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FARM SIZE AND PRODUCTIVITY IN NEPALESE AGRICULTURE: A CASE STUDY OF NAWAL PARASI DISTRICT

Bishwa Nath Tiwari

HMG Ministry of Agriculture-Winrock International

Policy Analysis in Agriculture and Related Resource Management

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FOREWORD

One of the most important activities under this program is the provision of funding for social scientists and others interested in the organizational and human aspects of agricultural and natural resource management. This research is carried out with the professional assistance of Winrock professional staff in Nepal.

The purpose of this *Research Report Series* is to make the results of these research activities available to a wide audience, and to acquaint younger and less experienced professionals with advanced methods of research and statistical analysis. It is also hoped that publication of the Series will stimulate discussion among policy makers and thereby assist in the formulation of policies which are suitable to the development of Nepalese agriculture.

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FARM SIZE AND PRODUCTIVITY IN NEPALESE AGRICULTURE: A CASE STUDY OF NAWAL PARASI DISTRICT

Bishwa Nath Tiwari[1]

INTRODUCTION

Growth and equity are twin goals of agricultural policy in most developing countries. The ability of agriculture to contribute to economic growth depends largely on productivity in the agricultural sector. Agricultural productivity, in turn, depends on the environment in which farmers work, and this is composed of physical-climatic, socio-cultural and structural factors. Of the three, structural environment is the most important for policy formulation. It is composed of tenurial structure, superstructure and infrastructure in agriculture. Since tenurial structure and farm size distribution are interdependent, farm size is one of several variables which, in a way, affect productivity.

In the absence of effective land reform programmes, the land tenure system of developing countries tends to be marked by pronounced unequal distribution of land ownership. This tends to freeze capital on the land, and retards progressive agricultural development, because large land owners have a tendency to amass landed wealth without making its use productive. Also, the extreme inequality in the distribution of land and its high demand have created a panorama of high rent, rack-renting, tenant eviction, land hunger and agrarian unrest. To correct these maladies most governments of developing countries have intervened in the tenancy market by fixing ceilings on land holdings and introducing other reform measures. These early

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reform measures were based on equity considerations. However, ceilings on holdings failed to release adequate surplus land, while the rapid growth of population and the consequently increased demand for land have also increased the importance of landed wealth. This called for further reduction in the ceilings limit on the one hand, and created pressures for the maximum utilization of the scarce land on the other. Thus, more recently, economists have given attention to both the productivity and equity aspects of land reform when fixing the ceiling ration. In the process they worked on `optimum holding', `minimum feasible holding' and similar concepts. Implicit in the working of these concepts is a search for a relationship between size of farm and efficiency, so as to identify the most efficient size which government may promote by appropriate policy measures.

Most of the studies on the relationship between size and efficiency are based on static analysis in which an attempt is made to evaluate the efficiency of farms/farmers in a given environment. But due to `economic dualism' in developing economies, the specification of the farmer's objective function has been the subject of much debate among economists. Whereas some have held that the primary concern of a farmer is to maximize profit, others argued that, above all, he seeks economic and food security. Analogous to this debate, there has also been a controversy among economists as to the extent of surplus labour and disguised unemployment. All these issues boil down to the existence or non-existence of perfect competition in the agriculture sector of developing countries. Consequently, two basic types of studies are found on the size-efficiency relationship. Two types of studies which have attracted considerable attention in the past decades are those relating to allocation efficiency, and the size-productivity relationship in traditional agriculture. While the studies on allocation efficiency, initiated by Schultz (1964), are based on perfect competition, those on size-productivity relationship are based on imperfect

competition.

It is widely held that land and labour are the two principal inputs in traditional agriculture, of which land is scarce and labour is abundant. Furthermore, it is observed that the markets for these two inputs are non-competitive. This view has tempted a group of economists from the Indian subcontinent to argue that, since labour and animal power are relatively cheap for family-based small farms, their use is relatively more intensive on these farms, which in turn yields higher land productivity. With this presumption, economists have attempted to examine efficiency in traditional agriculture by relating land productivity to farm size, measured in land acreage. The importance of these studies lies in the role they have to play in formulating policy related to land ceilings, land distribution, cooperatives or other forms of land reorganization.

THE PROBLEM

If an inverse relationship is observed between farm size and land productivity, the central policy implication will be to implement ceiling laws to reduce the upper limit of existing ceilings to promote economic growth. On the other hand, if a positive relationship is observed, an increase in average farm size (through co-operative farming or other forms of land reorganization) becomes a necessity.

Most of the studies conducted so far on the size-productivity relationship in developing countries show this to be inverse. Thus, they justify ceiling laws. But there are some studies which do not support this view: some reject the universal validity of the postulated inverse relationship, while others have found a positive relationship. In the extreme, there are a few studies which deny the existence of any sort of relationship between farm size and land productivity. Since a

striking characteristic of farms in developing countries is their high variability, the importance of the studies which stand against the inverse relationship should not be underrated. Moreover, the hypothesis of small farm efficiency is based on the assumption of a dual farming system, comprising surplus labour and primitive technology. These characteristics are not universal. For example, it is now observed that technical change has been taking place in most developing countries. It is asserted that the Green Revolution (GR) technology is rich (large) farmer biased. Therefore, the relative efficiency of the small farm may disappear gradually with technical change. But most of the studies conducted so far are based on data which predate the GR. The few post-GR studies that exist show a contrasting pattern. For example, Saini (1979) argued that there was a gradual closing up of the productivity gap between small and large farms. In contrast, Carter (1984) found that the productivity gap is widening. In other words, the empirical evidence for the post-Green Revolution period is inconclusive.

In view of the conflicting evidence on small farm efficiency and in the face of changing agriculture, there is a need for further exploration of the size-productivity relationship. One additional reason for such a study is that there is some evidence which suggests that there has been no major breakthrough in overall agricultural production, despite the implementation of ceiling measures and introduction of Green Revolution technology in developing countries (Griffin: 1974; Rudra: 1982). In the specific case of Nepal, most of the principal crops showed a declining productivity trend during the period 1964/65-84/85. This suggests that ceiling laws and other land reform measures, which were implemented in the country during that period, were not subject to any empirical investigation of their effect on cost and productivity. What is required, therefore, is an assessment of the correlation between size and productivity in different regions of the country. Yet only one study (Hamal,

1983), with a limited coverage of this aspect, has been conducted so far.

It therefore seems imperative to undertake a comprehensive study on the size-productivity relationship for a representative cross-section of farmers in Nepal. The present study is only a modest attempt to examine this relationship in one district.

OBJECTIVES

The basic objectives of the study were: (i) to identify the relationship between farm size and land productivity; and (ii) to explain such identified relationship in the light of some of the principles of agricultural economics. The objectives are specified for both the individual crops and whole-farm or `all crops' combined together. They are broken into the following component objectives:

(a) to observe the gross (bi-variate) relationship between farm size and land productivity for individual crops as well as `all crops' raised on farms;

(b) to examine the inputs/factors determining the size-productivity relationship on the farms of individual crops as well as `all crops';

(c) to observe the effects of traditional inputs, particularly labour and animal labour, on `whole-farm' land productivity;

(d) to determine the net effect of farm size on `whole-farm' land productivity; and

(e) to measure productivity differentials on small and large farms.

METHODOLOGY

For the analysis of size-productivity relationships, the researcher collected data for the agricultural year 1985/86 from a randomly selected sample of 170 farms in Nawal Parasi district

of Nepal. To obtain a more representative sample, a three-stage sampling procedure was adopted in the field survey. The units of sampling for these successive three stages were Village *Panchayat*, Village, and Farm Household. The primary unit of sampling was the Village *Panchayat*, which embraces several villages; the ultimate unit of sampling was the Farm Household. The selection of Village *Panchayats* was based on stratified random sampling, whereas that of Village and Farm was based on simple random sampling. For the selection of Village *Panchayats*, the District was divided into three regions: the Hill, the Inner Tarai, and the Tarai. The selected *panchayats* were Amaraut and Manjharia from the Tarai, and Parsauni and Arkhala from the Inner Tarai and Hill regions respectively. In the second stage, ten villages were selected randomly from these four *panchayats*. They were:

Panchayat	Villages
Arkhala	Deurali, Sinchang, Mathillo Arkhala and Tallo Arkhala
Manjharia	Jeetpur and Lanka
Parsauni	Bhittha and Tallo Bhiuran
Amaraut	Ainchawal and Parsawal

In the third stage, 170 farm households were sampled from these ten villages, but complete information was obtained only from 160 farm households. The farm-wise input-output data and related information were collected separately for each crop from a pre-tested questionnaire. Besides, information on price of inputs and yield of crops was collected at local markets. The collected input-output data were converted from local to standard units.

The analysis of farm size and land productivity relationships has been performed for individual crops and whole-farm (`all crops') separately. For individual crops the analysis has

been performed at the village level, and for `whole-farm' it has been done both at village and village *panchayat* level. The major focus of the study is on whole-farm analysis since the size-productivity relationship is more relevant for `whole-farm'. Simple and multiple regressions of different forms have been specified to analyze the data.

MAJOR FINDINGS: INDIVIDUAL CROPS

The following three models of four functional forms (linear, log-linear, simple quadratic and square root quadratic) have been specified for individual crop analysis.

Model (0.0)

$$Y_i/S_i = a + b\ S_i + u_i$$

$$Ln\ (Y_i/S_i) = Ln\ a + b\ Ln\ S_i + u_i$$

$$Y_i/S_i = a + b\ S_i + c\ S_i^2 + u_i$$

$$Y_i/S_i = a + b\ S_i^{0.5} + c\ S_i + u_i$$

Model (0.1)

$$L_i/S_i = a + b\ S_i + u_i$$

$$Ln\ (L_i/S_i) = Ln\ a + b\ Ln\ S_i + u_i$$

$$L_i/S_i = a + b\ S_i + c\ S_i^2 + u_i$$

$$L_i/S_i = a + b\ S_i^{0.5} + c\ S_i + u_i$$

Model (0.2)

$$A_i/S_i = a + b\ S_i + u_i$$

$$Ln\ (A_i/S_i) = Ln\ a + b\ Ln\ S_i + u_i$$

$$A_i/S_i = a + b\ S_i + c\ S_i^2 + u_i$$

$$A_i/S_i = a + b\ S_i^{0.5} + c\ S_i + u_i$$

Where,

Y = yield (kilogramme);

S = cropped area (hectare);

L = labour (adult man-days of eight hours);

A = animal labour (animal-pair days of eight hours);

u = residual; and i = cross-sectional data.

Model (0.0) describes the gross relationship between yield per hectare and cropped area, while models (0.1) and (0.2) estimate the equivalent relationship between labour/animal labour per hectare and cropped area. Thus, the latter two can be used to explain the relationship obtained from model (0.0).

Regression models (0.0) and (0.1) have been estimated on thirty-one pair-wise data sets and model (0.2) on twenty-seven data sets for different crops of ten villages selected from the three regions of Nawal Parasi district. The best fit of the four alternative functional forms estimated on each data set has been chosen on the basis of statistical criteria. Thus selected regression equations come from all of the four functional forms. The linear and log-linear equations identify either positive or negative relationships, whereas the quadratic ones allow for both positive and negative relationships. On the basis of the nature of the relationship when quadratic equations were separated from linear and log-linear equations, it was found that fourteen of

the thirty-one selected equations relating yield per hectare with cropped area, and sixteen of the equations relating labour with cropped area were quadratic relationships. Similarly, fifteen out of twenty-seven equations for the relationship between animal labour per hectare and cropped area were quadratic. Thus, evidence does not support the view that there is a continuous increase or decrease in yield/labour/animal labour per hectare with cropped area. Besides, most of the equations/coefficients pertaining to these three relationships are not statistically significant. A summary of the results of the three relationships is presented in Tables 1, 2 and 3 for Hill, Inner Tarai and Tarai regions respectively. Among the thirty-one data sets, fifteen are for Hill and there are eight sets each for the Inner Tarai and Tarai regions. The data sets are given in the left-hand column of these tables. The other columns provide information about the nature of the statistically significant relationships of yield, labour, and animal labour (all expressed on a per hectare basis) with cropped area. Non-significant relations are indicated by a dash (-).

Yield per hectare and cropped area were found to be significantly related in nine, five and two cases for Hill, Inner Tarai and Tarai regions respectively (Tables 1 to 3). Thus, in total, a significant size-productivity relationship has been observed in sixteen out of thirty-one cases. Similarly, labour and animal labour days per hectare appeared to be significantly related in only fifteen and thirteen cases out of thirty-one and twenty-seven cases respectively (Tables 1 to 3).

In view of the high variability in farming practices this evidence may not suggest that yield or labour and animal labour per hectare are completely independent of cropped area. Nevertheless, they do not imply a uniformly inverse relation between these three pairs, since all three relationships are also represented equally by simple and square root quadratic func-

tions. But the case for a negative relationship is stronger than that for a positive one, since in only very few cases was the coefficient of the linear and log-linear equations found to be positive. No significant positive relationship holds between labour/animal labour per hectare and cropped area, although in one case, that of wheat in Ainchawal village, such a relationship was found between per hectare yield and cropped area. At the regional level, yield per hectare was found to be more strongly inversely related in the Hill than in the Inner Tarai and Tarai regions. In addition, the size-productivity relationship holds better for maize than other crops. There is some evidence for a negative relation in paddy cultivation. Wheat productivity shows a positive relation in Ainchawal, but a U-shape relation in Parsawal (Table 3).

The results of these three relationships are not systematic and consistent with each other. In the Hill only four of the nine significant size-productivity relations are explained by the use of labour and/or animal labour (Table 1). The corresponding figure for the Tarai is one of the two significant relations. But labour and animal labour use per hectare do not correspond with yield per hectare in any of the five significant size-productivity relations observed in the Inner Tarai region (Table 2). Thus, in a total of only five of the sixteen significant size-productivity relations, was crop yield found to be responsive to the use of human labour and animal labour. In the remaining cases the results of the three relationships are heterogeneous. For example, human labour use per hectare bears a U-shaped relationship with cropped area for wheat in Ainchawal, while animal labour use per hectare has a U-shaped relationship with cropped area in two cases: wheat in Ainchawal and mustard in Mathillo Arkhala (Tables 1 and 3). There are also some cases in which the observed significant size-productivity relationships are not accompanied by a significant relationship between labour and animal labour, and cropped area. On the other hand, there

Table 1: Summary Table (Hill) for Three Different Relationships:

Individual Crops

Data Sets	Relation between Cropped Area and: Yield per Hectare	Labour Use per Hectare	Animal Use per Hectare
1. Maize (Deurali)	Negative	Negative	-
2. Millet (Deurali)	Negative	U Shape	N.A.
3. Mustard (Deurali)	-	Negative	Negative
4. Maize (Sinchang)	U Shape	U Shape	Negative
5. Millet (Sinchang)	-	Negative	N.A.
6. Mustard (Sinchang)	Negative	Negative	-
7. Maize (Mathillo Arkhala)	-	Negative	-
8. Millet (Mathillo Arkhala)	Negative	-	N.A.
9. Mustard (Mathillo Arkhala)	Inverted U Shape	-	U Shape
10. Mungbean (Mathillo Arkhala)	Negative	-	N.A.
11. Summer Paddy (Tallo Arkhala)	-	-	-
12. Winter Paddy (Tallo Arkhala)	-	-	Negative
13. Maize (Tallo Arkhala)	U Shape	U Shape	U Shape
14. Gahat (Tallo Arkhala)	-	Negative	Negative
15. Mustard (Tallo Arkhala)	Negative	-	Negative

Note: 1. A dash (-) indicates a non-significant relation.
2. N.A. refers animal labour not used.

Table 2: Summary Table (Inner Tarai) for Three Different Relationships:

Individual Crops			
	Relation between Cropped Area and:		
Data Sets	Yield per Hectare	Labour Use per Hectare	Animal Labour Use per Hectare
16. Paddy (Bhittha)	Negative	-	-
17. Maize (Bhittha)	Negative	U Shape	U Shape
18. Wheat (Bhittha)	-	-	-
19. Mustard (Bhittha)	-	-	-
20. Paddy (Tallo Bhiuran)	Negative	-	-
21. Upland Maize (Tallo Bhiuran)	Inverted U Shape	Negative	Negative
22. Lowland Maize	U Shape	-	-
23. Upland Mustard (Tallo Bhiuran)	-	-	-

A dash (-) indicates a non-significant relation.

Table 3: Summary Table (Tarai) for the Three Different Relationships:

Individual Crops			
	Relation between Cropped Area and:		
Data Sets	Yield per Hectare	Labour Use per Hectare	Animal Labour Use per Hectare
24. Paddy(Ainchawal)	-	-	-
25. Wheat(Ainchawal)	Positive	U Shape	U Shape
26. Paddy(Parsawal)	-	-	Inverted U Shape
27. Wheat(Parsawal)	U Shape	U Shape	U Shape
28. Paddy(Jeetpur)	-	-	-
29. Wheat(Jeetpur)	-	-	-
30. Paddy(Lanka)	-	U Shape	U Shape
31. Wheat(Lanka)	-	Negative	-

A dash (-) indicates a non-significant relation.

are some cases where variation in input(s) shows a significant tendency but yield per hectare does not. Therefore, labour and animal labour do not seem to explain the size-productivity relationship in the majority of cases. However, they are found to vary together with the cropped area in many cases. These evidences do not stand against some conclusions of the earlier studies. Most of the early studies could not find any systematic relation between yield per hectare and labour/ animal labour per hectare from crop-level data. Thus, they ascribed the size-productivity inverse relationship to the cropping intensity and cropping pattern.

MAJOR FINDINGS: WHOLE-FARM (`ALL CROPS')

Two variable and multiple variable regressions have been estimated to analyze the farm size and land productivity relationship for whole-farm. As in the case of individual crops, two variable regressions of linear, log-linear, simple quadratic and square root quadratic functional forms have been fitted to depict the relationship between size of holding and different variables separately. The linear version of the four variants is given below:

(0.0) $Y_i/X_i = a + b X_i + u_i$

(0.1) $L_i/X_i = a + b X_i + u_i$

(0.2) $A_i/X_i = a + b X_i + u_i$

(0.3) $C_i/X_i = a + b X_i + u_i$

(0.4) $F_i/X_i = a + b X_i + u_i$

(0.5) $E_i/X_i = a + b X_i + u_i$

(0.6) $XL_i/X_i = a + b X_i + u_i$

<u>Where</u>

Y = gross value of output exclusive of by-product (rupees);

X = size of holding inclusive of current fallow (hectares);

L = labour (adult man-days);

A = animal labour (animal-pair days);

C = gross cropped area (hectare);

F = number of fragments;

E = expenditure on fertilizer and pesticides (rupees);

XL= size of lowland (hectare);

u = residual; and i refers to cross-sectional farms.

The above regression models depict seven different relationships. Model (0.0) is estimated for identifying the size-productivity relationship and all other models are estimated for explaining such identified relationships. In the framework of the size-efficiency school, model (0.1) provides a labour-based explanation, model (0.2) provides an animal labour-based explanation, etc. The labour, animal labour, cropped area, fertilizer and pesticides have a positive effect on production. Besides, it was observed in the study area that lowlands are of better quality due to their higher moisture content and favourable location at the banks of rivers. But fragmentation of land is widely regarded as a source of production inefficiency in developing agriculture. Therefore, except for fragments the expected effect of all variables on production is positive. Thus, a negative relation observed between gross output per hectare and size of holding can be explained by a positive relation between fragments per hectare, but a negative relation between all other variables, and the size of holding.

All of the four alternative functional forms have been estimated for nineteen village-level data sets pertaining to whole-farm as well as its components. In the hills these components are upland and lowland. In the Tarai there are winter and summer crops, although in this study, since paddy is the dominant summer crop, only the winter crops component is

analyzed.

Among the nineteen data sets, five are for four Hill villages, six for two Inner Tarai villages, and the remaining eight represent the four Tarai villages (see Table 4). Among the four alternative functional forms the one which fits best has been selected for each data set pertaining to different relationships. As before a summary of the findings for all of the seven relationships is given in Table 4. The structure of this table is the same as that of earlier ones. The information not available for some dependent variables (F, E, XL) is indicated by (N.A.).

Unlike the case for individual crops, most of the selected equations for whole-farm happen to be linear and log-linear forms in some relationships but the majority of them are statistically non-significant. It is evident from column (0) that a significant size-productivity relationship exists in four out of five cases in Hill, and in four out of six cases in the Inner Tarai. But in the Tarai the relationship was found to be significant only in one out of eight cases. Thus, the size-productivity relationship holds better in the Hill and Inner Tarai areas than in the Tarai. However, the overall picture is less clear, since the significant relationship exists only in nine out of nineteen cases. But this situation is improved upon when the relationship is considered for only whole farms. Moreover, the statistical basis for the inverse size-productivity hypothesis is very poor since it exists only in three out of five villages where some sorts of significant relationship have been noted for whole-farm. This provides little support to the contention of earlier researchers who advanced the inverse size-productivity proposition. But at regional level the inverse relationship does not seem to be completely ruled out since it holds in three of the four villages of the Hill region.

Table 4: Summary Table for Seven Different Relationships: Whole Farm

Data Sets for Selected Villages	Relation between Size of Holding and: Gross Output/ Hectare (0)	Labour Use/ Hectare (1)	Animal Use/ Hectare (2)	Cropping Intensity (3)	Frag- ments/ Hectare (4)	Expenditure on Fertili- zer & Pes- ticide/ha (5)	Size of Lowland/ Hectare (6)
REGION: HILL							
(1) Deurali (Whole Farm)	Negative	Negative	Negative	-	Negative	na	na
(2) Sinchang (Whole Farm)	U-shape	U-shape	-	U-shape	Negative	na	na
(3) Mathillo Arkhala (Whole Farm)	Negative	-	-	-	Negative	na	na
(4) Tallo Arkhala (Upland Farm)	Negative	Negative	Negative	-	na	na	na
(5) Tallo Arkhala (Lowland Farm)	-	-	-	-	Negative	na	na
REGION: INNER TARAI							
(6) Bhittha (Whole Farm)	U-shape	-	-	-	U-shape	na	-

(Continues overleaf)

Table 4 (continued)

Data Sets for Selected Villages	Relation between Size of Holding and: Gross Output/ Hectare (0)	Labour Use/ Hectare (1)	Animal Use/ Hectare (2)	Cropping Intensity (3)	Frag- ments/ Hectare (4)	Expenditure on Fertili- zer & Pes- ticide/ha (5)	Size of Lowland/ Hectare (6)
REGION: INNER TARAI (continued)							
(7) Bhittha (Upland Farm)	-	-	-	Inverted U-shape	na	na	na
(8) Bhittha (Lowland Farm)	Negative	-	-	-	na	na	na
(9) Tallo Bhiuran (Whole Farm)	-	-	-	Positive	U-shape	na	Positive
(10) Tallo Bhiuran (Upland Farm)	Inverted U-shape	Inverted U-shape	Inverted U-shape	Inverted U-shape	na	na	na
(11) Tallo Bhiuran (Lowland Farm)	U-shape	-	-	-	na	na	na
REGION: TARAI							
(12) Ainchawal (Whole Farm)	-	Negative	Negative	Negative	U-shape	Inverted U-shape	na

(Continues overleaf)

Table 4 (continued)

Dats Sets for Selected Villages	Relation between Size of Holding and: Gross Output/ Hectare (0)	Labour Use/ Hectare (1)	Animal Use/ Hectare (2)	Cropping Intensity (3)	Frag- ments/ Hectare (4)	Expenditure on Fertili- zer & Pes- ticide/ha (5)	Size of Lowland/ Hectare (6)
REGION: TARAI (continued)							
(13) Ainchawal (Winter Farm)	-	-	Negative	Negative	na	Inverted U-shape	na
(14) Parsawal (Whole Farm)	-	-	-	Inverted U-shape	U-shape	na	na
(15) Parsawal (Winter Farm)	-	Negative	-	Inverted U-shape	na	na	na
(16) Jeetpur (Whole Farm)	-	Negative	-	Negative	-	-	na
(17) Jeetpur (Winter Farm)	-	Negative	Negative	Negative	na	-	na
(18) Lanka (Whole Farm)	Negative	U-shape	U-shape	-	Negative	-	na
(19) Lanka (Winter Farm)	-	-	-	-	na	Positive	na

Notes: 1. A dash (-) indicates a non-significant relationship.
2. "na" indicates that the relationship in question has not been estimated due to non-availability of data on fragments/fertilizer and pesticides/lowlands.

The relationship between labour use per hectare and size of holding for different components of whole-farm is found poor, but such a relationship is found stronger for whole-farm. According to regions the relation is found strong in the Hill and Tarai but poor in the Inner Tarai. In the Inner Tarai the relation appears only in upland cultivation of Tallo Bhiuran. Besides, it seems that labour use per hectare is positively related in the Inner Tarai. Although some significant relationships for whole-farm are found to exist, the case for an overall negative relationship is weak, since the relation is found to be U-shaped in two out of the five villages where a significant relationship between size of holding and labour per hectare holds for whole-farm.

The results pertaining to the relationship between animal labour use per hectare and size of holding were found to be very similar to those pertaining to labour per hectare and size of holding. In total, animal labour is found to be significantly related to holding size in seven out of nineteen cases. With regard to whole-farm, labour has been found significantly related in five villages, but animal labour has been found so only in three villages. Therefore, compared to labour the statistical basis for the relationship between animal labour use per hectare and size of holding for whole-farm is rather weak. Moreover, the inverse relation between animal labour per hectare and size of holding for whole-farm is observed only in two villages.

Regarding cropping intensity, it has been found significantly related in ten out of nineteen cases in total. From whole-farm point of view, the relationship holds in one village of each of the four and two villages of the Hills and Inner Tarai respectively. However, the relationship is stronger in the Tarai areas, where a significant relation is observed in three out of four villages. Thus, there is some evidence of a relationship between size of holding and cropping intensity in the Tarai, but

not an inverse one. Since inverse relation holds only in two Tarai villages, the proposition of earlier researchers that cropping intensity is inversely related is not supported.

Number of fragments per hectare has been related with the size of holding only for whole-farm. Except in Jeetpur, the relationship was found to be significant in all villages. Although the evidence on the relationship between size of holding and fragments per hectare is adequate, it does not substantiate the hypothesis of an inverse relationship in the study area.

The relationship between fertilizer and pesticide use per hectare and size of holding has been estimated only for the three Tarai villages, where there were enough data for purposes of estimation. A significant relationship has been observed in the winter farm of Lanka and in both the whole-farm and winter farm of Ainchawal. While a positive relation appears in Lanka, an inverted U-shape relation prevails in Ainchawal.

The relationship between size of holding and lowland per hectare has been estimated for whole-farm of the two inner Tarai villages, and a significant positive relation has been observed in one village, i.e., Tallo Bhiuran.

From the preceding summary of results, it could be remarked that in the majority of cases, while gross output per hectare was found to be significantly related to farm size in Hill and Inner Tarai areas, inputs were found to be significantly related to this variable in the Tarai region. This indicates that productivity and use of input per hectare do not vary in the same direction. However, there is some evidence for a significant relation between labour use per hectare and size of holding in Hill, and between cropping intensity and size of holding in the Inner Tarai. While variation in labour use seems to explain the significant size-productivity relationship in Hill areas,

cropping intensity seems so related in Inner Tarai areas. Moreover, cropping intensity and labour per hectare were found to be significantly related with size of holding in the majority of cases in the Tarai, but gross output per hectare was found to be significantly related in one case. One the whole, a significant relationship between size of holding and gross output per hectare was noted in nine out of nineteen cases. The inputs separately explain only four of the nine significant size-productivity relations. These four cases are Deurali, Sinchang and Tallo Arkhala (upland) villages from Hill and Tallo Bhiuran (upland) from the Inner Tarai. Thus, the productivity is found to be better explained in Hill, than in other, regions. However, it also suggests that either the marginal productivity of inputs is not significantly positive or the fragmentation is not detrimental to production. Furthermore, it could suggest possible limitations on explaining the productivity by individual inputs separately.

For this purpose multiple variable log-linear regression models have been estimated. The first model is:

$$\text{Ln } (Y_i/X_i) = \text{Ln } a + b_1 \text{ Ln } (L_i/X_i) + b_2 \text{ Ln } (A_i/X_i) + u_i$$

The variables appearing in the above model are the same as the earlier ones. In many cases the elasticity of labour and animal labour has not been found significantly positive. Again, the coefficient of labour in Bhittha (lowland farm) and that of animal labour in Tallo Arkhala (upland farm) and Tallo Bhiuran (whole-farm) appeared significantly negative. Most of the coefficients estimated for the Tarai region are insignificant. These results do not suggest a positive contribution of labour and animal labour in every village. However, there is some evidence on positive contribution of labour in hill farming which, of course, ensures the higher use of labour contributing to higher land productivity on smaller farms of some hilly

villages.

With a view to identifying the gross and net effect of farm size on land productivity, the following two regression models have been specified and estimated at village/village panchayat level:

$$Ln\ (Y_i/X_i) = Ln\ a + b\ Ln\ X_i + u_i$$

$$Ln\ (Y_i/X_i) = Ln\ a + b_1\ Ln\ X_i + b_2\ Ln\ (L_i/X_i) + b_3\ Ln\ (A_i/X_i) + b_4\ Ln\ (C_i/X_i) + b_5\ Ln\ (F_i/X_i) + b_6\ Ln\ (E_i/X_i) + b_7\ Ln\ (XL_i/X_i) + u_i$$

where all of the variable are as defined earlier.

The elasticity coefficient b of the former model estimates the gross relationship, whereas the coefficient b_1 of the latter model estimates net relationship between size of holding and gross output per hectare. Indeed, it is the b_1 which shows the pure scale/size effect. The difference between the estimates of these two coefficients depends on how far other factors included in the latter model are able to explain land productivity, and how and to what extent these correlate with farm size. These models have been estimated on five data sets relating to whole-farm. The data sets pertain to three panchayats, Arkhala (excluding Sinchang village), Parsauni and Amaraut, and two villages, Jeetpur and Lanka.

Among the five cases the gross effect of size of holding was found to be significantly negative only in Arkhala panchayat and Lanka village; the corresponding net effect was not found to be statistically significant in either case. Labour was found to be the main factor explaining the gross inverse relationship between size of holding and gross output per hectare in these two places. On the other hand, no significant gross relationship has

been obtained in Parsauni and Amaraut *panchayats*. The inclusion of other factors has resulted in a negative net effect of size in Parsauni and a positive one in Amaraut *panchayat*. The factors accounting for the difference in gross and net elasticity in Parsauni *panchayat* are cropping intensity and relative size of lowland holding. The significantly positive correlation between cropping intensity and size of lowland per hectare of holding appearing in Tallo Bhiuran village of this *panchayat* explains why small farms are not more efficient than large farms. Of particular importance is the positive partial elasticity of size of holding and fragments per hectare which was found in Amaraut *panchayat*. Again, cropping intensity has been found to be the main factor explaining the difference in gross and net effect of farm size in this *panchayat*.

In Jeetpur village both gross and net effects of size of holding are statistically non-significant. It seems, however, that the higher use of animal labour on smaller (winter) farms has given rise to a tendency of negative but insignificant correlation between size of holding and gross output per hectare in this village. In addition to the above, inclusion of a dummy variable, specified for two categories of farms, small and large, in the above two models has revealed that small farms as a group are more productive only in Lanka village.

CONCLUSIONS

Most economists have held the view that farm size governs the resource pattern and resource utilization in developing agriculture. In this regard, many research workers have verified empirically that input-intensity (especially of traditional inputs) as well as cropping intensity vary inversely with farm size. Consequently, such a relationship results in higher productivity on smaller farms.

The present work does not completely support this view. Indeed, only a very weak relationship between farm size and several other variables has been observed in the study area. Similarly, the hypothesized inverse relation between farm size and input intensity/land productivity does not appear strongly supported. Instead of a negative relationship, a curvilinear relation has been observed between these variables on some occasions. However, the curvilinear relation holds better for individual crops than for `all crops'. This difference could be attributed to the lack of a perfect positive correlation between the area under a crop and size of holding. Thus, cropping intensity appears to be one factor explaining the productivity on `whole-farm'. The effect of labour and animal labour has been found to be non-significant, especially in the Tarai villages. Thus, no significant relationship was found between land productivity and size of holding. However, an inverse relationship between land productivity and size of holding has been observed in most of the hill villages, and labour has been found to be the most important factor in explaining this relationship.

One of the reasons for the differences between the results of the present work and those of earlier works is the difference in methodology. From the methodological point of view the main distinguishing characteristics of the present study are:

(i) the use of ungrouped, rather than grouped, data;
(ii) the study at village level rather than at state level;
(iii) the use of curvilinear relation in addition to linear relation.

If the data are grouped and averaged out, and if the linear relation is fitted on a larger area basis (as was done by many others) then a strong relationship may appear between these variables. Perhaps such an observed relation may be negative between different variables. Even if one fits only linear

relation in ungrouped data at village level, one may observe a negative relation. This fact is evident from the estimates of linear and log-linear regression in the present work.

Productivity on farms depends on geo-climatic, socio-cultural, and structural factors. Thus, farm size is one among the large number of factors which govern productivity. Indeed, the effect of geo-climatic and socio-cultural factors is larger in agriculture than in industry. Furthermore, they are of paramount importance when developing agriculture is compared to developed agriculture. Thus, the possibility of obtaining a poor size-productivity relationship in developing agriculture is high.

In view of the above considerations, the only clear finding that emerges from the present study is that there is not one, but multiple forms of relationships between land productivity or input intensity and farm size. These results support the views of Rudra, who rejected the universal validity of the inverse relationship.

It has been observed that there is some correspondence between labour use and the extent to which agriculture is traditional or modern. This is evident from the results from the Hill region, the most backward region of Nawal Parasi District, where both labour use per hectare and land productivity have been found inversely related with farm size. But it is difficult to postulate a negative relation in an area where the Green Revolution has taken place. Due to the intervention of the GR technology in the Inner Tarai and Tarai parts of the study area, a systematic and consistent relation has not been observed. However, the relation in future depends upon the extent of adoption the new technology could achieve in these parts.

The next factor which hinders the emergence of an inverse relation is farm size distribution. Even in the initial phase

of intervention of GR technology, one may uncover a negative relation if farm size distribution is extremely unequal. Indeed, inequality in the distribution of land as such has not been so extreme in most of the selected villages of the study area. Only in Lanka village are some farms very large, and here an inverse relation is found between farm size and land productivity, in spite of the use of HYV technology.

On the whole, the existence of small farm efficiency depends on the inherent characteristics of traditional agriculture. In a predominantly agricultural society where off-farm employment opportunity is low and agriculture is practised along traditional lines, the inverse relation may be the rule rather than an exception. Thus, an extensive study of rural input markets and other characteristics is required for the formulation of a policy on the basis of size-productivity relationship.

Indeed, a study of the technical relation between output and input(s) would hardly prove very helpful for policy implication unless it were accompanied by an in-depth exploration of various characteristics of different sections of the peasantry of developing countries. Perhaps this is the main reason why earlier economists have been reluctant to jump to any conclusion against cooperative or other forms of joint farming involving land pooling in spite of their findings that suggest a significant inverse size-productivity relationship. The central issue in this context lies with economies of scale. Whether the existence of such economies can be discovered on the basis of an observed gross (bivariate) relationship between farm size and land productivity, or by estimating a multiple variable relation is worth consideration. Some studies found constant returns to scale by estimating a multiple variable regression, but an inverse gross relation between farm size and land productivity by estimating a two-variable regression. Technically these two results are feasible, since the marginal productivity of inputs

is positive. But the policy implications of each approach for land distribution is different, since constant returns to scale imply zero economies of scale, whereas an inverse relation implies diseconomies of scale. Thus, the question as to whether a two-variable or a multiple variable model should be used requires closer examination. The earlier researchers seem to justify their use of two-variable regression on the basis of zero or very low opportunity cost of inputs, especially traditional inputs. But whether the opportunity cost of labour or animal power is really zero again requires exploration of the agricultural sector of developing countries.

Lately, evidence against the idea of zero opportunity cost of traditional inputs in developing agriculture has been mounting, and this implies that the multiple variable model is the appropriate one to use for policy purposes in land redistribution. While estimating this type of relationship at the district level, one may find diseconomies of scale in one village and economies of scale in another, but no relation between farm size and land productivity in either village. Indeed, if the farms of one village are smaller, and the inequality in their distribution is lower, than in another village, there may be a positive relation between cropping intensity/labour intensity and farm size in the former, but a negative relation between them in the latter. Thus, the addition of cropping/labour intensity in the two-variable regression, with land (measured as farm size) as the only input, may produce decreasing returns to scale in the former and increasing returns in the latter village. This implies that policy should aim at a reduction in farm size in the village with smaller farms and an extension in the village with larger farms, something which is clearly inequitable! Moreover, the technical relation between farm size and productivity is characterized by high variability, as agricultural production involves a biological rather than a mechanical process, and is strongly affected by year-to-year climatic differences. This,

of course, explains why the technical input-output relation does not appear consistent on some occasions. Therefore, if the policy implication is inferred from a single year's data, it is quite liable to be absurd.

Thus, while the present study emphasizes the need for comprehensive study involving a broader spectrum of peasantry, it certainly warns against the universal generalization about small farm efficiency in developing agriculture.

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