PETER H. CALKINS

Small Farm Structure and Output in Selected Regions of Nepal, Taiwan and the United States

Traditionally, economists have been concerned with achieving Pareto-optimal output combinations for the evolving resource structure of growing economies, but they have focused little on the relative contributions – and fates – of small and large farms. Do agricultural economies fall into general types? What output mix characterizes each? What is the role of small farms in each? If certain classes of farm are disadvantaged by technological change, what countervailing short-run policies might help to guarantee their survival as unique actors in the agricultural sector?

There are two types of definitions for "small" farms:

1 Those that focus on size, and set some arbitrary break-point between classes in terms of land controlled or value of farm sales. Such definitions fail to illuminate the causes of small physical size or low sales volume and may include farms that actually achieve high profits.

2 Those that focus on structural disadvantages of certain farms. "Structure" refers not just to the quantities of land, labour, capital and management available, but also to the relative balance among these production factors on a given farm. Small farms are those which suffer from having either too few resources or an inappropriate balance among them to take advantage of new technologies and prevailing government policies.

The second type of definition seems preferable because it distinguishes structure from size. Disadvantage has its clearest roots in structure, and a given structure in turn dictates a most efficient output mix for a given farm. For example, labour is often the least limiting resource of farms small in size. Such farms have a comparative advantage in producing commodities which are labour-intensive. If tastes and preferences in the society favour such commodities, "small" farms will actually improve in relative income. Thus, the terms small and disadvantages are not always synonymous.

TYPES OF AGRICULTURAL ECONOMIES

We may group agricultural economies into at least four broad types.

1 Subsistence agriculture. More than 60 per cent of the workforce is directly involved in producing food, primarily grains and grain legumes to meet calorie-protein needs. The production possibility frontier (Figure 1a) would allow the production of more non-grain products, but society's utility curves favour a preponderance of resources to be devoted to grain production. These utility curves reflect an inelastic demand for grain crops in the face of inelastic supply schedules for both grains and non-grains (Figure 1c). The low level of technological development accounts for the inelasticity of supply, a consistent technology across farms of different size, and hence a very short and high long-run average cost curve (Figure 1b).

Although international trade may occur in the subsistence economy, it is either insignificant or takes the form of a plantation sector with little effect on most operators. Therefore, Figure 1a shows society under autarky. Examples of subsistence agricultural economies include Nepal, Indonesia, and Bangladesh.

2 Intensive mixed agriculture. Between 25 and 60 per cent of the workforce is in food production. Technological advances allow society to satisfy calorie–protein needs on limited land. Consequently, there is sufficient land to devote to producing non-grain commodities. The supply curves for both grain and non-grain commodities lie farther to the right and are more elastic than in subsistence economies. The demand for grain is also more elastic, but non-grain demand is comparatively less elastic because the better-off populace considers animal and horticultural products fixed components of their diets. Compared with subsistence economies, the production possibility frontier lies farther out for both grain and non-grain commodities, but the shift is relatively more pronounced for non-grains. The intensive mixed agriculture has a relatively high number of workers per ha cropped and an absolute or comparative advantage in producing labour-intensive horticultural commodities for export. Trade allows society to consume on a higher utility curve than possible under autarky (Figure 1a). Because of technological advances, the long-run average cost curve for agricultural production lies lower than and to the right of that for subsistence economies. These advances impart a structural advantage to large farms in grain production. However, the income distribution does not worsen because smaller farms are rewarded for producing commodities which favour labour. Intensive mixed economies include Taiwan and Korea.

3 Extensive monoculture. Less than 25 per cent of the workforce is in agriculture and land is abundant. Increasing income, investment in production, and improvements in internal markets and transportation allow for specialization and trade within the country. Smaller land areas provide the grain and horticultural portions of the diet, and more land is left for the production of feed crops. The very technical advances which allow

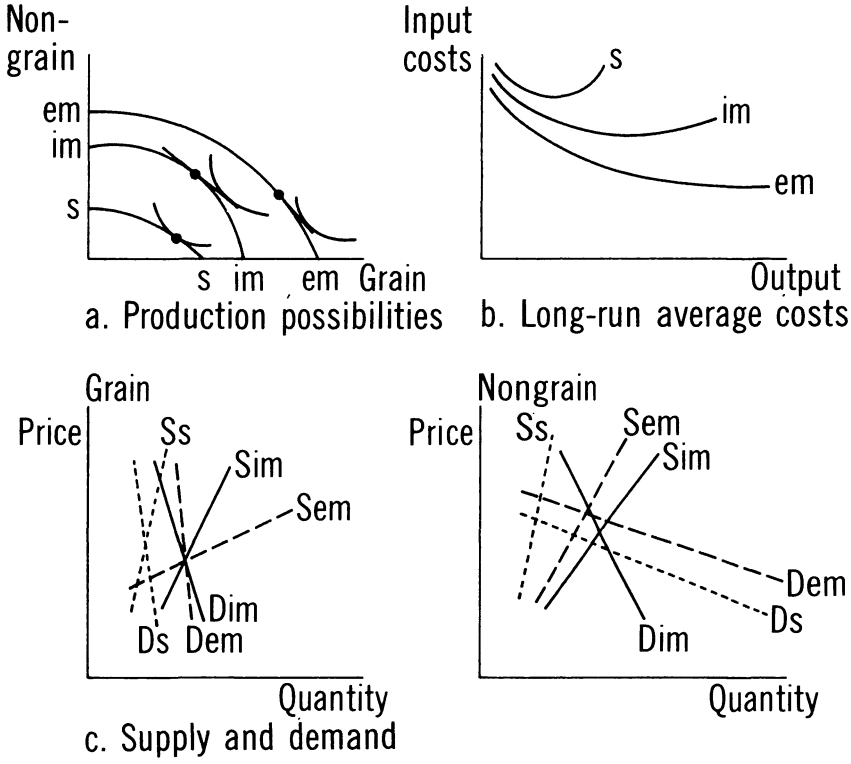

FIG. 1 Structure and output in three types of agricultural economy (s = subsistence, im = intensive mixed, em = extensive monoculture)

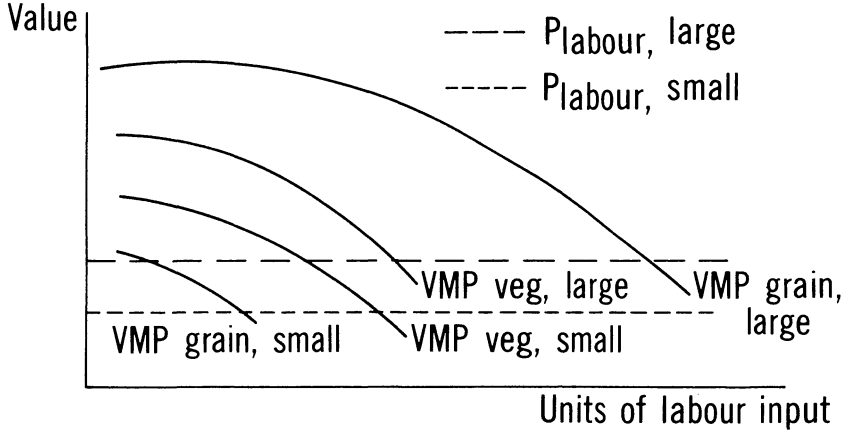

FIG. 2 Labour productivity in small- and large-scale farms for grain and vegetables

the production of more grain for human food now benefit grain production for animal feed. The long-run average cost curve shifts down and to the right as mechanization and higher-yielding varieties push unit production costs down on large-scale capitalized farms. Smaller farms are less able to take advantage of this change and are often so high on the long-run average cost curve that the price they receive is lower than their long-run production costs. The distribution of income tends to be less good than in intensive mixed agriculture and even in subsistence agriculture, where technological advantages of size are less important. Demand for grain (now processed through animals) becomes less elastic as the supply becomes more elastic, creating the chronic problems of the agricultural sector in advanced economies. For non-grains, the demand becomes more elastic (as meat becomes a more affordable alternative), but the supply less elastic as land is drawn out of horticultural production. The country tends to export grains in return for supplemental horticultural and livestock products. Extensive monocultures include the US, Canada, and Russia.

4 Intensive monoculture. This type of economy also has less than 25 per cent of the workforce in agriculture, but in contrast to extensive monocultures, is found in areas of the world with a high ratio of population to arable land. Production is both capital- and labour-intensive. Individual farms grow fewer crops than in intensive mixed economies. Examples of this type of economy are found in Europe. This paper will not consider intensive monoculture, but compare economies of the first three types.

At a given point in its history an agricultural economy may be a mixture of two or more of the above types. For example, Japan currently combines intensive mixed with intensive monoculture, and many South American countries have extensive monoculture co-existing with subsistence agriculture.

THE DATA

To compare resource structure and commodity output in different types of agricultural economy, Table 1 shows indices for three regions:

a) the middle hills of Nepal. Here the most limiting resource is land. Still a subsistence economy, Nepal has not been able to realize an effective land reform to reduce fragmentation of holdings. With average farm size at 0.35 ha, there has been little success in developing capital-intensive agriculture. Even if private capital were available, adequate markets and transportation do not exist. Human capital development has also been severely neglected. Even now the caste system and lack of a strong work ethic prevent the efficient pooling of capital and management.

b) the southwest coast plain of Taiwan, whose economy has successfully passed from subsistence to a well-developed intensive mixed agricul-

ture. The family structure allows for the ready transfer of savings from rural to urban and from agriculture to industry, and for the pooling of capital among friends and neighbours. Partnerships, formal and informal, have allowed the people to take advantage of economies of size. Input-intensive agriculture has freed workers now employed in skilled-labour industries. Land has always been the limiting resource.

c) the cornbelt of the United States, whose agriculture economy has evolved to a heavily-capitalized extensive monoculture. As throughout the United States, the limiting agricultural resource of states like Iowa has been labour. Because the economy has moved through technical change to a lower and longer long-run cost curve, larger operations have been favoured. This has made matters difficult for small-scale or beginning farmers in two ways: additional land is worth more to established farmers, who can bid up its price; and nonreal capital has become a costly *sine qua non* for adopting the new technology.

Appropriate technology in each economy should use labour and capital in inverse proportion to their prices. Table 1 shows that this is indeed the case for general farms in each economy. For example, the US with the highest cost of labour and lowest of capital uses the most capital per unit of labour.

The problem is that small farms in all economies command relatively less capital (and land) than labour. They must either acquire control of more non-labour resources to operate efficiently or produce different commodities from general farmers. Since other factors are limiting on small farms, the marginal physical product and value of the marginal product will be lower for equal inputs of labour on small than larger farms whether they produce grain or vegetables (Figure 2). But production processes for vegetables are generally labour-intensive. Therefore, the VMP curve for vegetables on small farms will lie above that for grains. In intensive mixed economies, where research and consumer demands favour technological improvements and price increases in horticultural over grain crops, small-scale producers will gain. Moreover, because small-scale farms already have relatively large amounts of labour, its opportunity cost may be lower than that for larger farms. If so, small farm benefits from labour intensive commodity emphases will be even greater.

BARRIERS TO IMPROVED EFFICIENCY ON SMALL FARMS

Before operators of small farms in subsistence and extensive monoculture economies can be induced to produce the labour-intensive crops in which their resource structure has an advantage, at least four major barriers must be alleviated:

1 Inappropriate research and extension. Government could devote more resources to the development of higher-yielding, more flavourful vegetable commodities suited to the often inferior microclimates in which small farms operate.

TABLE 1 *Indices of Agricultural Structure and Output*

Index	Nepal 1972–4	Taiwan 1976–8	Iowa, US 1920–5	Iowa, US 1976–8
% national population in agriculture	93[b]	34	30[d]	4
Av. farm size (ha)	0.35	1.20	63	107[a]
Overall cropping intensity*	0.61	1.00	0.35[gh]	0.37[c]
Vegetable cropping intensity**	0.23	0.36	0.002[g]	.002[cf]
% Vegetables marketed	1.6	96	26[gh]	12[acf]
% Vegetable value of gross crop value	18	32	3.2[g]	0.13[c]
Number full-time adult workers/farm	2.9	1.7	1.89[h]	1.26[a]
Man:land ratio (adults/cropped ha)	5.4	0.5	0.03[h]	0.01[a]
Labour use (man-days/ha/year)	1718	486	n.a.	6[a]
Capital use ($US/ha/year)	44	2462	n.a.	510[e]
% farms owning power tillers/tractors	0	17	9[g]	99[a]
M.t. chem. fertilizer applied/farm	0.009	11.8	n.a.	13.2[c]
M.t. organic fert. applied/farm	29.1	1.6	n.a.	n.a.
Years' education per farm	0.9	36.8	38.0[h]	46.7[a]
Risk level	high	low	mod./ high	mod.

* $\frac{\text{Total ha cropped x mos. cropped}}{\text{Total ha available x 12 mos.}}$

** $\frac{\text{Total ha cropped to vegetables x mos. cropped}}{\text{Total ha available x 12 mos.}}$

Sources:

a Hoiberg, E. and W. Huffman, 1978, Profile of Iowa Farms and Farm Families: 1976, Cooperative Extension Service Bull. P–141, Iowa State University, Amex, Iowa.

b Nepal, His Majesty's Government of, 1972, Agricultural Statistics of Nepal, Kathmandu.

c Iowa Crop and Livestock Reporting Service, 1978, Iowa Agricultural Statistics, Des Moines, Iowa.

d Hyami, Y. and Ruttan, V., 1971, Agricultural Development: *An International Perspective*, Baltimore.

e Herbst, 1976.

f Dr. Henry Taber, Department of Horticulture, Iowa State University, personal communication.

g United States, Government of, 1920, Fourteenth Census of the United States, State Compendium for Iowa, Washington.

h Iowa, State Government of, 1925, Iowa Census, Des Moines, Iowa.

All other data from Calkins, 1978a.

2 Unfavourable financial environment. Raup (1978) shows that the historic lack of ceilings on farm price support payments to individual operators plus the inequities of investment tax credits, deductibility of interest on borrowed funds, accelerated depreciation, preferential taxation on capital gains, non-accrual accounting, and fewer avenues to credit, put small-scale farms at a disadvantage in the United States.

3 Lack of markets. Transport, storage and processing facilities would allow small producers in subsistence and extensive monoculture economies to specialize in labour-intensive commodities. In intensive mixed-culture economies such as Taiwan, such facilities are generally available to all farmers. Contracts with factories, group marketing, pick-your-own operations, and roadside stands are other ways to give the small producer a market outlet.

4 No insurance. Crop insurance is now limited largely to row crops in the cornbelt and does not exist in subsistence Nepal. Such insurance could be extended to labour-intensive commodities in which small growers have a comparative advantage.

THREE CASE FARMS

Figure 3 shows the land and labour resources and output mix of three "small" farms.[1] The subsistence farm (Figure 3a) at 0.20 ha was the smallest of four representative farms in the middle-hill region of Nepal (Calkins, 1976). The farm was only 36 per cent irrigated, and the operator's major objectives were survival and variety in the diet. By contrast, the largest Nepal farm studied (1.31 ha) was 74 per cent irrigated and had much higher quality land overall. The larger scale farmer was mainly concerned with maximizing the value of output and devoted more than half of his non-rice land to vegetable and fruit crops. The operator of the larger farm also had much greater access to debt capital for hiring labour and bullocks.

In 1974, the operator of the small subsistence farms grew paddy, wheat and twenty-five other types of crops, sixteen of which were vegetables. Thus, overall cropping intensity[2] was high (0.85). Although vegetables showed the highest return per ha planted and had great potential for more fully utilizing family labour (Figure 3a), the relative cropping intensity of vegetables[3] was only 0.15 in 1974.

When linear programming was used to determine improved allocation of resources on this subsistence farm, the overall cropping intensity rose to 0.90 and the relative vegetable cropping intensity to 0.74. The shift to raising more vegetables would also increase employment on the farm and slightly reduce variability in month-to-month labour use (from a co-efficient of variation of 46 to 43 per cent). The main barriers to adopting the new pattern were lack of markets and inexperience with growing vegetables on a large scale. Such beliefs as the necessity of removing green leafy vegetables and citrus fruits from the diets of sick children

further served to undervalue the importance of vegetables.

The intensive, mixed farm (Figure 3b) was of 0.47 ha, the smallest of six farms studied in southern Taiwan (Calkins, 1978). The operator had few capital assets. He had one pumping set, compared with between two and four for the larger Taiwan farms studied; and he had neither a power tiller nor draft animals (in contrast to the three largest Taiwan farms). Still, since the farm was 100 per cent irrigated, the farmer could use his labour to achieve a very high overall cropping intensity (0.93), with a relative vegetable cropping intensity of 0.40. Because of the small size of the farm, the operator and his spouse engaged in off-farm employment. Although there were technically no "full-time" workers; with seven in the family, the number of total workers per hectare (14.9) was more than adequate to maintain the high intensity of vegetable cropping.

The operator's major objective in choosing crops was to maximize farm income per hour. Operators of larger farms in Taiwan endeavoured to maximize returns per ha and, especially as size increased, to reduce the level and variability in labour use from month to month. Thus, the goals of small-scale farmers differed from those of large-scale farmers.

A linear programming format was used to try to bring about a 20 per cent improvement in the objective function (higher income per hour of labour). The farmer also listed 20 per cent returns to investment and 50 per cent higher income per ha as subsidiary goals. However, no farm reorganization could better the current cropping pattern (compare the small subsistence farm). The operator could increase his income per hour on the farm, but in so doing would have to give up some of his higher-paying off-farm work. Nor was the return to off-farm investment high enough to meet the farmer's criterion for change. Though not an explicit concern, Figure 3b shows that the farmer reduced labour variability in 1976–77 by limiting the area planted to cauliflower in September (the period of rice harvest), and by planting fresh-market tomato and lima bean, which complemented these crops in labour use. Under the best alternative cropping pattern, month to month variability in labour use would jump from 55 to 74 per cent. Thus, in the current economic situation of southern Taiwan, where the operators of small farms have the option of working off the farm, they seem ill-advised to adopt changes in their farm plans to further utilize their abundant labour resource.

The Illinois farm shown in Figure 3c was located in the cash grain area of east-central Illinois, near very good markets for grain, cattle, and hogs. The operator did not have enough land to buy large machinery to take advantage of the capital-intensive mechanization which would allow him to move out farther on the long-run average cost curve. He had no confinement buildings for hogs and owned equity in only half the land he operated. Thus, even though the acres operated were of medium size, the resource structure would become inappropriate if the operator could not acquire the control of more capital through loans, business reorganization, and/or further leasing.

The major objective of the operator of the extensive monoculture farm

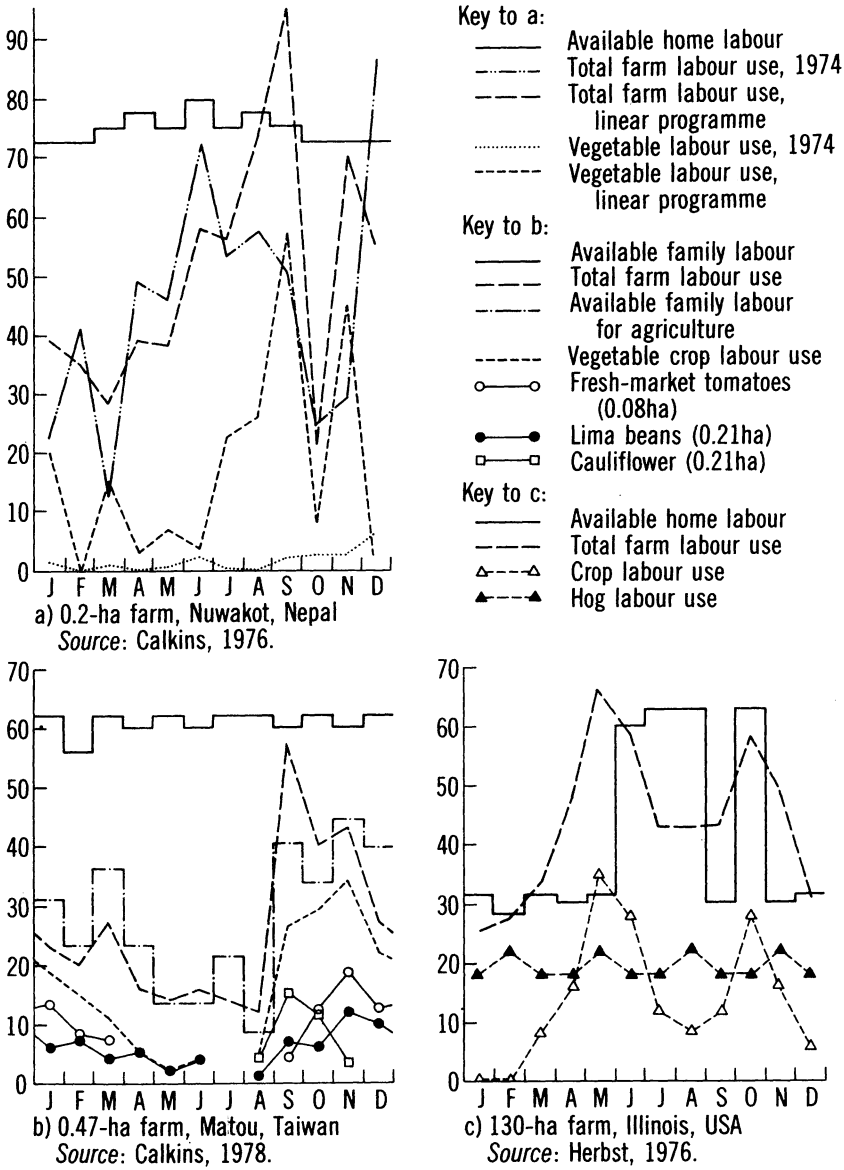

FIG. 3 Month-to-month patterns of labour use on farms

was to maximize net farm income. In contrast to many larger farms in the area, he did not feel an acute scarcity of labour. He was aided by his wife at harvest time and by his 16-year-old son after school and during the June–August period. In contrast to larger scale operators, he was not as concerned with reducing overall labour use as with reducing its month to month variability. He achieved this secondary goal by mixing livestock with crop production. The coefficient of variability for his crop labour (even when soybeans, maize, and wheat were considered together) was a high 78 per cent. The year-round hog operation, with a month to month variability in labour use of only 5 per cent, was used in part to reduce overall labour variability on the farm to only 30 per cent.

CONCLUSIONS

The structure, output, and income distribution of farms differ by type of economy. Data on Nepal, Taiwan, and the United States showed that:

1 Subsistence and extensive monoculture economies have a relative grain orientation while intensive mixed agriculture has a relative non-grain orientation.

2 Small-scale farmers can benefit in each type of economy by specializing in horticultural crop production, but it is easy for them to do so only in intensive mixed economies, where all farmers and agricultural institutions move toward non-grain production. Hence, intensive mixed economies show a strong tendency toward improvements in the income distribution.

3 The capital-labour ratio increases as economies develop. Technological advances geared to the general farmer allow him to achieve technology appropriate to his resource structure. Small farm operators, however, must use inappropriate technology or face huge risks in subsistence and extensive monoculture economies.

4 The cropping intensity of vegetables is at its peak in intensive mixed culture. In extensive monoculture it approaches zero in most areas and 1.0 in specialised production areas.

5 Human capital development is low and risk high for subsistence economies and for small-scale farmers. Institutional intervention can improve the choices of the small grower.

6 Seasonal and disguised unemployment is worst on small-scale farms, especially in subsistence and extensive monoculture economies. Inducements to grow labour-intensive crops could more fully utilise this idle resource.

7 Inappropriate research and extension, unfavourable financial conditions, lack of markets, and inadequate insurance are the major barriers to small farmers in realising their comparative advantage.

NOTES

[1] Because of lack of data, the Illinois farm shown is medium sized. In the short run it is in no danger of extinction; however, it has just the number of acres (320) commonly cited as the borderline for remaining competitive in the long run. The farmer also has equity interest in only half the farm: the other half he rents.

[2] $\frac{\textit{total crops grown x ha-mo planted to each}}{\text{total hectareage of farm x 12 mos.}}$

[3] $\frac{\textit{vegetable crops x ha-mo planted to each}}{\text{total crops grown x ha-mo planted to each}}$

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DISCUSSION OPENING – JOAQUIM J.C. ENGLER

First of all, I would like to thank the Executive Committee of the Association for the invitation to open the discussion of the paper presented by Dr Peter H. Calkins.

I think that it is clear that "small farm" and "poverty" are not the same thing. For this reason, it is fundamental that, in analysing the agricultural economy the structural "balance" or the relative ratio among production factors be considered, and not only size of farm.

Dr Calkins analyses the agricultural economies of three broad types:

1 Subsistence agriculture: with over 60 per cent of the workforce involved in producing food, especially grains, with inelastic supply and demand, insignificant international trade, low technological level and intensive labour. In his paper, this type is represented by Nepal, where the limiting resource is land.

2 Intensive mixed agriculture: with 25 to 60 per cent of the workforce engaged in producing food, where technological advances release resources for the production of other commodities and international trade is significant. Technological advances do not worsen the distribution of income because small farms produce commodities which favour labour, such as horticultural products. This type is represented by Taiwan, where input-intensive agriculture has freed workers for the skilled labour industries.

3 Extensive monoculture: with less than 25 per cent of the workforce

in agriculture, abundant land, investments in production, improved market and transportation conditions, higher market integration, and regional specialisation within the country. Mechanisation and higher yielding varieties favour the large producers and worsen the distribution of income. Under this type, grains are exported and horticultural and livestock products are imported. In Dr Calkins' paper, this type is represented by the US cornbelt, with its heavily capitalised extensive monoculture, and where labour is the limiting resource.

Improvement of the efficiency of small farms faces four main barriers:

1 Inadequate research and extension;
2 Unfavourable financial conditions;
3 Lack of market facilities such as transportation, storage and processing;
4 Lack of crop insurance.

These barriers encountered by small farmers in subsistence and extensive monoculture economies, such as Nepal and the US cornbelt, also occur in Brazil.

By using linear programming, Dr Calkins attempted to determine a better allocation of resources for the small farms of the three types of economies mentioned.

For the small subsistence farms (Nepal) a higher proportion of horticultural products would increase employment and decrease monthly variation. The adoption of this production pattern is made difficult by lack of markets and inadequate qualification of the available labour.

For the small intensive mixed farm (Taiwan), with the option of off-farm work, no reorganisation would be better than the present production pattern, since an improvement in agricultural income would sacrifice the gains from off-farm work.

The small extensive monoculture farms do not own land enough to take advantage of mechanisation and their facilities are also insufficient. In this case, we have a problem of resource structure versus technology.

The main conclusions of the paper which, in my view, merit further discussion are:

1 The small farm is not a problem in itself. The high ratio of labour to land may result in a comparative advantage for certain products, such as horticultural products.

2 The small scale of operation may be a problem depending upon the context in which it is located. Thus, the farm structure presents itself together with research, infrastructure, product, and labour market problems. The best income distribution in Taiwan, for example, results from technology, infrastructure and from the existence of adequate product and factor markets.

3 The typification of the agrarian structure merely in terms of resources and their ratios will not reflect the problem of poverty and efficiency. What is really important is to verify in what situation the small farm is problematic and why. As a rule, the problem is outside the small

farm and its causes are associated with research, extension and infrastructure policies. In such cases, it is essential that changes be made to allow the release of labour and capital from agriculture through increased productivity and that:

(a) the income generated outside the sector create a strong demand for labour-intensive products;

(b) there exists a market capable of absorbing eventual labour surpluses through migrations or off-farm work;

(c) the technology created by research is not biased in favour of large farms.

GENERAL DISCUSSION – RAPPORTEUR: JUAN CARLOS MARTINEZ

The general discussion of Dr Calkins' paper was developed basically around the following issues:

1 The regions in which the typology was based face a different situation in terms of policy setting. Would this have any implication in terms of the validity of the typology?

2 Dominating the analysis is the idea that 0.3 ha farmers can exist. Are we talking about mere subsistence or some meaningful change?

3 Could the consideration of income outside agriculture contribute to explain the concept of smallness?

Dr Calkins' replies could be summarized as follows: policy setting faced by the farmers will have clear implications for the typology. More specifically this was one of the elements used in the analysis to define the different types of farming.