FARM LABOUR CONTRACTS AND LABOUR QUALITY:EMPIRICAL EVIDENCE FROM SOUTH ASIA (NEPAL AND INDIA)

Shiva Sharma*
Jadu Pradhan**
and
John Quilkey*

*School of Agriculture, La Trobe University

**Faculty of Business, ST Albans Campus

Victoria University of Technology

Contributed paper presented to the 36th Annual Conference of the Australian Agricultural Economics Society, Canberra, February, 1992.

FARM LABOUR CONTRACTS AND LABOUR QUALITY: EMPIRICAL EVIDENCE FROM SOUTH ASIA (NEPAL AND INDIA)

Abstract

A variety of farm labour contracts have been observed in traditional agriculture, particularly of South and South-east Asia. Variation in contractual conditions are important methods employed by the farmers to elicit different levels of effort and quality from workers in such agriculture. Given that crops and farm operations are not similar in terms of demand for labour quality, changes in cropping patterns and farm activities are likely to be influnced by the farm labor relationships. Changes in such relationships may be crucial for technology adoption and welfare of workers. In this context, this paper has developed and implemented a farm output model using data from sample farms in Nepal and India, to test the 'labour-quality-difference hypothesis'. The empirical results lend support to the view that family and casual-hired workers are qualitatively different and are imperfect substitutes. The finding is not supportive of the conventional specification of farm labour inputs where no distinction is made between types of labour inputs.

1. Introduction

It is customary in farm production function analysis to represent labour inputs as a single, uniform input. All types and qualities of labour inputs, family and hired, are aggregated to obtain total labour input. This practice relies essentially on an assumption of quality homogenity across all types of workers which is also espoused in the development literature typified by Lewis (1954) and Ranis and Fei (1961). Two of the implications of the assumption are that substitutability among types and qualities of workers is perfect and, that changes in labour markets are expected to affect all types of workers identically.

Recently, in theoretical studies relating to 'work incentives', researchers have argued strongly that such aggregation may be erroneous because there are quality differences among different types of labour inputs (Benporath 1980, Pollak 1985, Stiglitz 1987). In these studies, the authors have identified differences in incentives as the major reason to expect family labour to be less likely to shirk in their provisions of the quantity and quality of effort. Whereas family labour share in the output produced from their efforts, hired labour receives a wage payment,which is generally not dependent on the output emanating from their performance of the job. The incentive differential has also been heralded as one of the important reasons for survival of family farms in industrialised countries of Europe and Americas (Schmitt 1991).

Empirical studies have supported the theoretical prediction of quality differences across types of labour inputs. In some of the studies it was found that family labour contributes more to output than hired labour, while others have reached opposite conclusions, confirming the view that they deserve differential treatment in production analysis. For example, in an analysis of the adoption of HYV in Orissa, India, Pradhan (1991) provides strong evidence that family workers are more productive than hired workers. While Nath (1974) for India, and Deolalikar and Vijverberg (1987) for India and Malaysia have argued cogently that hired workers are more productive than family workers.

Apart from incentive considerations, differences in labour quality may occur because different types of labourers are used in particular farm operations. Family labour is normally used in supervisory and monitoring roles. There is well documented evidence that the use of family labour has gradually increased in farm operations involving cash inputs or requiring care and judgement, such as in fertilizer application and irrigation (Hayami and Kikuchi 1986).[1] Use of family labour is intensified as farmers experience increasing managerial responsibility arising from the adoption of HYV-technology (Goddel 1984). Family labour is also very likely to be used in jobs performed in slack labour demand periods. Workers are hired largely for peak period jobs, when family labour is insufficient to carry out all of the farm's operations. Use of hired workers is thus generally concentrated in labour intensive farm operations such as planting and harvesting. The literature dealing with dualism in agriculture, particularly those in which the analysis is concerned with the farm size and yield relationship (Sen 1966, See Berry and Cline (1979) for a survey of related literature), is full of empirical evidence which supports the contention of differences in the timing of use of labour according to its type It is also suggested that the marginal products of workers differ across farm operations, and across the lean and peak seasons (Nath 1974).

In some of the studies it has been argued that within the hired labour group, workers hired on a long-term basis are retained throughout the year to minimise risks of labour shortage during peak periods (Bardhan 1979). In some studies it is demonstrated that farm operations such as land ploughing are invariably carried out by either family labour or using long-term labourers (Binswanger and Rosenzweig 1986, Pant 1983, Rudar 1982). The implication of such labour arrangements is that some hired labourers may be used even in slack cropping periods.

[1] Also see, Jayasuria and Shand (1986) for a survey of evidence for changes in the pattern of use of labour inputs associated with technological changes.

In the farm economics literature dealing with South and South-east Asia the hiring of farm workers under diverse terms and conditions is well documented (See Bardhan and Rudra 1981 and Rosenzweig 1984 for Indian cases, and Roumasset and Uy 1980, for time versus piece payments in the Philippines). The argument in the literature highlights the need for further disaggregation of the labour inputs in the analysis. In South Asia, along with casual (daily) labour contracts, long-term (annual) labour contracts seem to be common. In some studies the proportion of long-term labour used was found to be as high as one third of total labour employed (Bardhan 1979).[2] However, there seems to be a lack of adeqate data on farm workers according to type in all the South Asian economies. In micro level studies it is suggested that as much as a quarter of farm wage workers may be employed on a long-term basis in these countries (See, Sharma 1985 for Nepal, and Rahaman and Islam 1987 for Bangladesh). Typically, the casual labour contract is the most common contract on small farms where the supply of family labour per unit of land is high. It is mostly on large farms that long-term labourers are employed along with casual labourers (Bharadwaj 1974).

There are clearly two advantages from a disaggregated treatment of labour inputs. Firstly, as the proportion of landless wage workers is substantial in South Asia, welfare implications for such workers is inconclusive if labour inputs are aggregated for use in the analysis.[3] A disaggregated treatment of labour inputs may help in the assessment of welfare changes across types of workers brought about by general agricultural expansion or technical change. Secondly, the significance of this study is enhanced when one considers the arguments made in some of the development literature that problems involved in labour hiring are responsible for the adoption of mechanization (Binswanger 1978, Sen 1981), and for sliggish adoption or non-adoption of HYV-seed technology (Hariss 1972). Technological change alters the crop choice and crop farming practices, which ultimately affect the timing of labour demand and the demand for labour of particular types. Constraints on the availability of particular types of labour inputs may inhibit innovation and hence, growth.

[2]Two types of long-term labour have been identified in the literature. Rudra (1982) calls them 'attached' and 'semi-attached' labour and distinguishes between them by whether or not workers are free to work for other employers in the contract period. Those workers who are allowed to work for others are paid on an annual basis and are called 'attached labour'. Those who can work for others, are paid on a worked-day basis and are called 'semi-attached' workers.

[3]In the literature dealing with distribution of benefits from growth in agrarian economies, researchers are largely concerned with the plight of small farmers, or sharing of welfare gains between rural and urban communities. Given a large segment of rural household to be landless and employed in agriculture, study of employment conditions is important for a meaningful analysis of the distribution of benefit from growth. See, Cain (1984) and Singh (1979) for the analytical and data problems on landlessness in South Asia.

2. Objectives of the Study

The main purpose of the paper is to test the hypotheses that a quality differences exist between family and hired labourers, and that there are quality differences between family labour and different types of hired labourers. An attempt is also made to determine, if quality differences do exist, whether the difference is due to the incentives employed or to the timing of the application of particular types of labour inputs. The empirical analysis is directed to an investigation of the following views generally adopted in studies related to farm production analysis:

1. all types of workers are qualitatively the same,
2. family and long-term labourers are qualitatively similar, so that 'hired labour' should include only 'casual workers', 'family labour' should include long-term labour, and,
3. total labour can be disaggregated into family labour and hired labour, the latter being the sum of all kinds of hired workers, casual and long-term workers.

Our main emphasis in the paper is on the development of a methodology to carry out the proposed tests, and implementation of the model. Tests of 'quality-differential' hypotheses are carried out for various specifications of labour inputs. Theoretical considerations are detailed in Sharma and Quilkey (1991) and Sharma (forthcoming).

3. Methods of Analysis

Inferences regarding the quality of different types of workers can be drawn by comparing tasks for which the workers are paid, or alternatively, by comparing the contribution made to output by each type of labour at the margin.

Well defined wage data are difficult to obtain. One of the reasons for the difficulty in the acquisition of reliable wage information is the diverse components which constitute the wage, ranging from salt and edible oil to the right of labour to cultivate land under sharecropping arrangements (See Rodgers 1975 and Rudra 1982 for India,and Sharma 1985 for Nepal). Measurement problems are virtually insurmountable in such situations. Secondly, a comparision of wage data requires imputation of an opportunity wage for family labour, which is further complicated in the partially monetised and thin market environment of in rural South Asia. Thirdly, even if the requisite wage data are obtainable, wage differentials will not shed light on the reasons for labour quality variations nor will it be possible to determine whether the difference is due to the incentives structure or to the timing and function of labour application.

Production function analysis can be regarded as an appropriate analytical tool for the purposes of the study, constrained by the type of information available. The possibility of direct estimation of marginal products for each type of labour provides an alternative to wages as a quality index. We propose the use of a technical physical production function rather than a revenue function following Fuss,McFadden and Mundlak (1978) who note the following problems of the revenue function approach:

1. competitive assumptions relating to market and agent's behaviour may not be valid, and,

2. there may not be sufficient variation in output and input prices.

The estimated coefficients of the inputs can then be compared with one another and with the exogenous prices (wages) data to draw out the effects of quality variation and the efficiency implications.

When specifying the production function model for the purposes in view, two important considerations are to be maintained. Firstly, unlike most production function models, the model should treat elasticity of input substitution between types of labour inputs as a free parameter to be determined within the model. Secondly, because not all farms use all types of labour inputs, there should be provision in the model to allow for variables to take zero values. Traditional specification of production functions of the Cobb-Douglas type where each input is entered as a separate independent variable, is not capable of resolving the zero value problem. The usual method to solve the problem in traditional specification is either to discard observations for which the problem occurs, or to assign a very small value to the variable assuming a zero value. The first approach is credible only when there are large samples and a truncated type of analysis is acceptable. The second approach may not be theoretically appropriate, as a very small value of the independent variable may result in an estimate of a very large marginal product for that input making resource allocation on the farm inherently inefficient.

With these theoretical considerations and empirical requirements in mind, a Cobb-Douglas type of production function has, nevertheless, been adopted in this paper. However, as opposed to the conventional specification, the labour input is specified as labour services produced from different types of labour inputs. We are indebted to Deolalikar and Vijverberg (1987) for these insights into the appropriate model specification. The Deolalikar and Vijverberg (1987) Model is extended here to the employment of three types of labour. The algebraic properties of the model are derived, in what follows, in the light of the necessary hypothesis testing.

We assume that the farm production function is of the Cobb-Douglas type and can be written in log-linear form as:

$$lnY = ln(\beta_0) + \beta_1 lnL + \sum_{i=2}^{n} \beta_i lnX_i + u \quad (1)$$

where,

Y=Output per unit of cropped land,

L=Quantities of labour services produced by different types of labourers,

X_i=Non-labour inputs,

β_i=Regression coefficients,

and,

u=An error term.

Instead of introducing 'labour' inputs in the production function as the sum of the labour services of different types of workers as in most studies, L, here, represents a labour production function with different types of labourers as arguments.[4] Direct inclusion of the labour of different types of workers in the production function as separate variables is not possible using the Cobb-Douglas specification in Equation (1) owing to the likelihood that some of the farms may not be using some types of labour in the farm production process. The problem that some types of labour might assume zero value, has thus precluded most empirical models from using labour data in a disaggregated form. In introducing different types of labourers into the production function, we are proposing a deviation from the tradition of a homogeneity assumption for labour inputs.

Let us assume that different types of workers are employed to produce labour services, L, which enters as an argument in the output production function stated in Equation (1). The functional form through which different types of labourers contribute to the production of labour services is a generalised quadratic, and is of the following type,

$$L = \alpha_1 L_f + \alpha_2 L_p + \alpha_3 L_c + \alpha_4 L_f^2 + \alpha_5 L_p^2 + \alpha_6 L_c^2 + \alpha_7 L_f L_p + \alpha_8 L_f L_c + \alpha_9 L_p L_c \quad (2)$$

where,

L_f=Family labour,

[4]This specification for labour services production function has been adapted from Deolalikar and Vijverberg (1987). In this paper a distinction is made between family and hired labourers used to produce labour services.

L_p=Permanent labour,

L_c=Casual labour,

$\alpha_1, \alpha_2, \alpha_3 \leq 1$,

and,

$\alpha_1 + \alpha_2 + \alpha_3 = 1$.

Estimation of the parameters of Equation (1), when the labour services function is as stated in Equation (2), involves a non-linear technique, because of the non-linear form of the labour input, L. Equations (1) and (2), provide the opportunity to carry out the tests which are not feasible employing the conventional input specification in Cobb-Douglas or CES type production functions. Three important characteristics are worthy of note here in relation to the labour services production function:

1. All labour inputs, L_f, L_p, L_c, can be separately entered into the production function, and are free to take zero values,

2. L in Equation(1) can become a conventional Cobb-Douglas specification of 'total labour' as an input, if α_4 through α_9 are equal to zero. If so, all interaction terms in the labour production function vanish, and it reduces to

$$L = \alpha_1 L_f + \alpha_2 L_p + \alpha_3 L_c. \tag{3}$$

   Equation (3) further reduces to a simple labour input, 'L', only if $\alpha_1 = \alpha_2 = \alpha_3$ holds. Inequality among the α's and the presence of interaction terms in Equation (2), would, however, present a strong case for differential treatment for workers by type, in analytical investigations relating to farm labour

3. the specification of the labour service production function in Equation (2) allows an investigation of the influence of one type of labour upon another type in terms of productivity. This can be appreciated by differentiating Equation (2) with respect to one type of labour, say L_f. The marginal change in labour service due to a marginal change in L_f is,

$$\partial L/\partial L_f = \alpha_1 + 2\alpha_4 L_f + \alpha_7 L_p + \alpha_8 L_c. \tag{4}$$

   Taking partial derivatives of Equation (4) with respect to L_p and L_c,

$$\partial(\partial L/\partial L_f)/\partial L_p = \alpha_7. \tag{5}$$

   and,

$$\partial(\partial L/\partial L_f)/\partial L_c = \alpha_8. \quad (6)$$

The signs of α_7 and α_8 will provide information on the nature of the relationships among types of workers. For example a negative α_7 will be evidence that L_f and L_p are competitive. In contrast, a positive α_7 will indicate that L_f and L_p are complementary. An increase in the use of L_p causes the marginal product of L_f to shift upward.

Individual labour inputs are said to be technically independent of each other if a change in the use of one type of labour does not change the marginal product of another type of labour input. This is tantamount to saying that α_7 and α_8 assume zero values if L_f is independent of L_p and L_c. For any additive function like Equation (2), absence of interactive terms imply that inputs are technically independent.

Do different types of labour inputs contribute equally to the production of labour services ? This can be tested by comparing the marginal contribution of the labour services of each type of worker to production. Differentiating Equation (2) with respect to each type of labour input gives their respective marginal contribution in the labour services production. The derivatives are similar to Equation (4). As dissussed earlier, α_4, α_5, and α_6 are expected to be negative, while signs of α_7, α_8 and α_9 are to be empirically determined.

5. Study Area and Data

The data for the study come from a multistage random survey in Orissa, India and a simple random sample of farm households from the Western Nepal. In both study areas, rice is the main crop, and is the crop selected to fit the farm production functions. The Indian sample consists of 232 farm households, while the Nepalese sample is composed of 53 farms. The basic data reflecting the characteristics of the key variables,land, labour and capital, used in the empirical model are presented in Table 1. It can be seen from the table that Nepalese farms are relatively smaller in size and tend to be less labour intensive.

Table 1 **Descriptive Statistics of Key Variables Used in the Analysis**

Variables	*India*		*Nepal*	
	Mean	SD	Mean	SD
Land Size (acres)	3.17	2.95	2.61	1.85
Family Labour (workdays)	122.68	95.88	88.56	61.02
Casual Labour (workdays)	96.44	157.21	17.22	22.60
Amount of Fertilizer (kgs)	104.68	135.55		
Animal Labour (pairs-days)			28.77	5.56
Area Irrigated (percent)	44.20	47.55	16.32	24.40
Family Size (number)	6.01	2.46	6 22	2.63
Rice Output (kgs)	2890	2788	1202	778

Note: SD stands for standard deviation.
Source: Field Surveys.

It is clear from the discussion in the previous section that a generalised polynomial specification is essential if the estimated labour services production function is to provide an adequate measure of labour quality heterogenity. The farm production functions are specified in generalised Cobb-Douglas form without imposing the restrictions of constant returns to scale. Both farm functions include three fundamental factors, land, labour and capital services.

In the Indian case, the amount of nitrogen fertilizer, in terms of Calcium Ammonium Nitrate, has been used as an approximate measure for all capital services. In the Nepalese case, animal power, measured in pairs-of-bullock-days, is used to represent both the animal labour input and the capital services input.

In the estimation of the labour services functions, two types of labour have been identified. Hired labour measures the amount of labour service provided by casual (daily) workers. The family labour input includes the services of family members and long-term labourers engaged in crop production. In the Nepalese case, a finer classification of labour inputs into family, casual and long-term labour is possible. This classification has been maintained while analysing the labour services production functions consisting of three types of labour inputs.

5. Empirical Results

The production function estimates along with the goodness-of-fit diagonistics are presented in Tables 2 through 4. For each of these cases three equations were estimated. It is clear that Model I is the complete model encompassing the possibilities of labour quality heterogenity in productivities and substitutabilities. Model II is one that allows for labour quality variation but imposes the perfect substitutability restriction. In Model III, both the restrictions of equality in labour quality and perfect substitutability are imposed, implying the traditional Cobb-Douglas specification in a single labour input variable. In the complete model of two-way classification (family labour and casual labour), the estimated parameters have identical signs in both samples. Further, these signs are in agreement with the theoretically expected signs.

There are, however, significant differences in the magnitude of the individual coefficients. For example, the output elasticity of labour services in the Indian sample (0.28) is only about a third of that in the Nepalese case (0.87). Despite some striking differences in the contributions of individual factors of production and types of labour inputs, the hypothesis of perfect substitution between family and casual labour is rejected in both cases. This is evident in the comparision of the likelihood-ratio test statistics[5] with the appropriate critical F-values. For example, in the Nepalese case, the likelihood ratio of 3.00 between Model I and Model II exceeds the F-value of 2.82, thus the hypotheses of perfect substitution is rejected at the 5 percent level. As can be seen from Table 3, a similar conclusion follows for the Indian sample. Comparison between Model II and Model III leads to rejection of the hypothesis of labour quality uniformity in both the samples.

[5]The formula used to calculate the ratio is $\frac{(SSE_r - SSE_f)/q}{SSE_f/(n-p)}$, where, SSE stands for the Error Sum of Squares, and subscripts r, f, q and p stand for the restricted model, fuil model, parametric restrictions and number of parameters estimated in the full model, respectively. See Gallant (1987) for detail.

Given these results, it appears that Model I is to be preferred if one is to draw valid inferences about the contributions of individual factor inputs on the farm and the labour services production functions.

The results from implementation of a generalised labour services production function are also presented in the Tables. The negative signs associated with both parameters, α_3 and α_4, in both countries, confirm the expectation that the marginal contribution of each type of labour declines with increases in their use at the margin. Similarly, negative α_5 values in both countries indicate that labour inputs elicited from family and hired workers are gross substitutes.

Which type of labour is qualitatively superior in terms of its contribution to the labour services production function ? This can be answered by comparison of the marginal contributions of different types of labour inputs in the production of labour services. From Model II, the ratios of the marginal contributions of family labour to those of hired labour are 0.39 for Nepal and 0.11 for India, indicating that under the sample conditions hired workers appear to contribute more to production at the margin.

In Table 3, results from a similar exercise with a finer classification of labour inputs are presented. Data used are for Nepalese farms and the classification is family labour, casual labour and long-term labour. The likelihood ratio statistic between Model I from Table 3 and Model I from Table 4 is 3.00, which is greater than the critical F-value of 2.25. This suggests the retention of the the model with a finer classification of labour inputs.

Among the models with a finer classification of labour inputs (Table 4), the test statistics indicate rejection of Model III against Model II, and rejection of Model II against Model I. The economic interpretation of the results is that family, casual and long-term workers differ in terms of their contributions, and are not perfect substitutes. The positive coefficients associated with the interaction between casual and family labour, and casual and long-term labour, though not statistically significant, indicate that both family and long-term labour inputs are complementary to casual labour. However, family and long-term labour inputs are found to be gross substitutes.

6. Conclusions

The main conclusions, strengths and limitations of the study can be summarised as follows. Empirical results from both the case studies, despite the apparent diver-

Table 2 **Estimated Production Functions and Diagonistics:Nepal**

Parameters	*Models* I	II	III
Overall Farm Production Function			
Intercept	1.9061(1.15)	1.8634(1.18)	1.4915(1.08)
β_1(Labor Services)	0.8459(4.37)	0.7184(3.83)	0.7356(3.68)
β_2(Capital Services)	0.0766(0.43)	0..1631(0.89)	0.1394(0.71)
β_3(Land Services)	0.1355(0.89)	0.0573(0.73)	0.1412(0.87)
Labor Services Function			
α_1(Family Labor)	0.2541(3.56)	0.2821(4.61)	
α_2(Hired Labor)	0.7459	0.7179	
α_3(Family Labor Squared)	-0.0005(1.25)		
α_4(Hired Labor Squared)	0.0122(20.33)		
α_5(Interaction Term)	-0.002(.10)		
Sample Size	53	53	53
Likelihood Ratio Test Statistic	-	3.00	8.61
Critical F-values	-	2.82	4.04

Note: Figures in the parenthesis are t-values calculated by using asymptotic standard errors.

Table 3 **Estimated Production Functions and Diagonistics: India**

Parameters	*Models*		
	I	II	III
<u>*Overall Farm Production Function*</u>			
Intercept	1.1090(2.13)	1.7692(3.20)	1.4669(2.88)
β_1(Labor Services)	0.2812(2.29)	0.2195(2.62)	0.1819(1.99)
β_2(Capital Services)	0.3745(8.75)	0.3619(8.16)	0.4149(9.82)
β_3(Land Services)	0.3355(3.87)	0.1996(2.43)	0.2612(3.03)
Labor Services Function			
α_1(Family Labor)	0.2912(1.73)	0.100(0.115)	
α_2(Hired Labor)	.7078	0.900	
α_3(Family Labor Squared)	-0.0006(1.54)		
α_4(Hired Labor Squared)	-0.0004(3.81)		
α_5(Interaction Term)	-0.0008(1.19)		
Sample Size	232	232	232
Likelihood Ratio Test Statistic		6.00	11.22
Critical F-values		2.65	3.89

Note: Figures in the parenthesis are t-values calculated by using asymptotic errors.

Table 4 Estimated Production Functions and Diagonistics: Nepal (With Further Classification of Hired Labor)

Parameters	*Models*		
	I	II	III
Overall Farm Production Function			
Intercept	2.3817(0.96)	1.9325(1.96)	1.4915(1.59)
β_1(Labor Services)	0.5995(1.65)	0.7270(3.56)	0.7356(3.68)
β_2(Capital Services)	0.0403(0.22)	0.1614(0.87)	0.1394(0.71)
β_3(Land Services)	0.1366(0.85)	0.0573(0.35)	0.1412(0.87)
Labor Services Function			
α_1(Family Labor)	0.0788(0.47)	0.2220(5.55)	
α_2(Casual Labor)	0.7099(2.69)	0.5615(7.41)	
α_3(Long Term Labor)	0.2130	0.2165	
α_4(Family Labor Squared)	0.0019(0.73)		
α_5(Casual Labor Squared)	-0.0455(1.15)		
α_6(Long Term Labor Squared)	-0.0001(0.1)		
α_7(Family-Casual Interaction)	0.0262(0.87)		
α_8(Family-Long Term Interaction)	-0.0001(0.1)		
α_9(Casual-Long Term Interaction)	0.0032(0.46)		
Sample Size	53	53	53
Likelihood Ratio Test Statistic		2.83	4.20
Critical F-values	-	2.25	3.20

Note: Figures in the parenthesis are t-values calculated by using asymptotic standard errors.

sity in crop production technology and detailed model specification, lend support for the rejection of the hypothesis of 'labour quality equality' between labour input types. This conclusion is valid whether or not one treats long-term contract labour as different from both family and casual labour or as coextensive with family labour.

The hypothesis of perfect factor substitution of different types of labour inputs is also rejected in all cases. These results suggest that a flexible attitude should be taken in the estimation of agricultural production functions. In the absence of strong theoretical support, it may be advisable to adopt functional forms that allow for both, labour quality differentials and imperfect substitution between labour inputs.

In view of the lack of statistical significance of some of the coefficients in the model, inferences about the relative importance of individual inputs should be interpreted with caution. It appears that the model needs to be applied to diverse crop and decision enviroments to gain insights into the nature and sources of labour heterogenity.

References

Bardhan, P., (1979), 'Wages and unemployment in a poor agrarian economy: a theoretical and empirical analysis', *Journal of Political Economy*, 87 (3), 479-500.

Bardhan, P., (1983), 'Labor tying in a poor agrarian economy: a theoretical and empirical analysis', *Quarterly Journal Of Economics*, 98 (3), 501-514.

Bardhan, P., and Rudra, A., (1981). 'Terms and conditions of labor contracts in agriculture: results of a survey in West Bengal', *Oxford Bulletin of Economics and Statistics*, 43 (1), 89-111.

Ben-Porath, Y., (1980), 'The f-connection: families, friends and firms and the organization of exchange', *Population and Development Review*, 6 (1), 1-30.

Berry, C., and Cline, R., (1979), *Agrarian Structure and Productivity in Developing Countries*, Baltimore: Johns Hopkins University Press.

Bharadwaj, K., (1974), *Production conditions in Indian agriculture: a study based on farm management surveys*, Cambridge: Cambridge University Press.

Binswanger, H., (1978), *The economics of tractors in South Asia: an analytical review*, New York: A/D/C and ICRISAT.

Cain. M., (1984), 'Landlessness in India and Bangladesh: a critical review of national data sources', *Economic Development and Cultural Change*, 32 (1), 149-168.

Deolalikar, A., and Vijverberg, P., (1987). 'A test of heterogeneity of family and hired labour in Asian agriculture'. *Oxford Bulletin of Economics and Statistics*, 49 (3), 291-305.

Fuss, M., McFadden, D., and Mundalak, Y., (1978), 'A survey of functional forms in the economic analysis of production', in Fuss, M., and McFadden, D., (eds), *Production Economics: A Dual Approach To Theory and Application*, Amsterdam, North-Holland Publishing Company.

Gallant, A., (1987), *Nonlinear Statistical Models*, John Wiley and Sons, Inc.

Harris. B., (1972), 'Innovation adoption in Indian agriculture- the high yielding variety program', *Modern Asian Studies*, 6 (1).

Hayami, Y., and, Kikuchi, M., (1986), 'Directions of agrarian change: a view from villages in the Philippines', in Mellor, J., and, Desai, G. (eds), *Agricultural change and rural poverty*, Delhi: Oxford University Press.

Jayasuriya, S., and Shand, R., (1986), 'Technical change and labor absorption in Asian agriculture: some emerging trends', *World Development*, 14 (3), 415-428.

Junankar, P., (1989), 'Neo-classical economics and Indian agriculture: an econometric analysis of production behaviour', *Indian Economic Review*, 17 (2-4), 139-164.

Lewis, A., (1954), 'Economic development with unlimited supply of labour', *Manchaster School of Economics and Social Studies*, 22, 139-191.

Nath, S., (1974), 'Estimating the seasonal marginal products of labor in agriculture,' *Oxford Economic Papers*, 26 (3), 375-387.

Pant, C., (1983), ' Tenancy and family resources', *Journal of Development Economics*, 12 (10), 27-39.

Pollak, R., (1985), 'A transaction cost approach to families and households', *Journal of Economic Literature*, 23 (2), 581-608.

Pradhan, J., (1991), 'Adoption of HYV rice technology in a farm household theoretic model', unpublished Ph. D Thesis, La Trobe University, Austrialia.

Pradhan, J., and Quilkey, J., (1985), 'Some policy implications from modelling household firm farm decisions for rice farmers in Oissa, India', Paper presented in the annual conference of the Australian Agricultural Economics Society, Februuary (1985), Armidale.

Rahaman, A., and Islam, R., (1987), 'An empirical account of hired labour market in rural Bangladesh', *The Bangladesh Development Studies*, 15 (1), 129-142.

Ranis, G., and Fei, J., (1961), 'A theory of economic development', *American Economic Review*, 51, 533-565.

Rodgers, G. (1975), 'Nutritionally based wage determination in the low income labor markets', *Oxford Economic Papers*, 28.

Rosenzweig, M., (1984), 'Determinants of wage rates and labor supply behaviour in the rural sector of a developing country', in. H. P. Binswanger, and M. R.

Rosenzweig (eds), *Contractual arrangements, employment and wages in rural labor markets in Asia*, Yale University Press.

Roumasset, J., and, Uy, M. (1980), 'Piece rates, time rates, and teams: explaining patterns in employment relations', *Journal of Economic Behaviour and Organization*, 1 (1), 343-360.

Rudra, A., (1982), *Indian agricultural economics: myths and realities*, New Delhi: Allied Publishers.

Schmitt, G., (1991), 'Why is the agriculture of advanced Western economies still organised by family farms? Will this continue to be so in the future?', *European Review of Agricultural Economics*, 18(3/4), 443-458.

Sen, A. K., (1966). 'Peasants and dualism with and without surplus labor', *Journal of Political Economy*, 74 (5), 425-450.

Sen, A., (1981), 'Market failure and control of labor power: towards an explanation of structure and change in Indian agriculture, Part I and II', *Cambridge Journal of Economics*, 5 (3, 4), 201-228 and 327-350.

Sharma, S., (1987), 'Agrarian change and agricultural labor relations: Nepalese case studies,' Research Paper Series No.4, HMG-USAID-GTZ- IDRC-WINROCK Project, Kathmandu.

Sharma, S., and Quilkey, J., (1991). 'Labour quality and farm labour contracts', Paper presented in the annual conference of the Australian Agricultural Economics Society, February (1991), Armidale.

Singh, I., (1979), 'Small farmers and landlessness in South Asia', World Bank Staff Working Paper No. 320, World Bank, Washington D.C.

Stiglitz, J., (1987), 'The causes and consequences of the dependence of quality on price', *Journal of Economic Literature*, 25 (1), 11-48.