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A Model of an Agricultural Household in a Multi-Crop Economy: the Case of Korea

1 INTRODUCTION

A large part of world agriculture comprises semi-commercial family farms operating in a multi-crop environment. These family farms or agricultural households combine two fundamental units of microeconomic analysis – the household and the farm. Although traditional economic theory has dealt with each separately, in developing agriculture dominated by peasant family farms it is their interdependence that is of crucial importance. Models of such households, therefore, should allow for the integration of production and consumption decisions within the context of a single theory of behaviour. That is, labour supply, household consumption (of goods as well as leisure) and the composition of farm output and resource use (including family labour) should all be determined simultaneously.

Existing models have tended to focus on selected aspects of this simultaneous problem and are, therefore, deficient to some, as yet undetermined, extent. Thus, econometric models have been developed recently which allow for the integration of consumption and production decisions but which do not consider the crop composition decision.[1] On the other hand, linear programming models have had as their main purpose an analysis of the allocation of resources to competing crops, but have not allowed for the simultaneous determination of consumption and production decisions.[2] It is the purpose of this paper to describe one method of extending the empirical applicability of the theory of the farm-household to multi-crop economies by integrating the econometric and linear programming models already available in the literature.

The central idea is to replace the single, econometrically-estimated

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profit or production function employed in econometric models of the farm-household with a set of linear production activities which can be analysed by means of linear programming techniques. The net result is that the model determines the allocation of inputs to different production activities as in any linear model of production; in addition, however, it determines the level of profits which are in turn a component of total household income and hence a determinant of household consumption behaviour. Changes in farm technology or in input and output prices on the production side can thus be traced in great detail through profits to elucidate their impact on *household* consumption of both goods and leisure. In turn, the household's demand for its own (farm-produced) output and its labour supply to farm production are no longer treated as exogenous variables but are determined from the consumption side of the model in the light of the household's subjective preference.

The paper is organized as follows. In Section 2, the theoretical model is presented. In Section 3, Korean data are used to assess the quantitative significance of the approach by calculating and comparing household response to changes in input and output prices and technology for two different specifications of the models.[3] First, the household is analysed from the consumption side on the assumption that farm profits are exogenous; this corresponds to the standard econometric approach in consumer demand theory. And second, results are presented for a model in which consumption and production responses are integrated in a theoretically consistent fashion, and farm profits are allowed to reflect production responses to prices and technological change. In Section 4 some of the policy implications that stem from this type of analysis are discussed.

2 A THEORETICAL MODEL

The model of household behaviour describes a semi-commercial family farm with a competitive labour market. The farm also engages in subsistence production in that it retains some part of its output for household consumption. A major part of agriculture in LDCs may be characterized by this type of model which lies intermediately on a continuum between a wholly commercialized farm employing only hired labour and marketing all output and a pure subsistence farm using only family labour and producing solely for home consumption with no marketed surplus.

The planning horizon is assumed to be one agricultural cycle. As a result, decisions relating to the total supply of household factors of production are treated as given. Total household labour availability and total area operated may, therefore, be treated as exogenous variables. Similarly, it is assumed that the household has already made some decision concerning its desired level of saving. The model, therefore, focuses on the short-run determination of the allocation of expenditure to different commodities (including own-consumption and leisure), and the allocation of inputs to different production activities.

Further, it is assumed that there is a market for agricultural and other types of labour and all households participate in the labour market either as buyers or sellers of labour. Thus, the use of labour time and the disposal of output are determined with reference to market wages and prices. In output and input markets, the household is assumed to be a price taker. Finally, it is assumed that land, if rented, is rented by means of fixed charges and that there are no sharecropping or other contractual arrangements which might lead to non-standard profit maximizing conditions.

With these points in mind, the model is formulated in matrix notation as follows:

$$\text{Max } U = \underset{(h\times 1)}{U(C)} \tag{1}$$

$$\text{s.t. } \underset{(1\times n)}{[1]}X_i \leq \underset{(n\times 1)}{\bar{Z}_i} \qquad i = 1, \ldots k \tag{2}$$

and

$$\underset{(1\times h)}{P'}\ \underset{(h\times 1)}{C} = \underset{(1\times m)}{\prod'}\ \underset{(m\times 1)}{X} + Y \tag{3}$$

where

- C is a (hxl) vector of items consumed (own-consumption and purchased) including leisure;
- X_i is a (nxl) vector of land use by crop and technologies on the ith type of land (or other quasi-fixed resources);
- $\bar{Z}_i$ is the maximum available quantity of the ith type of land (or quasi-fixed resource);
- P is a (hxl) vector of prices of consumed goods including leisure;
- $\prod$ is an (mxl) vector of net profits per unit of land by crop and by technology and by land type;
- X' = $[x_1, x_2 ,,,x_k]'$; and
- Y is Becker's concept of 'full income' and equals the market value of total time available to the household plus any (net) non-labour income.[4]

Thus, the household is assumed to maximize its utility function subject to a land constraint by quality or type (e.g., lowland, upland, irrigated and unirrigated) and a combined income and time constraint. The consumption of family leisure is included on the RHS of equation 3 and is valued at the market wage. The total (family and hired) labour input into crop production, again valued at the market wage, is included on the LHS of equation 3 in the determination of II. The household is a net buyer or seller of labour depending on whether total time available less time allocated to leisure is less than or greater than total labour requirement in production.

It is assumed that technology is linear. Thus for the rth crop on the ith type of land we have:

$$\prod_{ir} = p_r a_{ir} - \sum_j q_j b_{irj}$$

where pr is the price of the rth crop (and hence the rth consumption good), a_{ir} is the yield of the rth crop on the ith type of land, q_j is the price of the jth input, and b_{irj} is the jth input requirement per unit of the ith type of land for the rth crop. As noted above, the total (family and hired) labour requirement is included as one of the inputs.

Forming the Lagrangian expression, we have

$$\text{Max } L = U(C) - \lambda(P'C - \prod{}' X - Y) + \sum_i V_i(\bar{Z}_i - [1]X_i) \qquad (5)$$

The first order Kuhn–Tucker conditions are: [5]

$$\underset{(h\times 1)}{U_c} - \underset{(1\times 1)}{\lambda}\ \underset{(h\times 1)}{P} = 0 \qquad (6)$$

$$\underset{(1\times h)}{P'}\ \underset{(h\times 1)}{C} - \underset{(1\times m)}{\prod{}'}\ \underset{(m\times 1)}{X} - \underset{(1\times 1)}{Y} = 0 \qquad (7)$$

$$\underset{(1\times 1)}{\lambda}\ \underset{(m\times 1)}{\prod} - \underset{(m\times 1)}{V} \leq 0 \qquad (8)$$

$$\underset{(m\times m)}{I}\ \underset{(m\times 1)}{X}\left[\underset{(1\times 1)}{\lambda}\ \underset{(m\times 1)}{\prod} - \underset{(m\times 1)}{V}\right] = 0 \qquad (9)$$

$$\underset{(1\times 1)}{\bar{Z}_i}\ \underset{(1\times n)}{[1]}\ \underset{(n\times 1)}{X_i} \geq 0 \qquad i = 1, \dots k \qquad (10)$$

$$\underset{(n\times 1)}{V_i}\left[\underset{(1\times 1)}{\bar{Z}_i} - \underset{(1\times n)}{[1]}\ \underset{(n\times 1)}{X_i}\right] = 0 \qquad i = 1, \dots k \qquad (11)$$

where $V' = [V_1' \, V_2' \dots V_k']$ and I is a unit matrix.

Equations 6 and 7 correspond to the standard first-order conditions of consumer demand theory. Equations 8 to 11 represent the production side of the model. If equation 10 is binding for the ith type of land, then $Vi \geqslant 0$ represents the shadow price of that type of land. If for the rth crop $\lambda\Pi ir \leqslant Vi$ the rth crop will not be grown on the ith type of land. For the sth crop, however, assume that $\lambda\Pi is = Vi$ – in this event the ith type of land will be allocated completely to the sth crop. The model thus produces the standard result of complete specialization by land type. The results also indicate that the production side of the model can be solved independently of the value of λ (the marginal utility of income). Since $V_i = \lambda\Pi_{is}$ where s is the most profitable crop, a comparison between V_i and $\lambda\Pi_{ir}$ for any $r \neq s$ is not affected by the value of λ; λ is a scalar which can be cancelled out, the allocation of land to competing crops being determined exclusively by a comparison of profitability at market prices.[6] The model may be treated, therefore, as a block recursive one, in which production decisions are first determined by profit maximization given the level of maximized profits. For any given farm technology and set of input and output prices, the linear programming model of farm production (using data for a *representative* farm) allows the determination of the level of farm profits, which is then introduced into the consumption side of the model to arrive at the household's expenditure pattern.

The consumption side of the model is specified econometrically to conform to the linear expenditure system. To differentiate between the use of time by dependents and working family members the system is developed in per caput terms. For an individual member of the family the utility function is written as:

$$u = \sum \beta_i \ln (c_i - \gamma_i) \qquad i = 1, \dots h$$

where c_i indicates *per caput* consumption of the ith commodity, and γ_i are functions of a variety of household characteristics. Dependents are assumed to consume all their available time in the form of leisure and to consume the same quantities of other goods as do working family members. The household utility function is assumed to be identical for each member and additive across individuals, so that summing over the n_1 working family members and the n_2 dependents ($n = n_1 + n_2$), the household consumption problem is to maximize

$$U = \sum u = n_1 \beta_1 \ln (c_1 - \gamma_1) + n_2 \beta_1 \ln (t - \gamma_1) + n \sum_i \beta_i \ln (c_i - \gamma_1)$$

$$\text{s.t. } n_1 w c_1 + \sum_i p_i c_i = \prod{}' X + Y$$

where $i = 2..h$, c_1 = consumption of leisure, t = total time available (= consumption of leisure by dependents), and w is the market wage.

Household characteristics are introduced by making the γs linear functions of household composition; that is,

$$\gamma_i = \alpha_{i0} + \alpha_{i1} n_1 + \alpha_{i2} n_2 \qquad i = 1, \dots h$$

The solution to this problem is described in Barnum and Squire (forthcoming) and their estimation procedure is followed here. In our case the final set of estimating equations yields estimates of β_i for $i = 2, \dots h$. The value of β_1 is then obtained by the adding up restriction i.e. that marginal expenditures must exhaust the budget. The transformation of the demand curve for leisure into a supply curve of labour allows us to replace γ_1 by γ_s in all the estimating equations where $\gamma_s = t - \gamma_1$.[7] Accordingly, the estimating equations yield estimates of α_{io}, α_{i1} and α_{i2} for $i = 2, \ldots h$ and α_{so}, α_{s1} and α_{s2} where $\alpha_{so} + \alpha_{s1} n_1 + \alpha_{s2} n_2 = \gamma s$.

3 RESULTS FOR KOREAN AGRICULTURAL HOUSEHOLDS (1970)

The linear expenditure system is estimated for six "commodities": labour supply (s), paddy (c_2), barley (c_3), other farm produce (c_4), market purchased food items (m_1), and market purchased non-food items (m_2).[8] The final results are shown in Table 1.

These estimates, in conjunction with the linear programming production model (not reported here for lack of space), are used to calculate two sets of elasticities:

1 Where household and farm behaviour are treated separately, and the responses of *endogenous* variables in the utility maximization problem (consumption of rice (c_2), barley (c_3) and other farm products (c_4), food purchases (m_1), non-food purchases (m_2) and labour supply (s)) to *exogenous* variables (prices, expenditures and wage rates) are estimated assuming that farm profits are exogenous. These elasticities correspond to those obtained by the standard approach to consumer theory.

TABLE 1 *Estimated parameters of the linear expenditure system for an agricultural household in Korea*[1]

Coefficient	Estimate	T-Statistic	Coefficient	Estimate	T-Statistic
β_1[2]	0.23	—	α_{10}	233.9	(6.71)
β_2	0.05	(4.01)	α_{11}	–27.5	(–3.63)
β_5	0.03	(2.68)	α_{21}	–18.4	(–2.90)
β_6	0.81	(68.32)	α_{40}	4,373.3	(4.84)
α_{so}	580.30	(8.28)	α_{41}	–649.1	(–3.04)
α_{s2}	73.70	(3.07)	α_{42}	–330.3	(–2.02)
			α_{50}	60,969.6	(4.46)
			α_{51}	–14,056.3	(–4.84)
			α_{52}	–4,775.5	(–1.83)

[1] N = 443 households. Only statistically significant coefficients are reported.

[2] Calculated from the restriction $\frac{n_1}{n_1 + n_2} \beta_1 + \beta_2 + \ldots \beta_6 = 1$

and a mean value of 0.5082 for $\frac{n_1}{n_1 + n_2}$

2 Where household and farm behaviour are treated jointly and the responses of the endogenous variables incorporate the change in farm profits that may result from any changes in the exogenous variables including technology. These elasticities correspond to the integrated approach we have developed in Section 2. A comparison of the *elasticities* corresponding to these approaches and reported in Table 2 allows an assessment of the quantitative significance of the integrated model.

The first set of elasticities corresponds to those obtained from the linear expenditure system. The results prove to be highly plausible. Consumption of food items responds positively but inelastically to changes in total expenditure,[9] whereas non-food consumption responds positively and elastically while labour supply response is negative and inelastic. The corresponding elasticities obtained by Barnum and Squire (forthcoming) for Malaysian farm-households are 0.52 for paddy, 2.74 for market-purchased food and non-food items and −0.81 for labour supply. The overall pattern of elasticities is thus very similar for the two studies. On the assumption that farm profits are determined exogenously, all own-price elasticities are negative and inelastic. A comparison with the Malaysian results again reveals remarkable similarity. Barnum and Squire (forthcoming) produce estimates of −0.04 for paddy, and −0.07 for labour supply. The consumption side of the household model is therefore adequately captured in our LES estimates as reported in Table 2.

The production side of the model is also captured well as can be seen in Table 3 by comparing the *observed* farm cropping pattern, labour use, production costs and farm profits, with those predicted by the linear programming model of the representative farm. We can proceed to use this model to generate changes in farm profits in response to prices and technology with some degree of confidence.

Of course, one of the basic points of the theory is that in an agricultural household farm profits are not exogenous, but are a function of, among other things, farm input and output prices, wage rates and technology as captured by the production model. If we compare the second set of elasticities estimated by allowing farm profits (and hence total incomes) to vary as a consequence of the impact of input and output prices and wage rates on farm production, the full implications of integrating consumption and production decisions are revealed. Apart from the elasticities with respect to the prices of purchased commodities which do not enter into farm production decisions and with respect to total expenditures which remain the same by definition, *thirteen out of the sixteen remaining elasticities change sign*, while the remaining three are significantly different in magnitude. In addition, the integrated model allows the estimation of elasticities with respect to input prices and technological changes in *farm production* which are not defined for models that focus exclusively on consumption behaviour. These results demonstrate the

TABLE 2 *A comparison of selected arc elasticities to test the significance of integrating household production and consumption decisions (Korean agricultural households, 1970)*[1]

Elasticity of: / With respect to:	Own consumption of Rice (C_2)		Food purchases (M_1)		Non-food purchases (M_2)		Labour supply (S)	
	I	II	I	II	I	II	I	II
Total Expenditures (E)	0.5692	0.5692	0.9167	0.9167	2.76	2.76	2.76	–0.451
Price of Rice (P_2)	–0.1778	0.0104	–0.0645	0.269	–0.1941	0.81	0.0317	–0.1322
Price of Barley (P_3)	–0.0031	0.0625	–0.005	0.1007	–0.0151	0.3031	0.0025	–0.0495
Price of Other Crops (P_4)	–0.0009	0.1178	–0.0015	0.1897	–0.0044	0.5712	0.0007	–0.0932
Price of Food Purchases (P_5)	–0.0147	–0.0147	–0.2494	–0.2494	–0.0715	–0.0715	0.0117	0.0117
Price of Non-Food Purchases (P_6)	–0.041	–0.041	–0.066	–0.066	–0.8665	–0.8665	0.0324	0.0324
Wage Rate (W)	0.1583	0.0097	0.255	0.0156	0.7678	0.047	–0.0020	0.105
Seed Costs (Q_1)	NA[3]	–0.0111	NA	–0.0179	NA	–0.054	NA	0.0088
Fertilizer and Pesticide Costs (Q_2)	NA	–0.0484	NA	–0.078	NA	–0.2349	NA	0.0383
Power Tiller Capacity[2]	NA	0.0019	NA	0.0031	NA	0.0094	NA	–0.0015

[1] The first set of elasticities in the columns marked (I) are computed on the assumption that farm profits (π) are constant. The second set of elasticities in the columns marked (II) are computed on the assumption that farm profits (π) are variable. Changes in farm profits (π) are estimated by using the l.p. production model to trace the impact of discrete changes in exogenous variables. The first set of elasticities correspond to the linear expenditure system alone and in the second set to the integrated model.

[2] This elasticity is obtained by increasing the capacity of power tillers available per household to simulate the impact of changes in mechanical technology from bullocks to power tillers. It should be read as the percentage change in endogenous variables for a 1% change in tiller capacity available.

[3] NA = Not Available because changes in production costs and technology are possible only in the integrated model.

quantitative significance of the model and indicate the importance of integrating consumption and production decisions in models that examine the behaviour of agricultural households. Several interesting and important policy implications follow.

4 SOME POLICY IMPLICATIONS

To begin with, consider the own and cross-price elasticities for rice, the most important food item (and hence nutrition source) in the household's consumption bundle and the most important crop on the farm. Traditional consumer theory suggests that own-consumption of rice will *decrease* if its price is raised (the estimated elasticity is −0.18), but the integrated model predicts that it will *increase* (the estimated elasticity now being 0.01), because increased prices also mean increased profits (and incomes) for agricultural households thus swamping the price and income effects predicted by consumer theory.[10] Similarly positive elasticities are predicted for food purchases and non-food purchases with respect not only to the price of rice but to the prices of all crops grown on the farm. Thus, while raising farm output prices may have a *negative* impact on the nutritional status of non-farming rural households, it has a *positive* impact on agricultural households. By the same token marketed surplus response is *lower* because own-consumption of farm-produced goods increases rather than decreases in response to increased prices. Non-farm households, however, may benefit from increased wages and employment opportunities because increased output prices also decrease the supply of farm labour as profits and income increase instead of *increasing* it as predicted by consumer theory. The integrated model predicts that households are willing to take *part of their increased incomes in increased leisure*, so that any increased demand for labour in agricultural production (say, through land intensification programmes) will have some spill-over effects on the demand for hired labour (hence the incomes of the landless) even where the farm size is very small because not all the increased demand may be met by an increase in the household's own labour supply to farm production.

Finally, there are the set of elasticities that can be estimated *only for the integrated model* – those with respect to input costs and changes in farm technology. Thus our model correctly predicts reduced expenditures on all commodities and increased work effort as input (seed and fertilizer–pesticide) costs are increased, and increased expenditure and reduced labour supply as the availability of tiller capacity is increased and bullock cultivation is replaced by power tillers in farm operations. Increased availability of power tillers also changes the cropping pattern in favour of vegetables that are highly profitable under tiller technologies, in turn affecting the seasonal demand for labour. Thus even labour displacing technological change, such as the increased use of power tillers, may

TABLE 3 *Observed VS predicted values of farm production*

	Observed from Sample Households[a]	*Predicted by* Linear Programming Model
Cropping Pattern (%)[b]		
Rice	40.7	43.14
Barley Mixtures	28.2	32.8
Misc. Grains	4.2	1.0
Pulses	12.2	12.1
Potatoes	6.1	1.5
Vegetables	8.6	9.5
Resource Use		
Labour Use (in hours)[c]	2,181.1	2,318.0
Draft Animal Use (hours)	103.6	86.1
Borrowing (in 1970 won)[d]	36,742.0	37,325.0

	Observed from Sample Households	*Predicted by* Linear Programming Model
Gross Values of Production (in 1970 won)	213,244	224,326
Total Production Costs (in 1970 won)		
Variable Inputs[e]	35,395	42,558
Labour	81,684	85,470
Draft Animals	2,642	2,196
Power Tiller[f]	—	3,648
Interest Charges	4,738	8,958
Total	124,459	142,830
Net Farm Profit	88,785	81,496
Farm Profit per Hectare	70,464	64,679

[a] All observed values are from a sample of 443 farm-households.

[b] The household survey data do not give information of area sown to various crops except for rice. The observed values are from a national survey of cropped land reported in the *Yearbook of Agriculture and Forestry*, 1971, Ministry of Agriculture and Fisheries, Korea, and a total correspondence between this and the household survey figures is not to be expected. The area planted to orchards, mulberry and tobacco is deleted in computing this cropping pattern because of the very small proportion of total area devoted to these crops.

[c] Excludes labour spent on orchards, mulberry and tobacco production which is a very small proportion of total labour use and non-agricultural activities for which no data are available.

[d] The interest rate on borrowing charged in the model is 2 per annum and is close to the commercial bank rate. The lending rate in agricultural cooperatives is perhaps low, about 18% – accounting for the overestimation of interest charges in the model.

[e] Includes expenses on fertilizers, manure, salt, insecticides and irrigation.

[f] No data are available on tiller costs in the household survey.

have some positive effects on the demand for hired labour, even though the total demand for labour declines, because agricultural households may reduce their own labour supply as their incomes increase. Such positive associations between farm mechanization and increased demand for *hired labour* are observed in widely differing farming conditions as in the Indian Punjab, Taiwan, Philippines and in Korea.

CONCLUSIONS

The policy implications discussed here are not in the least exhaustive, but rather indicative of the importance to be attached to the development of an integrated approach to the behaviour of agricultural households. In this paper the theory of the agricultural household was extended to a multi-crop economy. The results from this and other studies that use an integrated approach to production and consumption decisions highlight the need to change our perceptions concerning agricultural household response to economic incentives in developing countries and to revise the design of economic projects and policies accordingly.

NOTES

[1] See, for example, Lau, Lin and Yotopoulos (1978) and Barnum and Squire (forthcoming).

[2] See, for example, Odero-Ogwell and Clayton (1973) and Heyer (1971).

[3] The data are drawn from the Korean Farm Household Economy Survey for 1970.

[4] The model thus had h consumption goods (of which one is leisure), k types of land, n crops, and m (=kxn) different possible crop combinations or activities by land type and technology.

[5] Noting that all C's and λ (the marginal utility of income) are positive.

[6] If, on the other hand, equation 10 is not binding for the ith type of land, that type of land is not cultivated. Once again the solution is independent of λ.

[7] This transformation allows us to avoid specifying total time available (t) in the estimating equations. See Abbott and Ashenfelter (1976).

[8] The labour supply curve is estimated instead of the demand curve for leisure because data on hours worked are usually more readily available than data on hours spent in leisure by family members. This follows from the substitution of γl by γs above.

[9] Total expenditure (E) is the sum of expenditure on commodities and leisure (valued at the market wage). In computing leisure time, we set t = 2,400 manhours per year; i.e., 8 hours per day for 300 days. On this basis, E = 328,103 won.

[10] Traditional consumer theory includes both price and "income" effects of price changes *but assumes the budget line is fixed*. Our model traces, in addition, the shifts in the *budget* line through farm production and its impact on farm profits and hence total income.

REFERENCES

Abbot, M. and Ashenfelter, O. "Labour Supply Commodity Demand and the Allocation of Time", *Review of Economic Studies*, Vol. 63, pp. 389–412, 1976.

Barnum, H.N. and Squire, Lyn "An Econometric Application of the Theory of the Farm Household", *Journal of Development Economics*, (forthcoming).

Heyer, J. "A Linear Programming Analysis of Constraints on Peasant Farms in Kenya", Food Research Institute Studies in Agricultural Economics, Trade and Development, Stanford University Food Research Institute, Vol. 10, pp. 55–67, 1973.

Lau, L.J.W.L. Lin and Yotopoulos, P.A. "The Linear Logarithmic Expenditure System: An Application to Consumption-Leisure Choice", *Econometrica*, Vol. 46, No. 6, July 1978.

Odero-Ogwell, L. and Clayton, E. "A Regional Programming Approach to Agricultural Sector Analysis", School of Rural Economics and Related Studies, Wye College, 1973.

GENERAL DISCUSSION – RAPPORTEUR: KENNETH H. BAUM

The discussion of this paper centred primarily on methodological issues and assumptions made by the authors in their empirical investigation. The large interest expressed by the audience resulted from the authors' linking consumption and production theory and activities in a programming model of a representative Korean farm. The authors were asked to consider additional research with the model to include non-representative farms to find if their results changed. In particular, questioners were interested to know under what conditions estimated elasticities would reverse signs, and under what conditions one would get opposite results with their model. It was also argued that the use of a linear expenditure system in the model acts to preclude its usefulness for policy analysis. A trade-off must be made between the demand assumptions made in the model and the estimated elasticities. For this reason, modifications of the demand and utility structure were recommended to indicate alternative demand assumptions. It was also noted that the model is quite interesting because a direct investigation of net substitution and income effects may be observed with regard to labour availability and goods consumption in rural areas. This may be especially important for various policy and planning analysis either to increase incomes in rural areas or to promote use of capital. Finally, a number of participants observed that the specification of an endogenous rather than an exogenous labour supply in the model was a step forward in the process of understanding household consumption and production behaviour.

Dr Singh responded to the above observations with an awareness that the modelling procedure was at an early stage of development. Yet the model was still capable of generating useful information. It was indicated that the authors were aware of the limitations the linear expenditure system of demand equations placed on their analyses. Hope was expressed of further model development, recognizing that assumptions made in this area would certainly affect empirical estimation of production and consumption elasticities in the model. Second, Korea has a fairly homogeneous farm structure so a representative farm may be used, although this is not true for other countries and disaggregation may have to occur in other models for a meaningful aggregative policy. Finally, Dr Singh noted that farms can only really determine the amount of labour supplied to non-farm markets if these markets exist, and if rural families participate in these markets.

Participants in the discussion included J. Heyer, Murty K. Narasimha, Bob Wells, Richard H. Day, George T. Jones, Robert L. Thompson and Richard A. King.