Micro-Level Approaches to Analysing Rural Development Problems

Euan M. Fleming and J. Brian Hardaker*

Micro-level analyses of the farm sector may be conducted at intra-household, household or village levels. Most economists have preferred to work at the household level because of the existence of a well-developed farm-household theory. Empirical studies at the micro level have mostly used econometric or mathematical programming approaches. For both, but especially the former, the strong assumption of separability of production and consumption decisions is usually crucial. While the number and sophistication of empirical studies continue to grow, operational shortcomings remain severe. The limited use in policy making of many analyses is noted and the merits of combining comprehensive formal models with less formal and relatively simple approaches are canvassed.

1. Level of Analytical Focus

Three main choices of level of aggregation face those wishing to analyse economic behaviour at the micro level in the farm sector. At the most disaggregated level, analyses can be made of intra-household decision making and power relations. The second level is the farm household where all members of the household are viewed as a homogeneous group. At a more aggregated level, inter-household economic behaviour can be analysed. The most common unit of analysis at this level in rural areas in developing countries is the village. The middle level (the household) has proved to be the most popular unit of analysis for economists. This has been primarily because it fits most comfortably into the paradigms in which economists work (but not perfectly, as indicated below).

Intra-household studies involving economists have been relatively rare. Perhaps the most common form of analysis has been time allocation, especially in respect of the productive activities of individual household members (e.g. Evenson 1978, Khandker 1988). Economic analyses have also been undertaken as part of interdisciplinary studies of intra-household decision making. Examples include studies of migration decisions, gender relations and factors influencing nutritional status. Generally, however, the involvement of economists in intra-household studies has been small relative to that of anthropologists and sociologists. Difficulty in obtaining relevant data has probably been the factor most constraining such studies.

Major household decisions have not yet been adequately considered by economists analysing intra-household decision making. In particular, the correct choice of underlying household utility function has been neglected. How are conflicts in preferences among household members resolved, can these resolution procedures be modelled and, if the resolution procedures are deemed to be unsatisfactory, how can they be changed? And what about inter-household relationships? Most farm-household models are based on the Western concept of a nuclear family, with its own consumption needs and its own resources. Yet households in many developing countries are not like that. Some important resources such as land and water resources may be communally owned and used. Non-market forms of transaction such as reciprocity and gifting may be important, even to the point of dominating other forms of transaction. While such reciprocal arrangements may well be economically rational at a community level and in the long run, they may seem to be far from rational when viewed in the short time span of a typical farm-household analysis.

Village studies have been more numerous than intra-household studies, and the involvement of economists greater. The popularity of village studies in developing countries probably reached its peak in the 1970s. In a review covering the period 1950 to 1975, undertaken at the Institute of Development Studies (IDS) (Lambert 1978), some 863 studies were annotated. While agriculturalists, anthropologists, demographers, educationists and sociologists dominate these studies, quite a number were undertaken by economists. A feature of the

* Department of Agricultural and Resource Economics, University of New England, Armidale, NSW 2351.

economic studies, however, was their strongly descriptive nature, particularly surveys, with little analytical content. Some economic studies dealt with village labour use, such as those undertaken in the Village Studies Programme (VSP) at IDS (Connell and Lipton 1977). See also Dasgupta (1977, 1978).

The time perspective of village economy studies has varied. Some analysts have traced the growth, transformation or demise of a village economy over time (e.g. Gudeman 1978, Frazer 1986) while others, such as Hayami (1978), in his well-known study of a rice village in the Philippines, have taken a cross-sectional profile of a village economy. Hayami and Kikuchi (1982) extended the work of Hayami by investigating institutional aspects of Philippine and Indonesian village economies.

Economists have had difficulty coming to grips with rural villages as units of analysis. As emphasised below, they have enough difficulty in handling the complexities of farm-household systems. Village systems add yet more complexities for quantitative and integrated economic analyses. Hayami's (1978) study exemplifies these difficulties. One of the few quantitative and integrated studies of a village economy, it nevertheless suffers from superficiality in analysis. There is little of substance emanating from his study likely to be of use to policy makers.

The same is true of most of the (chiefly government-sponsored) large village surveys that have been undertaken in developing countries. For example, the Thai government has undertaken periodic surveys of poor villages, collecting data on economic and social variables to use as a base for rural development planning and selecting projects for alleviating poverty. However, there is little of prescriptive value that can be gleaned from the data collected and there are limits to the scope for further analysis.

A different sort of village study with some economic content has been the 'lessons from experience' approach. People involved in development work at the village level recount their experiences - both successes and failures - seeking to provide useful information for policy making and development project planning. A number of such studies were edited by Stamp (1977). These studies can suffer from a lack of rigour in their analyses, and contain too many flawed subjective judgments. However, they do have the merit of providing a record of observations of experienced people in specific circumstances based on a long involvement in practical development problems.

The Village Level Studies (VLS) Program undertaken by the International Crops Research Institute for the Semi-Arid Tropics in India represents perhaps the best example of micro-level data collection and analysis in the developing world. Walker and Ryan (1990) have provided an excellent review of this ambitious program, including the nature of the data collected and uses to which they have been put. Among the important characteristics of the VLS data, Walker and Ryan (p. 23) cite their "village focus as opposed to a single crop or socio-economic group". The studies transcend a number of levels of aggregation, from "the microscopic level of individuals and fields ... to regional contrasts" (p. xvii). Despite the impressive nature of the VLS data set, however, it is doubtful whether many governments in developing countries have the resources to undertake such a program of collection of longitudinal data.

Because most analytical efforts by economists have gone into farm-household studies, we concentrate on these in the remainder of the paper. A brief survey of farm-household theory is given first. It is followed by a classification of approaches to farm-household modelling. The classes of models are discussed and assessed for their efficacy in contributing to rural development policy analysis in developing countries.

2. Farm-Household Economic Theory and Modelling

2.1 Combining Farm-Household Production and Consumption

Households the world over are both production and consumption units. Production occurs even in prosperous urban households when household labour and other inputs are combined to produce consumption goods such as a meal or a tidy living

area. The integration of production and consumption activities in the one unit is strongest, however, in the semi-subsistence farm-households that predominate in most developing country villages. A potted history of advances in farm-household economic analysis is given in the Appendix. Economists were remarkably slow in recognising that proper appreciation of the economic behaviour of such household units requires simultaneous consideration of the production and consumption processes.

2.2 Modelling the Complexities of Farm-Household Systems

Farm-household systems are complex. Production is especially difficult to model. It is seldom confined to a single staple food crop, so that a multiproduct production function is commonly needed, incorporating both cash and food crops, as well as livestock. It may also be necessary to recognise production functions within the household for so-called Z-goods, such as cooked meals, handicrafts or child rearing, that are significant (and too often ignored) components for farm-family production. Inputs to production usually extend beyond just labour, perhaps including use of family-owned assets such as perennial crops and draught animals, which may have associated cash operating costs and perhaps market values. Family labour may not be homogeneous and hired labour may be an imperfect substitute in at least some aspects of production. Borrowing for production purposes is also likely to require consideration.

Farm-household consumption decisions are also difficult to model. Subsistence consumption is tricky to measure. Quality and taste differences in foods may need to be recognised, along with a preference for diversity in what is consumed. Consideration may also have to be given to households that borrow for consumption purposes, especially among the very poor.

The following further six characteristics give a good indication of the complexity that needs to be considered in modelling these systems:

(a) Farm-household systems are dynamic, particularly in respect of production and investment decisions. Time brings many changes to a typical farm-household, such as demographic changes and growth or depletion of assets.

(b) Dynamic farm-household systems also imply instability and uncertainty. Risk attitudes of farm-household members influence both production and consumption decisions. Risk aversion is likely to colour many household decisions so that an analysis that ignores risk is likely to be very imperfect.

(c) Most farm-household systems are undergoing technical change. The thorny issues relating to the rate and nature of such change have mostly been addressed to date via agricultural sector-level econometric studies rather than at the micro level.

(d) Many farm households undertake marketing activities as a major source of income. Where this occurs, analysts need to incorporate a separate component of household marketing activities alongside the farm production and consumption components in farm-household models. The too-ready assumption of perfect markets means that the need for households to engage in active marketing is overlooked.

(e) Emerging ideas about the importance of gender relations affecting farm-household decisions also should be represented in farm-household models.

(f) Nutrition is important in rural households, requiring that analysts incorporate nutritional variables in farm-household models.

All six of the above issues contain many difficult methodological questions to resolve, and make considerable demands on data in modelling farm-household systems. Further, the need for farm households to maintain sustainable systems in a changing and risky environment further complicates modelling work.

3. Classification of Approaches to Modelling Farm-Household Systems

Attempts over the past 15 years to develop an

analytical framework for studying farm-household systems in developing countries have yielded some impressive advances in theory and its applications.

The breadth of empirical studies using farm-household models based on recent theoretical advances is evident from the nine case studies reported by Singh, Squire and Strauss (1986). These studies have been augmented by further such empirical studies in the intervening years, and cover policy issues such as farm input and product pricing, technology, food consumption and nutrition, farm profitability, yield and price risk, rural credit, and labour supply and demand.

The theoretical advances have been accompanied by advances in the sophistication of modelling techniques. They have been especially evident in econometric analyses but also in mathematical programming work and, to a lesser extent, simulation, as summarised below.

3.1 Econometric Models

Econometric models of farm household systems may be categorised as either comprehensive or partial. In comprehensive household models, both production and consumption decisions are treated endogenously. Partial models include either production or consumption aspects or, if both are included, the decisions relating to one aspect are regarded as exogenously determined. For example, in an analysis of consumption behaviour, production parameters may be treated as predetermined. Or, in a production study, consumption may be regarded as fixed.

Traditional econometric research was of a partial nature, covering topics such as commodity supply and/or marketed surplus response, household agricultural production functions, labour supply, demand for credit and food consumption decisions. Major methodological concerns expressed in these partial studies were about the choice of the functional form, the dynamics of the systems, pooling time series and cross-sectional data, and the treatment of risk.

Concern about the strength of the *ceteris paribus* assumption in these partial studies prompted analysts to take a more comprehensive view of each type of farm-household decision. Singh *et al.* (1986, p. 4) viewed comprehensive farm-household models as important in helping policy makers understand the responses of farm households to different policy alternatives:

> Questions such as [the impacts of policy alternatives] are difficult to study without a thorough understanding of the microeconomic behavior of agricultural households. That means it is essential to know what factors determine the level of farm production and the demand for farm inputs, what factors govern consumption and the supply of labor, and how the behavior of the household as a producer affects its behavior as a consumer and supplier of labor, and vice versa.

In parallel with the theoretical developments in farm-household economics outlined above, attempts have been made to develop econometric methods that enable models more accurately to fit these theories. Some important refinements in methodology have been attempted. They include means of relaxing the separability assumption, developing more suitable expenditure systems, specifying more flexible functional forms in production, cost and profit functions, incorporating farm saving and borrowing behaviour, and accounting for dynamics and risk in farm-household systems. Brief comments follow on each of these undertakings.

3.1.1 Separability

Possibly the most vexed issue in empirical studies of farm-household decision making has been, and remains, the strength of the separability assumption. Under this assumption, production can be analysed first, accounting for the household's stock of fixed resources, such as land, and assuming profit-maximising behaviour in terms of output produced, whether sold or not, and variable inputs used, whether owned or not. Then the consumption decisions can be analysed second, assuming the existence of a household utility function for consumption goods, and measuring the total income to be allocated among expenditures on these goods to include the profit from production. Models of household behaviour of this kind are described as 'separable' since the production decisions can be analysed separately from the choices about consumption, though not vice versa.

The conditions necessary for a farm-household system to be truly separable are stringent. There must be effective markets operating for both household-owned inputs (chiefly labour) and for the farm products that may be used for subsistence consumption. Moreover, the prices households pay if they buy in these markets must be the same as the prices they receive for the corresponding items if they sell. These prices must be independent of the behaviour of the household or groups of households being modelled. Finally, risk must not be important in production or prices. Clearly, these conditions will seldom be satisfied in reality. Rural households in developing countries are often unable to sell surplus labour at the going wage rate on a year-round basis, they often have to pay more to buy foodstuffs than they can earn from selling the same commodities, and risk is an inescapable fact of life for them all. Yet, despite these weaknesses of the separability assumption, it is widely adopted, simply because to do otherwise makes systematic analysis difficult, if not impossible (see below). It seems that most analysts have relied on the well-known maxim of Occam's razor, preferring the simpler approach unless and until it is found to be inadequate. Their position is fortified by the fact that it is seldom possible to assess with any precision the extent of bias introduced by falsely making the assumption.

The difficulties that ensue if separability is not adopted are several, and vary according to which of the component assumptions are taken not to hold. If there are differing selling and buying prices, analysis can proceed for households that elect to trade as either buyers or sellers. If may be presumed that the relevant prices are those that pertain in each case. But for households that neither buy nor sell, say, labour, the shadow price of family labour is determined endogenously and, worse still, is unobservable. There is therefore no way of determining the appropriate price to use in the comparative statics. If risk is to be recognised, risk aversion in consumption implies risk aversion in production decisions. There is little prospect yet of developing implementable integrated farm-household models that accommodate risk at all comprehensively. Finally, attempts to move towards a general equilibrium analysis in modelling farm-household systems confront another range of difficulties. As Singh *et al.* (1986) explain, there are issues of aggregation bias, much more detailed data are required, estimation difficulties are likely to be magnified, and numerical solution of the resulting system of highly nonlinear equations may be impossible.

It seems clear that much future research will be directed to tackling these many difficulties, as well as to some other related challenges. Among the latter are questions raised above about intra-household decision making. With increasing interest in the role and status of women in farm households, for example, questions arise about the legitimacy of a 'household' utility function.

3.1.2 Expenditure systems

The principal issue to be resolved in modelling household expenditure systems is the choice of functional form and the consequent properties it endows on the model. Early farm-household studies of consumption decisions used a linear expenditure system (LES) or linear logarithmic expenditure system (LLES). More recently, attempts have been made to alleviate the restrictiveness of the assumptions underlying these models by using more flexible function forms such as a quadratic expenditure system (QES) or Almost Ideal Demand System (AIDS) model.

The QES is to be preferred to the LES and LLES in that it allows for quadratic Engel curves and inferior goods. The implication is that budget shares can vary with level of household income. AIDS models also have the advantage of flexibility, especially in terms of their properties for estimating price and income elasticities, distinguishing between luxury and necessity goods, and testing the validity of the homogeneity and symmetry conditions. At the same time, however, the AIDS model can be limited by its approximate nature in estimation.

3.1.3 Functional forms in production systems

Most of the early analyses of production in a farm-household context used simple production functions, notably the Cobb-Douglas function. In line with econometric modelling efforts generally to specify production, cost and profit functions more

in accord with economic theory and reality, analysts have turned to more flexible functional forms, such as the translog, normalised quadratic and generalised Leontief functions. With these forms, an underlying assumption of profit maximisation is accompanied by assumptions about symmetry, linear homogeneity in prices, monotonicity, convexity, nature of technical change and non-jointness in inputs. Few farm-household studies have used flexible functional forms, and none we are aware of in developing countries.

3.1.4 Farm-household saving and borrowing behaviour

Early farm-household studies largely ignored the saving and borrowing behaviour of farm households. This omission exposes household models to the criticisms that they fail to take account of the impacts of the propensities of farm household members to save and borrow, and of interest rates on household production and expenditure.

To overcome this omission, saving and borrowing decisions need to be incorporated in farm-household models to bring empirical work more closely into line with economic theory. First, interest rates need to be included as an endogenous variable. Second, saving and borrowing functions should be specified as part of the model. To date, few analysts have successfully formulated farm-household models that are adequate in these respects.

3.1.5 Dynamics and risk

Accounting for the dynamic and risky nature of farm production is proving difficult in all types of econometric studies in agriculture. Despite their obvious importance, dynamics and risk have been virtually ignored in farm-household econometric methodology. Reasons for the neglect of dynamics include difficulties in obtaining time series data that allow the formulation of dynamic household response functions and, even if data are available, in identifying and specifying appropriate lag functions. Neglect of risk in modelling farm-household decision making can largely be attributed to the fact that the incorporation of risk means that separability can no longer be assumed (Roe and Graham-Tomasi 1986, p. 257). In addition, there are difficulties in simultaneously calibrating households' risk perceptions (subjective probabilities) and their preferences for outcomes (utility functions).

3.2 Mathematical Programming Models

Mathematical programming (MP) appears to have many advantages for modelling farm-household systems. These systems can be conceptualised as constrained optimising systems, apparently well suited for representation in the MP form. Moreover, the separability assumption that bedevils much econometric modelling appears to present few difficulties in MP formulations; it is simple enough in concept to combine both production and consumption aspects in the one model.

In practice, however, things are not so straightforward. The major difficulty, perhaps, is the formulation of an appropriate objective function. Farm-household theory suggests a presumably nonlinear, multi-attributed utility function. But how is such a function to be specified? It cannot usually be estimated econometrically without confronting the problems of separability and estimation difficulties noted above. Although there have been some apparently successful attempts to elicit utility functions directly from household heads (e.g. Binswanger 1980, who used real money payoffs in eliciting preferences from household heads in rural India), the task becomes much more challenging for both analyst and subject if a multi-attributed function is needed. One of us has been so bold (or ill-advised) as to attempt such multi-attributed utility elicitation from semi-subsistence farmers, and is now convinced that the method is unlikely to be feasible in all but the most exceptional circumstances.

With neither direct elicitation nor econometric estimation appearing to be practicable, analysts have usually fallen back on much more arbitrary approaches to specifying objective functions in MP models of farm-household systems. Typically, preferences for consumption are specified as fixed constraints, permitting the objective function to be defined in terms of some measure of income such as farm cash flow. Risk may be ignored or treated rather arbitrarily as in the plethora of MOTAD programming formulations that Hardaker, Pandey and Patten (1991) have criticised. More realistic are those applications in which risk aversion for

cash income or wealth is recognised (Krause *et al.* 1990) or where priority is given to security of subsistence needs via specifications such as Target-MOTAD (Delforce 1991, Jaeger and Matlon 1990). Some analysts have been more ambitious and have tried to capture multi-attributed preferences via goal programming models (e.g. Flinn, Jayasuriya and Knight 1980, Barnett, Blake and McCarl 1982), while others have used parametric approaches to map out 'efficient' sets of solutions in terms of two or more presumed dimensions of preference (e.g. Romero, Amador and Barco 1987).

Some authors have sought greater flexibility than is offered by MP and have developed simulation models of farm-household systems (e.g. Zuckerman 1977). Simulation tends to appeal to agrobiological scientists who are often more aware than agricultural economists of crudities of representation of production processes in MP work. As with other simulation studies, the greater realism in modelling, particularly of production aspects, is at the cost of the loss of an optimising algorithm. Hence, simulation models may be regarded as rather sophisticated (usually stochastic) budgeting models that are useful for answering 'what if' questions rather than for modelling households' responses to stimuli such as prices or available technologies. Lyne, Ortmann and Vink (1991) combined the use of MP and simulation in predicting the responses of rural households in KwaZulu to changes in a number of macroeconomic variables.

The basic problem with almost all MP and similar studies is that of validation. In the absence of data about actual preferences, how can the validity of the model be judged? The test of acceptable congruence between model output and the actual farming system is difficult to implement and very weak, since approximately right answers may be obtained for the wrong reasons.

Despite these problems, MP models have been popular and seemingly useful. As noted, the small-scale farm-household systems that prevail in rural areas in most developing countries are highly constrained. It is possible that the exact specification of the objective function in such systems is not so important, since the degree of flexibility that people have in what they do and how they do it is so limited. Moreover, MP models have the important advantage over econometric models of allowing assessments of variants of the systems that do not yet exist. For example, MP has proved useful in the assessment of prospective technologies (e.g. Ghodake and Hardaker 1981). With greater access to the needed computer hardware and software, we may expect to see more such studies in future.

3.3 Informal Models

Although there are some difficulties in estimating integrated farm-household models, whether using econometrics or MP, the conceptual framework provided by farm-household economics is undoubtedly valuable. Perhaps the best evidence of this is in the work of Low (1986) who was able to use the conceptual framework to gain useful insights into the operation of rural economies in southern Africa where the marginal product of labour was not necessarily falling. He used simple graphical and tabular analyses to explain the choice between subsistence production, cash cropping and wage earning in situations where employment demanded migration away from the household and where, partly in consequence, there were substantial differences in earning potential of different household members.

Farm-household economics also gives a new perspective to farm management studies in developing countries. In the past, much work along these lines inherited from the West a focus on 'the farm as a business'. In other words, the emphasis was on the production side of the system with a near total neglect of the consumption side. Such a bias still prevails, for example, in the Cost of Cultivation Survey carried out on some 9000 farms annually in India. In future, however, we can expect more farm-household surveys and budgeting studies to include both production and consumption components. The growing concern, for instance, about human nutrition has led to a research network, coordinated by the International Food Policy Research Institute, to examine the relationship between cash cropping and nutritional status, particularly of small children (Bouis *et al.* 1984).

The farming systems approach may be said to have important links to farm-household economics, at

least as perceived by many economists. The focus is usually firmly on the farm-household units in the target domain and the holistic approach commonly advocated is certainly wide enough to embrace both production and consumption aspects. In some farming systems research, with an emphasis on finding solutions to identified agrobiological problems that will be adopted by client farmers, the acknowledgment of the broader socioeconomic context of the work is little more than lip service. On the other hand, there are farming systems approaches where the primacy of the needs and behavioural responses of the farm families is recognised, and where the insights obtainable from farm-household economics are therefore important.

3.4 Operational Shortcomings

Some analysts have tried to make farm-household models more realistic by considering the various complications outlined above. Their success in doing so has been rather limited. While some progress has been made on several of the fronts mentioned, little success has been achieved in combining these advances into more comprehensive and realistic models. A major reason for lack of success has been the difficulty of assembling the necessary data required for modelling.

Further, in practice, neither the theoretical nor methodological advances appear to have been widely translated into improved policy making. The three main barriers are the limitations of the separability assumption underlying farm-household models, data deficiencies and inappropriate research technology.

3.4.1 Limitations of the separability assumption

Some progress in econometric methodology has been made towards removing the restrictive separability assumption in comprehensive farm-household models. Yet, to our knowledge, few such studies have dealt convincingly with the separability issue. Apart from the problem of heavy data demands which are unlikely to be met (see below), estimation procedures without separability are complex, and are themselves based on strong assumptions about farm-household behaviour. Furthermore, model results are likely to be sensitive to changes in specification. We are sceptical whether the recent methodological breakthroughs can be translated into enhanced knowledge derived from model results.

3.4.2 Data deficiencies

The efficacy of comprehensive farm-household models in aiding economic policy making in developing countries is constrained by the volume and quality of data available and by the high costs of collecting such data. Considerable amounts of good quality data are needed for these models. Econometric models are particularly affected as, in the main, they are best estimated using time series, which are seldom available for rural households in developing countries. Most empirical studies have depended on a cross-section of household data, restricting the predictive ability of the estimated models. Insufficiency of degrees of freedom, limitation of validity of model results to the estimation period, failure to account effectively for inequality constraints and lack of data on the full range of relevant explanatory variables mean that econometric models are more constrained by data deficiencies than MP models (Norton and Schiefer 1980, p. 230). Where time series data are available (e.g. the VLS data in India, discussed above), analysts usually rely on pooled time series and cross-sectional data, requiring further econometric refinements to deal with biases caused by the properties of the disturbance terms.

Data deficiencies are also severe for MP and simulation studies. Such models are often built based on highly subjective and unsubstantiated estimates of key coefficients, yet too often these data limitations are not properly acknowledged. Surveys to collect the kinds of detailed input-output coefficients needed for comprehensive MP models are difficult and expensive, and methods of accounting for inter-farm differences in circumstances and performance are not easily accommodated in MP-based analyses. The related problem of aggregation bias also limits the use of MP methods for policy analysis.

3.4.3 Inappropriate technology

Three factors cast doubt on the appropriateness of comprehensive farm-household modelling in developing countries. First, such models - whether based on econometric, MP or simulation tools - are

intensive users of skilled and experienced human resources, which are usually in scarce supply in these countries. Formulation and testing of the model usually take a long time, and the opportunity cost of the time of analysts is usually high.

Second, the benefits from the model results are likely to be limited. The economic paradigm in which these models are formulated is narrow, parameter estimates tend to be unstable, and users of these estimates will seldom have much confidence in their accuracy.

Third, it is often difficult for modellers to explain their work to users of the results. Consequently, users, who do not understand how the results are derived, do not know what faith to place in them and so may not make full use of them.

4. Contribution of Micro-Level Analysis to Policy Making

4.1 Assessing the Application of Micro-Level Model Results to Rural Development Policy Making

That people are at the core of achieving rural development in developing countries is now well recognised. Understanding rural people - their aspirations, motivations, culture, spiritual beliefs, demography and social interaction - has become indispensable for rural development policy making. Yet it is difficult to represent these human dimensions in formal models, including comprehensive and partial farm-household models.

The major conceptual advance has been to set out some themes and concepts that govern analyses of rural problems, commonly called the 'people-centred' development approach (e.g. Korten and Klauss 1984). Central to this approach is the definition and use of a number of sociological variables. It involves "making social organizations the explicit concern of development policies and programs and constructing development projects around the mode of production, cultural patterns, needs, and potential of the populations ..." (Cernea 1985, p. ix).

Although we see major limitations to such an approach, discussion of them is outside our brief. Rather, our point is that the growing popularity of such an approach to a significant degree reflects the inability of formal quantitative models in general, and farm-household models in particular, to meet the needs of rural development planners and policy makers. A comparison of the complexities of farm-household systems and advances thus far achieved in modelling methodology shows how far there is still to go before comprehensive farm-household models can accurately portray the realities of such complex systems.

Comprehensive farm-household models have a poor record to date in incorporating qualitative variables, and nor have they proved able to accommodate the disciplinary diversity required for rural development policy making - it is usual to include a few demographic variables but little more. A review of the nine case studies reported by Singh *et al.* (1986) reveals the following 'non-economic' variables included in the analyses undertaken: household size (3); number of dependants (2); age of farmer (3); education of farmer (3); food energy availability (1); access to water supply (1); and access to health facilities (1). Considering the complexity of the systems being modelled, outlined in section 2, this list is trivial.

4.2 Synthesising Formal and Informal Micro-Level Models for Policy Analysis

A chief function of rural development policy makers is to influence the mechanisms through which beneficial socioeconomic changes are introduced in rural systems. Farm-household decisions on production, consumption and labour supply are a key set of such mechanisms. Hence, to bring about many potentially beneficial changes, these policy makers need to have a good understanding of farm-household decision processes. Formal and informal models are potentially useful means of enabling them to achieve this understanding. Examples of the sorts of studies that attempt to synthesise formal and informal models for policy analysis are provided by Delforce and Potter (this volume).

The limitations of results from comprehensive farm-household models, documented above, may suggest that we are pessimistic about the potential of these models to satisfy the needs of rural develop-

ment policy makers. However, there are other uses of such models which assuage our pessimism, deriving not so much from the results of the models but the deductive processes involved in their formulation.

The better understanding that can be gained of farm-household systems through the theoretical advances in formal comprehensive modelling is, in our view, the most important gain. Together with intuition, some simple induction and heuristic reasoning, the logic of the economic models can be used to make reasonable 'order-of-magnitude' estimates of the impacts of key economic policy variables on farm-household behaviour. If empirics are to be attempted, the simpler estimation procedures outlined in section 3.3 might be preferred. These models may be more robust, the work involved less demanding of scarce personnel, data requirements less stringent, and the analyses more easily understood by policy makers.

Estimates derived using these procedures need to be integrated with results from studies undertaken in other disciplines to be useful for policy analysis. This points up the need for a systems approach to analysis for rural development planning and policy making in which rough orders of magnitudes for impacts of economic variables on farm-household behaviour can be integrated with information from other disciplinary endeavours.

The impact of this approach can be quite substantial. As we have demonstrated elsewhere in the context of South Pacific island nations (Hardaker and Fleming 1990), a number of important misconceptions about the rural system in developing countries can be corrected through some fairly simple quantitative work based on a holistic approach to analysing rural development problems. However, it is not without its risks. There are limits to the extent to which comprehensive and partial formal models, and formal and informal micro-level models can be used as complementary analytical tools for policy analysis. The main limitation is when the different approaches yield contradictory model estimates of key variables. The policy analyst is left with a dilemma about which set of results to believe. The trade-off in making this decision is typically between the robustness of informal and partial formal model results and the lower risk of mis-specification error of formal models.

Effective use of informal and partial formal farm-household models depends to a large extent on the judgment of the analyst. This judgment in turn depends on that person's experience, knowledge and observation skills.

Appendix: Summary of Some Major Theoretical and Modelling Advances in Farm-Household Studies

A precursor of more recent ideas on farm-household economics was the contribution by Chayanov (1925) who wrote about the behaviour of peasant farmers in Russia. Chayanov suggested that peasants sought to minimise the 'drudgery' of work in production while seeking to satisfy the consumption needs of household members. Because Chayanov wrote in Russian, his work did not start to become widely known in other countries until an English translation appeared in the mid 1960s.

At about the same time, other contributions were appearing. A paper by Becker in 1965 marked the beginning of a series of theoretical advances and empirical studies in what has become known as the 'new household economics', while, in 1969, Nakajima published an early version of his 'subjective equilibrium theory' of farm-household behaviour that eventually culminated in his major contribution on the same topic in 1986. An influential empirical study by Barnum and Squire appeared in 1979 and was followed by a number of other such studies some of which were compiled into a book edited by Singh *et al.* (1986). The papers in this collection are still close to the 'state of the art', despite the intervening years. However, a good, more up-to-date review is provided by Pradhan (1991).

Becker (1965) introduced the idea of a household utility function defined in terms of 'Z-goods' that are produced for consumption within the household using inputs of time of household workers, purchased inputs and drawing on household endowments such as capital goods or land. The notion here is that consumption is seldom possible without some effort and some cash expenditure.

The household utility function is assumed to be maximised subject to the limited endowments of the household and to constraints on household time available, a cash constraint and the production functions of the Z-goods. These constraints may be combined into a single 'full-income' constraint under some strong assumptions about the nature of the production functions for Z-goods and the value of time.

Becker defined full income as "the maximum money income achievable ... by devoting all the time and other resources to earning income, with no regard for consumption" (Becker 1965, pp.497-8). The household full income is assumed to be allocated among alternative consumption possibilities, making use of market opportunities where necessary, to maximise overall utility. For instance, a household may elect to send some members to sell their time in a labour market in order to purchase cash goods for consumption, while others work at home.

Nakajima (1986) extended Becker's model to several kinds of rural household situations and derived the subjective equilibrium conditions for each. The types of household he considered ranged from pure subsistence, with no markets for output, labour or land, to the mixed cash-earning/subsistence farm household, with opportunities to sell surplus production and to buy or sell labour. He was able to demonstrate effects on household production and consumption behaviour of a number of important variables such as family size and composition, land tenure system and improved technologies.

While the basic notions of farm-household theory are simple enough, practical complications have been many. There is no reason to presume that the household utility function, if it exists at all, has only the three arguments of staple food, cash goods and leisure assumed by Nakajima. Preferences may extend to many commodities, perhaps including such 'goods' as health or education. For instance, Delforce (1991) observed that farmers in Tonga ranked religious and status objectives above food, cash and leisure.

The assumption of separability was used in most early farm-household econometric studies (e.g. Lau, Lin and Yotopoulos 1978, Barnum and Squire 1979). Reducing the constraints to a single full-income constraint considerably simplifies analysis. It means that the production and consumption decisions of the household can be treated as recursive (e.g. Strauss 1984).

An example of an attempt to overcome the separability assumption and model simultaneous decision making in production and consumption is the study of farm households in Canada by Lopez (1986). Lopez found that the cross-effects between production and labour supply response were strong and total labour supply elasticities were drastically different between recursive and non-recursive models. Two main conclusions flow from his work. First, he demonstrated that it is feasible to estimate a farm-household model in which decisions on labour supply, production and consumption are treated as simultaneous. Second, his results indicate that "non-separable models are both theoretically and empirically sounder than separable models" (Lopez 1986, p. 323).

Barnum and Squire (1979) were among analysts who first attempted to model consumption decisions as part of a farm-household study. They employed a LES model. In another early study, Lau *et al.* (1978) selected a LLES model. Recent studies have employed more flexible expenditure systems. For example, Strauss (1982) used a QES model while Delforce (1991) applied an AIDS model.

Similar exploratory work has taken place in trying to apply functional forms in farm household production models. Early studies such as those by Barnum and Squire (1979) and Lau *et al.* (1978) employed restrictive Cobb-Douglas functions. More recently, attention has turned to the use of flexible functional forms. An example of such a study (albeit in a developed country) is that by Lopez (1984), who specified a generalised Leontief function in applying a conditional profit function to cross-sectional farm-household data in Canada.

Iqbal (1981, 1983) incorporated saving and borrowing decisions in a farm-household model in India. Two important features of his model are that interest rates are endogenous and a borrowing function is specified. His study departed from

previous studies in two main respects. First, he redefined the demand for funds by the household to take account of self-financing. Second, he better specified the impact of the cost of borrowing on farm-household decision making.

Some partial studies have been undertaken of risk attitudes of farm-household members. Among the best-known earlier studies were those by Dillon and Scandizzo (1978) and Binswanger (1980). Pradhan (1991, pp. 6-12) summarised a number of other studies of the risk attitudes of farm households and their impact on decision making, especially in relation to technology adoption.

The only study in a comprehensive farm-household framework we are aware of is that by Roe and Graham-Tomasi (1986), who formulated what they conceded was a very simple model to assess the impact of yield risk on production and consumption decisions, given household risk preferences. They recognised that risk aversion in consumption implies risk aversion in production decisions. Their attempt to model a simplified risky situation fell well short of a comprehensive and integrated farm-household model that accommodates risk. It raises more questions than it answers about the complex set of factors influencing farm-household behaviour in a dynamic, risky environment.

An interesting recent development of farm-household theory based on a notion of aversion to income risk is given by Finkelshtain and Chalfant (1991). These authors challenge conventional wisdom about the response to price uncertainty of producers who consume a significant share of their own output.

Behrman (1988a) provides a good summary of the types of studies undertaken over the past decade, and the methodological problems faced, in attempts to incorporate nutritional impacts of production and consumption decisions in farm-household models. He outlined the addition of health as a dimension of the household utility function to be maximised subject to the constraints of the household production functions and household full income. Among the production functions, he pointed to the health production function as relevant for examining household nutritional issues. He also noted that "there are additional production functions for own farm/firm output ... and for wage rates ... that depend on health and nutrition intakes" (p. 6). Hence, reciprocal relations exist between health and nutrition on one hand and farm production and wages on the other. If these relations are not properly reflected in farm-household models, simultaneity bias in econometric estimation may result.

Among the various problematic issues that need to be resolved in empirical studies, Behrman highlighted the problem of defining full income. In addition, he listed six other key issues in making and interpreting empirical estimates of nutrition elasticities: the level of aggregation at which nutrient conversion factors are applied; avoiding the simultaneity bias referred to above; choosing between alternative direct (nutrient intake) and indirect (availability of nutrients) means of estimating nutrient intake elasticities with respect to income; correlated measurement error in nutrients and in total expenditures; measuring permanent versus transitory effects on nutrition; and omitted variable biases (pp. 11-18). He also addressed the difficult empirical issue of intra-household allocation of nutrients (e.g. Behrman 1988b).

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