantity decreases from Q_L to Q_L'.

Figure 7. A Three Segment Model for Philippine Copra



With an infinitely elastic demand curve for copra in the adopting region, there is no consumer surplus in the 'with' or 'without' research situations. However, 'with research' producers' surplus decreases as fewer farmers produce low quality copra. In the aggregate (country) low copra market, consumer and producer benefits decrease.

The algebraic expressions used in measuring the economic surpluses are shown in Table 1.

Medium quality segment. Producers in the medium quality segment comprises farmers who adopt partially the improved copra dryer technology.[1] With research, some of these producers shift to the high quality segment. These producers are replaced by producers from the low quality segment. The number of producers may increase, decrease or remain the same. In the present paper, it is assumed that the number of producers have increased. The movement of producers to the medium sector may be just enough to cause a small reduction in the costs of producing medium quality copra. The supply curve shifts downwards (S_M to $S_{M'}$). Price falls (P_M to $P_{M'}$) and there is a small expansion in quantity (Q_M to $Q_{M'}$). Benefits to producers increases in both the adopting region and aggregate medium quality segment, but decreases in the non-adopting region. Consumers in the non-adopting region and in the aggreegate market enjoy large surpluses due to the reduction in price.

High quality segment. Initially, the technology for producing high quality copra is high costs, such that no producer is adopting the technology. The initial supply curve is represented by a shadow curve with an intercept at or above the initial equilibrium price. Due to research, a low cost technology is developed that produces high quality copra. This encourages more producers from the low and high quality segments to move to the high quality market segment. The low cost technology induces a downward shift of the supply curve (S_H to $S_{H'}$). Price reduces (P_H to $P_{H'}$) and quantity produced is Q_H. The cost reducing effect, hence, the shift in the supply curve in the high quality segment is larger than the supply shift in the medium quality segment.

A surplus is created for high quality segment producers in the adopting region, from a zero producer surplus in the 'without' research condition. There is no consumer surplus due to the assumption of an infinitely elastic demand curve. Consumer benefits increases in the non-adopting region and in the aggegrate country, but producer benefits decreases.

The aggregate producer and consumer surpluses for the country are the sums of the surpluses in the three market segments (Table 1).

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[1] In this paper, partial adoption of a technology means that some of the recommended practices that go with the technology are not adopted.

Multistage Production

From the farm, copra flows to the processing sector through a trading sector comprises village and town buyers. A marketing sector which is defined in Freebairn, Davis and Edwards (1982) as subsuming trading, processing and distribution, is disaggregated into trading and processing sectors. The disaggregation depicts the distinctive roles of these activities in the domestic marketing of copra in the Philippines. A trading sector provides transport, storage and distribution of copra to the processing sector, while a processing sector manufactures and distributes CNO to domestic and external users. The trading sector serves as an important link to the processing sector due to the poor and inadequate market facilities in the country. Traders' mark-up comprises 11.2% on average of the millgate price of copra (Tigno, 1983). Given the segregated market approach for copra, it is also assumed that the trading sector is divided into three, corresponding to the low, medium and high quality markets in the copra and CNO sectors.

Following Freebairn, Davis and Edwards (1982), the framework used in Figure 1 is extended to assess the effects of quality-enhancing research at the farm sector to the other production stages (Figure 2).

In each of the market stages, each final buyer is represented as a combination of farm production of copra and the off-farm services of trading, or processing of coconut oil. To simplify the analysis, the following are assumed: copra and trading inputs are in fixed proportions with non-farm inputs in the manufacture of CNO; these inputs are non-substitutable; the supply and demand curves are linear; the shift in supply curve is parallel; the supply of non-farm inputs and trading services are perfectly elastic; constant per unit margin between farm and wholesale processed products; and markets are competitive.

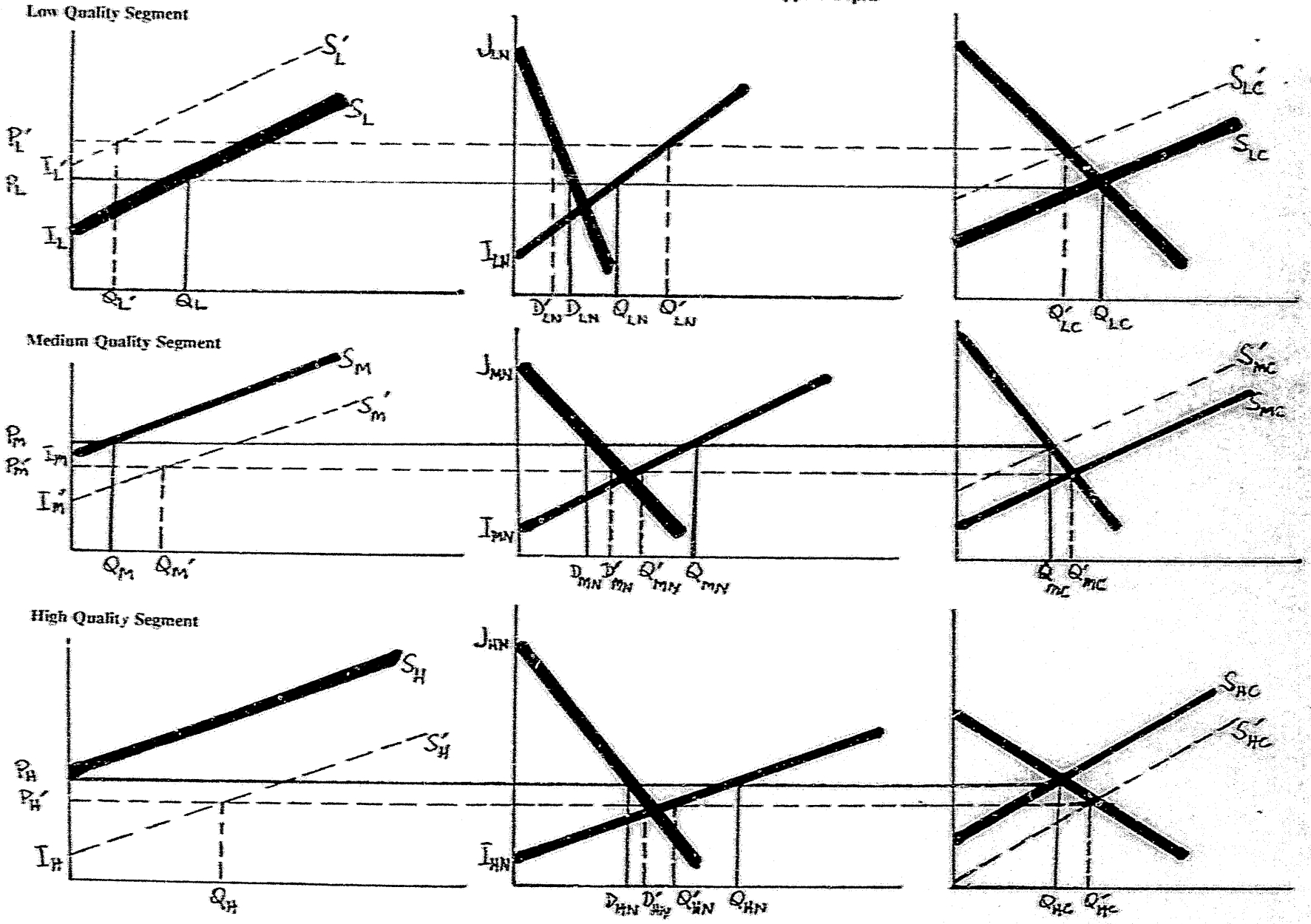
The consumer demand of the wholesale processed product in each market segment is the wholesale demand for CNO expressed in terms of the farm product (copra). The constant per unit costs of trading services is represented as T. The demand curve for the farm product is $D_f = D_w - T$. There is a constant rate of transformation between farm and wholesale processed product. The initial and 'with' research conditions are depicted by straight and broken lines, respectively; the parameters with prime (') superscript are the 'with' research equilibrium conditions.

Low quality segment. The price increase and reduction in quantity caused by a rising supply curve in the farm sector results to lower profits for traders. Wholesale product price goes up (P_{WL} to $P_{WL'}$), consumer surplus falls by the area DEF.

Medium quality segment. With a reduction in farm production costs, traders earn normal profits on a fall in price and increased quantity. In the processing sector, wholesale price decreases (P_{WM} to $P_{WM'}$), consumer surplus increases by area

High quality segment. The effects of a downward shifting supply curve is similar with those in the medium quality segment in terms of price and quantity directions. The price reduction and quantity increase are however, larger. Traders continue to earn normal profits but at a larger turnover than in the medium quality segment. Wholesale price falls (P_{WH} to $P_{WH'}$). Benefits to consumers increases by the area $P_{WH'}P_{WH}NO$.

Figure 1. A Three Segment Model for Philippine Copra



In the medium and high quality segments, traders do not gain extra surplus because of the assumed perfectly elastic supply curves. The consumer benefits are larger than the benefits to producers if the slope of the farm supply curve is greater than the slope of the demand curve in the processing sector.

The gains to consumers in the wholesale processing sector in each market segment can be measured by the following:

Low quality segment	$CS_{LP} = 0.5(P_{WL'} - P_{WL})Q_{LC'}$
Medium quality segment	$CS_{LM} = 0.5(P_{WM'} - P_{WM})Q_{MC'}$
High quality segment	$CS_{LH} = 0.5(P_{WH'} - P_{WH})Q_{HC'}$

In Figure 2, a technological change in the copra trading sector and in the processing sector can also be analysed. The multistage production approach shows that the distribution effects of a research-induced change in quality is the same, regardless of which stage the technical change occurs. The relative distribution of benefits between each production stage however, depends upon the price elasticity of demand at the CNO processing sector and the price elasticities of supply of the value added in each of the production stage (see Freebairn, Davis and Edwards, 1982).

CONCLUSIONS

Technological change in the quality of a commodity, i.e copra, has been analysed through a shift of the supply curve in contrast with a shift in the demand curve as in most studies. The framework in the present paper is an attempt to integrate the two approaches of segmented markets and multistage production systems. Using the segmented market approach, the copra market has been divided into three components: low, medium and quality. Also, the copra trading sector and the CNO processing sector have been divided into three markets. The analysis has been extended further to the distributional effects of research in multistage production. Simple formulas have been used in calculating research benefits. The algebraic expressions for the supply and demand curves have not been provided. The present paper has not taken into account non-parallel shifts, and substitution in production and demand. These aspects will be considered in future research work.

Table 1. Measuring Research Benefits to Producers and Consumers

	Producer Surplus (PS)	Consumer Surplus (CS)
Adopting Region		
Without research		
Low quality segment	$0.5(P_L - I_L)Q_L$	"
Medium quality	$0.5(P_M - I_M)Q_M$	"
High quality	"	"
With research		
Low quality	$0.5(P_{L'} - I_{L'})Q_{L'}$	"
Medium quality	$0.5(P_{M'} - I_{M'})Q_{M'}$	"
High quality	$0.5(P_{H'} - I_H)Q_H$	"
Gains in PS, CS	Gains in PS_{LQA} + Gains in PS_{MQA} + Gains in PS_{HQA}	-
Non-adopting Region		
Without research		
Low quality	$0.5(P_L - I_{LN})Q_{LN}$	$0.5(J_{LN} - P_L)D_{LN}$
Medium quality	$0.5(P_M - I_{MN})Q_{MN}$	$0.5(J_{LM} - P_M)D_{MN}$
High quality	$0.5(P_H - I_{HN})Q_{HN}$	$0.5(J_{HM} - P_H)D_{HN}$
With research		
Low quality	$0.5(P_{L'} - I_{LN'})Q_{LN'}$	$0.5(J_{LN'} - P_{L'})D_{LN'}$
Medium quality	$0.5(P_{M'} - I_{MN'})Q_{MN'}$	$0.5(J_{MN'} - P_{M'})D_{MN'}$
High quality	$0.5(P_{H'} - I_{HN'})Q_{HN'}$	$0.5(J_{HN'} - P_{H'})D_{HN'}$
Gains in PS, CS	Gains in PS_{LQN} + Gains in PS_{MQN} + Gains in PS_{HQN}	Gains in CS_{LQN} + Gains in CS_{MQN} + Gains in CS_{HQN}
Aggregate Country		
Gains in PS, CS	Gains in PS_A + Gains in PS_N + Gains in PS_C	Gains in CS_A + Gains in CS_N + Gains in CS_C

Note: The subscripts L, M, H indicate the low, medium and high quality market segments; A is for 'Adopting Region' and N is for 'Non-adopting Region'; and C is for aggregate country. The prime supercript (') represents 'with' research conditions. The notations LQ, MQ, HQ, refer to the low, medium and high quality market segments.

REFERENCES

Alston, J. M. (1990), "Research Benefits in a Multi-Market Setting", ACIAR-ISNAR, Project No. 18.

Alston, J. M. (1991), "Research Benefits in a Multimarket Setting: A Review", Review of Marke ing and Agricultural Economics, Vol. 59, No. 1, pp. 23-40.

Brennan, J. P., D. L. Godyn and B. G. Johnston (1989), "An Economic Framework for Evaluating New Wheat Varieties". Review of Marketing and Agricultural Economics, Vo. 57, Nos. 1,2,3, pp. 75-92.

Deaton, A. and Muelbauer, J. (1980). Economics and Consumer Behaviour, Cambridge University Press Syndicate, New York.

Edwards, G. W. Freebairn, J. W. (1981), Measuring a Country's Gains from Research: Theory and Application to Rural Research in Australia, A report to the Commonwealth Council for Rural Research and Extension, Australian Government Publishing Service, Canberra.

Edwards, G. W. and J. W. Freebairn (1982), "The Social Benefits from an Increase in Productivity in a Part of an Industry", Review of Marketing and Agricultural Economics, Vol. 50, pp. 193-209.

Edwards, G. W. and J. W. Freebairn (1984), "The Gains from Research into Tradable Commodities", American Journal of Agricultural Economics, Vol. 66, No. 324, pp. 41-49.

EEC (1986, 1991), Council Directives, Nos. 86/354, 91/126.

Freebairn, J. W., J. S. Davis and G. W. Edwards (1982), "The Distribution of Research Gains in Multistage Production Systems", American Journal of Agricultural Economics, Vol. 64, pp. 39-46.

Grothues, B. and A.K. Sen 2Gupta (1991), "Quality Problems with Copra", paper presented at the 3rd Exporters Forum of the Asian and Pacific Coconut Community, 28-29 October, Rabaul, Papua New Guinea.

Ladd, G. W. and V. Suvannunt (1976), "A Model of Consumer Goods Characteristics". American Journal of Agricultural Economics, Vol. 58, No. 33, pp. 504-510.

Lancaster, K. (1971), Consumer Demand: A New Approach, Columbia University Press, New York.

Lemieux, C. M. and M. K. Wohlgenant (1989), "Ex-ante Evaluation of the Economic Impact of Agricultural Biotechnology: The Case of Porcine Somatotropin", American Journal of Agricultural Economics, Vol. 71, No. 4, pp. 903-914.

National Economic Development Authority (1985), The Philippine Coconut Industry, a country study, NEDA, Pasig, Metro Manila.

Philippine Coconut Authority (1988), Coconut Industry Yearbook, Quezon City.

Philippine Coconut Research and Development Foundation, Inc. (1986), "Abstract of Completed Agro-industrial Studies", PCRDF Report, 1975-1985 pp. 21-35, Quezon City.

Philippine-German Coconut Project (1992). Mimeographed.

Quilkey, J. J. and Gunawardana, P. J. (1990), "Gains from Quality Improvement for Dried Fish in Indonesia", in J.J. Quilkey, et al, Fish Drying in Indonesia: Some Economic Issues of Improved Technology, ACIAR/ISNAR Project Paper No. 20, pp. 29-52.

Tiglao, R. (1983), "The Political Economy of the Philippine Coconut Industry", in Political Economy of Philippine Commodities, Third World Studies Program, University of the Philippines, Diliman, Quezon City, pp. 181-271.

Unnevehr, L. J. (1986), "Consumer Demand for Rice Grain Quality and Returns to Research for Quality Improvement in Southeast Asia", American Journal of Agricultural Economics, Vol. 68, No. 2, pp. 634-641.

Voon, J. P. and G. W. Edwards (1991), "Research Payoff from Quality Improvement: The Case of Backfat Depth in Pigs", Journal of Agricultural Economics, Vol. 42, No. 1, pp. 66-76.

Voon, J. P. and G. W. Edwards (1992), "Research Payoff from Quality Improvement: The Case of Protein in Australian Wheat", American Journal of Agricultural Economics forthcoming.

Appendix Table A1. Types of Copra by Moisture Content

Class/category	Moisture content (%)
1. Copra corriente	≤ 28.0%
2. Corriente mejorado	≤ 23.0%
3. Buen corriente	≤ 18.0%
4. Buen corriente mejorado	≤ 15.5%
5. Semi-resecada	≤ 13.0%
6. Resecada	≤ 8.0%
7. Resecada bodega	≤ 6.0%

Source: Philippine Coconut Authority (1988).

Appendix Table A2. Grades and Standards for Philippine Copra

	Philippine Fair Grade (PCA superior)	Philippine Fair Merchandise	Philippine Domestic
Moisture	5% maximum	8% maximum	14% maximum
Coconut oil	66% minimum	60% minimum	58% minimum
Free Fatty Acid (as oleic)	0.5% maximum	4% maximum	5% maximum
Color of meat	white to pale white	brown to dark brown	brown to dark brown
Color of oil	2 red & 12 yellow max.	9 red & 50 yellow max.	9 red & 50 yellow max.
Extraneous matter	None	3/4% maximum	1% maximum
Other specifications	edible/good grade cut into halves or quarters		
Mold infection	None	10% maximum	10% maximum

Source: Philippine Coconut Authority (1988).