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Productivity Differences between Male and Female Managed Farms in the Eastern and Central Highlands of Kenya

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PRODUCTIVITY DIFFERENCES BETWEEN MALE AND FEMALE MANAGED FARMS IN THE EASTERN AND CENTRAL HIGHLANDS OF KENYA

Introduction

A wide variety of literature is available on the role of agriculture in economic development in Africa and on the critical role that rural women play within this sector. In Sub-Saharan Africa (SSA), agriculture accounts for approximately 21% of the continents GDP with as low as 8% in Congo and as high as 50% in Tanzania (FAO, 1995). Employment in agriculture ranges from as low as 40% in Morocco to as high as 85% in Burkina Faso. Women contribute 60-80% of the labour used to produce both for household consumption and for sale (FAO, 1995). A growing body of empirical evidence from both developing and developed countries now indicates that allocation decisions within householdsare commonly not consistent with the unitary household model (Quisumbing, 1996). Allocation decisions appear to reflect both different preferences among different household members by gender, age and differences in resource control including income, assets and education as well as factors external to the household such as laws, norms and economic institutions. Power relations within the householdand the community also affect household and resource allocation choices.

Studies that have measured productivity of men and women farmers without attempting to take into account women's lower access to resources have found women to be less productive than men. Quisumbing (1996) documents the difficulty in comparing levels of productivity between men and women. The author attributes this to methodological and conceptual difficulties, which arise from defining appropriate measures of productivity in different farming systems, omission of individual characteristics in attempts to measure productivity differences by sex, and the lack of clarity regarding the measurement of sex and gender differences. It is feasible to estimate technical efficiency differences between male and female farmers in farming systems where men and women manage different plots. It is however more difficult to isolate managerial efficiency differences in settings where plots are cultivated jointly by male and female members and hired labor (Quisumbing, 1996). Despite the volume of attempts to document male-female productivity differences, relatively few studies control for individual characteristics of the male and female farmers such as education and physical assets.

The focus on the gender relations within which resources are controlled and used is crucial both for understanding local resource management, practices and innovations, and for assessing policies to support or supplement them. Both conventional gender blind approaches and those, which isolate women's roles for analysis, tend to obscure these gender relations (Leach, 1991). This paper is based on data collected in a study on the role of gender on farm enterprise management in the Central highlands of Kenya. Time allocation studies have been used to describe gender and age based labor patterns (Wollenberg, 1988). Labor patterns have been analyzed to support a wide range of findings including the determination of peak labor periods (Maxwell, 1984; Price and Barker, 1978), income opportunities for female farmers (Burfisher and Horenstein, 1985), the contribution of children to farm production (Navera, 1978), crop labor investments (Barlet, 1980), seasonal fluctuations in agricultural and non-agricultural activities (Norman et al, 1981) and inter household differences in the family cycle (Cadelina, 1985).

1.3 Objectives of this study

This study had three objectives;

1. To compare the productivity and the technical efficiency of male and female managed farms
2. To make an assessment of the factors that contribute to differences in productivity and technical efficiency of farms
3. To make an evaluation of the measure of efficiency in the use of resources notably inputs, labour and extension services by male and female managed farms.

2 Methododology

Data collection

Data was collected from 40 farmers during the short rain season in two ecological zones in the central highlands of Kenya. Data were collected on crop production, inputs and both hired and family labour during the short rain season of 1999/2000. To obtain uniformity in data collection among farmers, data was collected on five common crops, coffee, tea, maize, beans and potatoes. Data was also collected on cattle and trees. Three methods of data collection were used; respondent recall, direct observation and farmer records. Information on input prices was obtained from retail outlets, cooperatives and from farmers themselves. Households were visited every three weeks for seven months. In total, each household was visited 7 times during the data collection process. Visits over a one-month interval were found to be a compromise between too short and too long an interval. A very short interval would have caused farmer fatigue while a very long interval would have caused data unreliability since most farmers depended on recall.

Data analysis

The Cobb-Douglas Production Function.

The most commonly used production function is the Cobb-Douglas production function. The function is easy and convenient to estimate since it is linear in parameters. The dependent variable in the function is Total Value Product (TVP). The TVP is obtained by calculating the value of the gross output using prevailing market prices. The data was explored using scatter plots in order to determine whether there was a relationship between the TVP and different independent variables. An elliptical scatter plot indicates the existence of a linear relationship. When the data was subjected to a scatter plot, the relationship was not linear. The variables were log transformed and subjected to a scatter plot again. Elliptical scatter plots were obtained indicating that there was an almost linear relationship between the natural logarithms of the variables. The use of scatter plots also helped in the identification of outliers.

A pooled regression of all the farms was done. This approach has been most commonly used to estimate differences in the technical efficiency between male and female farm managers and is recommended if all the farms are producing the same crops or if similar crops are under consideration as was the case in this study (Quisumbing, 1996). Several studies have used pooled regression method (Moock, 1976; Jamison and Lau, 1982; Bindlish and Evenson, 1993; Bindlish *et al.,* 1993). It allows for sex differences by using a sex dummy while also interacting the sex dummy with other variables to see its effect on input utilization. To allow for gender differences rather than merely sex differences, the access to resources and personal characteristics such as age are included in the model. Quisumbing (1996) argues that some of the methodological problems in measuring male–female differences in productivity include the omission of individual characteristics and the lack of clarity regarding the measurement of sex and gender differences.

The general form of the Cobb-Douglas production function is specified as:

$$Q = AX^{bi} \ldots\ldots\ldots\ldots e^{u}$$

Where Q = total output

A is Constant term of the regression

b_i is Elasticity of production with respect to the ith input

X_i is the ith input used in the production process u is the error term

e is the base of the natural logarithm.

The function is estimated in its log linear form, which is specified as follows;

$$\ln Q = \ln A + bi \ln Xi + u$$

Where ln is the natural logarithm and other variables are as specified in formula 2.

The log linear form of the estimated functional relationships is specified as follows;

$$\ln Y = b_i \ln X_i + b_i X_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + b_n X_n.$$

This production function approach focuses on the technical rather than allocative efficiency. Resource allocations within the household are considered Pareto efficient if no reallocation of resources to different household members or to different uses could increase total output. Quisumbing (1996) argues that the asymmetric distribution of rights, resources and responsibilities by gender may have more serious implications for allocative efficiency than sex differences do for technical efficiency. Attempts to study the effects on allocative inefficiencies in this study have been made by interacting the female dummy with other exogenous variables including extension, education, labour and inputs. Although this does not sufficiently address the issues of allocative efficiency within households, it gives an indication of the relative efficiency in use of resources by male and female farm managers.

In order to examine the allocative efficiency the Marginal Value Product (MVP) for the respective factors was calculated. From the Cobb-Douglas production function, the marginal factor productivities and the average productivity measures were computed from the estimated production elasticities as follows.

$$MVP = bi\ AVP = Q/Xi$$

The MVP gives the absolute response per unit of factor input and allows for a comparison of relative efficiencies of resource use within the given farms.

The level of technical efficiency, which is the ratio of actual to potential output, was calculated for each of the farmers surveyed for each crop and for all the crops combined. The aim of this analysis was to make a comparison of technical efficiency of male and female managed farms as well as farms managed by both male and female. Two methods were used in this analysis for the determination of technical efficiency of the sampled farms. The first, a simple calculation of technical efficiency using the potential crop output for specific crops as given by Acland (1971) and the second, an estimation of the frontier production function from the Cobb-Douglas production function. Several studies have recommended the use of the second method in the determination of technical efficiency (Bravo-Ureta and Rieger, 1990, 1991; Karilajan, 1991; 999).

3 Results and Discussion

Contribution of various farm enterprises to TVP

Figure 2 shows the contributions of various enterprises to TVP. Tea made the highest contribution to TVP contributing 34.5%, followed by coffee, which contributed 32.8%. Livestock, maize and beans contributed 17.2%, 4.1% and 4.0% to the total value product respectively. Tree products contributed 3% to the TVP. When the TVP was compared for male managed, female managed and both male and female managed farms, a one-way ANOVA found no significant differences (F=1.531; p=0.230; 39df).

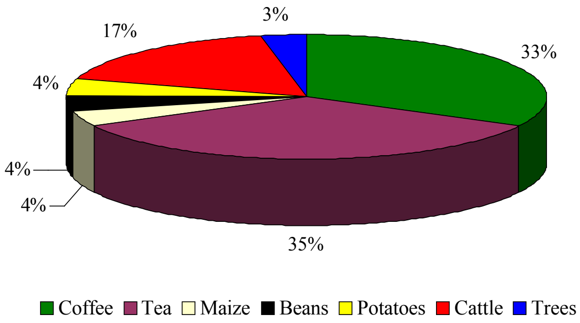

Figure 1. The contribution of various enterprises to TVP

Factors affecting the total value product

The factors affecting the TVP were determined using the Cobb-Douglas production function model. The regression results are shown in Table 1. From the results of the estimation, the value of R^2 was 0.667 and was significant as indicated by the significance of the F value (7.306) which had a p=0.005. The variables in the function explained almost 67% of the variability of TVP. From the specified variables, the coefficients for land, inputs, female labour and the age of the farm manager were statistically significant.

Table 1. The determinants of TVP

Variable	Unstandardized	t-values	P values	MVP	MROCR
Constant	4.858	2.893	0.007	-	
Lnland	-0.483	-2.711	0.011		
ln of female labour	0.281	2.328	0.027	1.47	103.36
ln of male labour	0.153	1.503	0.144		
ln of inputs	0.258	2.363	0.025	9.01	9.01
ln of age	0.731	1.778	0.089	-	
Extension dummy	0.0129	0.050	0.960	-	
Education dummy	0.0681	0.268	0.790	-	
Female dummy	-0.360	-1.595	0.122	-	
R^2		0.667			

Source: Survey data (1999)

The coefficient for the female dummy was not significant. A negative and significant female dummy would indicate that female farm mangers are less productive than male farm mangers while a positive and significant female dummy would indicate that they are more productive than male managers. The non-significant female dummy shows no evidence of difference in productivity between male and female farm managers. Other studies (Moock, 1976; Bindlish and Evenson, 1993; Saito *et al*., 1994; Jamison and Lau, 1982) have found women farm mangers to be as productive as male farm managers. The study by Jamison and Lau (1982) in Korea however found male household heads to be more productive than female household heads in mechanized farms. Bindlish *et al.* (1993) found female heads of households to be less productive than men in a study in Burkina Faso, a fact that the authors attributed to cultural, religious and ethnic factors.

Interactions between the female dummy and other variables were used to test for sex differences in input utilization. The interactions with female labour, male labour and education of the farm manager were significant. The female dummy had a positive interaction with female labour and a negative interaction with both male labour and education of the farm manager.

The interaction of the female dummy with education was negative and significant (r=-0.328, p=0.024) indicating that female farm managers benefit less from education than male farm managers as far as farm production is concerned. One explanation for this could be that as women get more education, they tend to shift their focus and efforts from farming activities to other off farm and income generating activities. When the same happens to men, it is assumed that women take over the responsibility for farming activities. When it happens to women however, farming activities are left in the hands of hired labour. These results agree with those of a study by World Bank (1990) in Kenya, which found that as women's number of years of schooling increases, the number of hours spent farming decreases at a much faster rate than for men.

The non-significance of the interaction between the female dummy and the extension dummy is important in that it indicates that both male and female managers benefit equally from extension. Moock (1976) found a negative and significant interaction between a female dummy and extension dummy indicating that exposure to agricultural extension increases the productivity of male farmers relative to female farmers.

The coefficient for land was significant and took a negative sign. It would be expected that increasing the land area would have a positive effect on the gross output. However, given the importance of inputs in the farming system and the low access to these inputs and their high cost, increasing the area cultivated implies a wider application of insufficient inputs in terms of fertilizers and pesticides as well as the use of uncertified seeds which could lead to a reduction in the value of gross output. A similar relationship between plot size and yield has been observed in other research in Africa without satisfactory explanation (Bindlish *et al*., 1992; Blarel *et al*., 1992). The variation of the TVP with land is shown in Figure 3. As land size increases, there is a fluctuating but general increase in the TVP. Beyond a land size of 2.5 ha however, there is a fluctuating but general decrease in the TVP, which reaches a minimum at approximately 3.5 ha. Other reasons for the negative relationship between land size and the value of total products could be the difference in crops grown in the various farms as well as agricultural intensification which is normally associated with small farms or inefficient allocation of the inputs between farm enterprises. An example of such inefficiencies is the study by Udry *et al*. (1995) in Burkina Faso who found that re-allocating the inputs used in male owned plots to female owned plots would increase productivity considerably.

An increase in inputs led to an increase in the value of total products. This is shown by the positive and highly significant coefficient of inputs in the regression model. Saito *et al.* (1994) found a significant increase in production with increase in insecticide use while Jamison and Lau (1982) found an increase in productivity with fertilizer use. The age of the farm manager, which was used as a proxy for experience, was found to be positive and significant. It was found that the longer the farming experience, the higher was the TVP. Saito *et al*. (1994) found a similar relationship in a study in Nigeria when they used plot level data. Age was however not significant when farm level data was used. Bindlish and Evenson (1993) found a significant relationship between age of the farm manager and productivity in Kenya. Female labor was found to be significant at $p<0.05$ indicating that female labor is more productive than male labor. Similar findings have been reported by Udry et al. (1995) in a study in Burkina Faso and by Saito *et al*. (1994) in a study in Nigeria.

Resource use efficiency

Using the estimated production elasticity and the Average Value Product (AVP), the Marginal Value Product (MVP) was estimated and was presented earlier in Table 5. This was done for both female labour and inputs since they were both positive and significant. An increase in 1 Ksh worth of inputs increases the value of total products by Ksh9.01. The marginal value product for female labour was 103.36, which means that adding one person day of female labour increases the value of output by Ksh 103.36.

The Marginal Returns to Opportunity Cost Ratios (MROCRs) was calculated and used as a measure of the efficiency of resource use prevailing on average throughout the sample. It is computed as the ratio of the marginal product to the marginal cost given as the opportunity cost of the respective factor. For profits to be maximized, the ratio of the marginal product to the marginal cost must be one (Heady and Dillon, 1961 cited by Atieno, 1995). This means that the revenue from using one additional unit of an input is equal to the cost of acquiring that unit. A ratio of less than one implies that too much of the resource is being used under the existing price conditions, implying inefficient resource use. If the ratio is greater than one, it indicates that too little of the resource is being used, and increased use of the resource would result in increased profits.

For the given production resources used, their opportunity costs represent the market prices that prevailed on the average during the production period. The prevailing wage rate of Ksh 70 in Kirinyaga was used as the marginal cost of labour. On the assumption that the employment of additional labour would imply the purchase of hired labour, the market wage rate of labour is taken as the opportunity cost of a unit of both male and female labour in this analysis. This reflects the benefits forgone by the family in order to participate in the activity (Gittinger, 1982). For inputs, the marginal cost was taken as the market price of these. Since the inputs were measured in monetary terms the marginal cost is taken as equivalent to Ksh 1. The computed efficiency measures for each resource were presented in the last column of Table 5.

The ratio for inputs was greater than one indicating that too little inputs are being used. If the use of fertilizers, improved seeds and farm chemicals were increased, it would result in increased production. The low level of factor use could be explained by farmers inability to purchase these inputs or inefficient marketing conditions for commodities as well as delayed payments and low prices giving farmers little incentive to invest more resources in production of these commodities. The ratio for female labour on the other hand was less than one. This means that under the existing price conditions, too much female labour is being used in relation to the level at which farmers use other factors of production.

Technical efficiency

The level of technical efficiency, the ratio of actual to potential output was calculated for each of the farmers surveyed for each crop and for all the crops combined. The aim of this analysis was to make a comparison of technical efficiency of male and female managed farms as well as farms managed by both male and female managers. The method used was an estimation of the frontier production function from the Cobb-Douglas production function. Several studies have used the second method in the determination of technical efficiency (Bravo-Ureta and Riegler, 1990, 1991; Parikh and Shah, 1994; Karilajan, 1991,). First the average production was estimated using the coefficients of the Cobb-Douglas production function. Only those observations with positive error terms were retained. These were then regressed against the same explanatory variables and the process repeated until the estimates were stable, that is they did not vary noticeably from one iteration to the other. This was achieved after 3 iterations. The coefficients for inputs, land and female labor were still significant and in addition, those for male labor and the female dummy were significant. The level of technical efficiency, the ratio of actual to potential output was calculated for each of the farmers. The actual output is the observed output while the potential output is the output from the frontier production function.

Table 2: A comparison of technical efficiency based on farm management

	Level of efficiency (% No. of farms)			Min	Max	Mean	SD
	<0.50	0.51-0.75	>0.76				
Male manager	30.0	30.0	40.0	0.19	0.98	0.62	0.25
Female manager	50.0	18.8	31.3	0.23	0.97	0.56	0.24
Combined	11.1	22.2	66.7	0.49	0.94	0.77	0.14
Overall	34.3	22.9	42.9	0.19	0.98	0.64	0.23

Source: Survey data (1999)

For all farms, the mean technical efficiency was 64% with a minimum of 19% and a maximum of 98%. This implies that on average, the respondents were able to obtain 64% of potential output from a given mix of production inputs. This level of technical efficiency was lower than that given by Amara *et al*. (1999) for potato farmers in Quebec (80.27%), and by Bravo-Ureta and Riegler (1991) for dairy farms (83%). It is however higher than that given by Bravo-Ureta and Evenson (1994) for cotton and cassava farmers (58-59%) and that given by Yao and Liu (1998) for grain farmers in China (63%). About 43% of the farms had an efficiency level of above 75% while 343% were operating at an efficiency level of below 50%. When farms were compared based on farm management, combined male and female managed farms have the highest proportion of farms with technical efficiency above 75% while female managed farms have the lowest. Mean technical efficiency was 62%, 56% and 77% for the male managed, female managed and combined male and female managed farms respectively. Half of the female managed farms had an efficiency level below 50% while only 11.1% of the combined management and 30% of the male managed farms were in this category. When the mean technical efficiency was compared for the different farms based on management using ANOVA, the F-value was found to be significant at $p<0.05$. Only the technical efficiency of the female managed and the combined male and female managed farms were significantly different at $p<0.05$.

Given the differences in efficiency levels among production units, it is appropriate to question why some producers can achieve relatively high efficiency whilst others are technically less efficient. Variation in technical efficiency may arise from managerial decisions and farm characteristics that affect the ability of the producer to adequately use the existing technology. A probit regression was carried out to determine the extent of the contribution of various factors to technical efficiency. Farms with technical efficiency below 50% were considered inefficient while those above 50% were considered efficient. Results of the probit analysis are shown in Table 7.

Table 3. Factors affecting farmers' technical efficiency

Variables	Coefficients	T-ratios
Assets ownership	0.5923	0.9811
Education	0.1716	0.2357
Age	-0.0181	-0.9684
Extension	0.8617	1.6175*
Total land area	-0.3191	-1.5314*
Dummy for transitional zone	0.6346	1.5848*
Dummy for male manager	0.2940	0.4923

*Significant at $p<0.1$

Source: Survey data (1999)

Education and age were used as proxy variables for managerial input. It is expected that increased farming experience and high education would lead to a better assessment of the importance of good farming and decision making including the efficient use of inputs. It is assumed that education and farming experience increases a farmer's ability to seek and use agricultural information and production inputs. However, both of these variables were not significant as determinants of farmers' technical efficiency. Bravo-Ureta and Riegler (1991) in their study of dairy farms also found education and experience not to be significant determinants of technical efficiency. The land area takes into account production inefficiencies arising from differences in the economies of scale. It is expected that increased farm size diminish the timeliness of input use as well as actual inputs available per ha of crop. Efficiency arguments have been in favour of large farm units on the ground that these are more efficient whatever the overall land endowment. These arguments were partly explicit and implicit in the 1954 Swynerton plan for the development of African Agriculture in Kenya (Swynerton, 1954). These arguments are that large farms offer scope for greater efficiency in on-farm resource use, technical innovation is most likely to occur in large farms while large farms will also provide scope for marketing economies through bulk purchase of inputs and sale of produce, dissemination of technical information and improved access to credit. These are based on several assumptions, which are detailed in Hunt (1984). Most of these assumptions are however invalid. Group extension programmes have reduced the cost and scope of extension services to farmers while the economies of scale in agriculture have been difficult to prove. At the same time, credit provision has diversified to include credit to small-scale farmers through crop cooperatives and agricultural finance institutions. These arguments make a positive case for the greater efficiency of small farm agriculture. Extension information is expected to improve farmers' use of inputs as well as provide information on better crop and livestock production practices. The coefficient for extension was positive and significant. Farmers in the transitional tea zone are more likely to operate efficiently as opposed to farmers in the coffee zone. This may be associated to the higher rainfall in this zone and this implies that the technical efficiency may not be independent of the geographical location. Amara *et al* (1999) found no significant relationship between technical efficiency and the geographical location for Quebec potato farmers.

4 Summary of findings, Conclusions and Policy implications

When enterprises were evaluated for their contribution to TVP, tea was found to make the highest contribution to TVP followed by coffee. Cattle made the third largest contribution to TVP while food crops made the lowest contribution. Both tea and coffee had a higher gross margin than the food crops. Among the food crops, potatoes had the highest gross margins. The factors found to have a significant influence on TVP were female labour, land and inputs. An increase of 1Ksh worth of inputs was found to increase TVP by Ksh 9.01. The marginal rate of opportunity cost ratio for inputs was greater than one indicating that too little of inputs was being used in the farming enterprises. This underlines the importance of fertilizers, pesticides and improved seeds in raising agricultural productivity in this region. Average farm technical efficiency was found to be 64% with the highest technical efficiency being in tea (82%) and the lowest being in beans (11%).

Given the irreversible trend in the decline of agricultural land, one feasible way to raise food output is to increase land productivity. The short-term solution is to use more land augmenting inputs such as fertilizers and irrigation. However, the law of diminishing returns is in operation as more physical inputs are applied to shrinking land. Growth of agricultural food production must therefore rely on improvements in technical efficiency. Higher levels of production and productivity however cannot be achieved without improving the income level of farm households. Conditions that are conducive to high levels of efficiency and production including economic incentives, education, and improved nutrition are closely related to incomes.

Given the importance of farm inputs in raising the total value product, future policies should be aimed at increasing rural farmers' access to agricultural inputs at an affordable price as a strategy to increase agricultural production. There has been a methodological debate on the appropriateness of using cross sectional data in measuring technical efficiency. For a more comprehensive analysis of a comparison of technical efficiency in male and female managed farms, a data set covering more years, larger sample and more information on farm and farmer characteristics as well as the different management strategies employed by farmers would be better to draw more firmer conclusions than have been drawn in this study.

References

Acland, J.D. (1971) *East African Crops*. Food and Agriculture Organization.

Barlett, P.F. (1980) Cost benefit analysis. A test of alternative methodologies. In: *Agricultural Decision Making. (Edited by Barlett, P.F.)* Academic Press, San Fransisco.

Bindlish V., Evenson, R. and Gbetibouo, M (1993) *Evaluation of T&V-based extension in Burkina Faso.* World Bank Africa Technical Department Paper No. 226. World Bank, Wahington DC.

Bindlish, V. and Evanson, R. (1993) *Evaluation of the performance of T&V extension in Kenya*. World Bank Technical paper No. 208. World Bank, Washington DC.

Blarel, B., Hazell, P., Place, F. and Quiggin, J. (1992) The economics of farm fragmentation: evidence from Ghana and Rwanda. *World Bank Economic Review* 6 (2), 233-254.

Bravo-Ureta, E.B. and Evanson, R.E. (1994) Efficiency in agricultural production. The case of peasant farmers in eastern Paraguay. *Agricultural economics* 10, 27-37.

Bravo-Ureta, E.B. and Riegler, L. (1990) Alternative production frontier methodologies and dairy farm efficiency. *Journal of Economics* 41, 215-226.

Bravo-Ureta, E.B. and Riegler, L. (1991) Dairy farm efficiency measurement using stochastic frontiers and neoclassical duality. *American Journal of Agricultural Economics* 73, 421-428.

Burfisher, M.E. and Horenstein, N.R. (1985) *Sex Roles in the Nigerian Tir Farm Household*. Kumarian press, West Hartford.

Cadelina, R. (1985) *Reproduction patterns, household developmental cycle stages and participation of household members. The case of lake Balinsasayao lowland migrant upland farmer*. Working paper, University Research center. Philippines.

Coyler, D and Jimenez, G. (1971) Supervised credit as a tool in agricultural development. *American Journal of Agricultural Economics* 53, 45-73.

Dawson, P.J. (1985) Measuring technical efficiency from production functions. Some further estimates. *Journal of Agricultural Economics* 36, 31-40.

Food and Agriculture Organization (1995) *Forest resources assessment 1990; Global Synthesis*. FAO forestry paper No. 124. FAO, Rome.

Gittinger, J.P. (1982) *Economic analysis of agricultural projects*. John Hopkins University Press. Baltimore.

Gyekye, A.B. and Whyte, C. (1977) *An evaluation of institutional credit and its role in agricultural production in Ghana*. Petersburg, Virginia.

Heady, E.O. and Dillon, J (1961) *Agricultural production functions*. Iowa State University Press. Iowa.

Jacoby, H. (1993) *The economics of polygyny in Sub-Saharan Africa: female productivity and the demand for wives in Côte d'Ivoire*. Department of Economics, University of Rochester, NY.

Jamison, D. and Lau, L. (1982) *Farmer education and farmer efficiency*. John Hopkins Press for the World Bank.

Karilajan, K.P. (1991) The importance of efficient use in the adoption of technology. A micro panel data analysis. *Journal of Productivity Analysis* 2, 113-126.

Leach, M. (1991) Engendered Environments. Understanding Natural Resource Management in the West African Forest Zone. *IDS Bulletin* 22, 17-24.

Maxwell, S. (1984) *The role of case studies in farming systems research*. IDS Discussion paper No.198.

Moock, P. (1976) The efficiency of women as farm managers in Kenya. *American Journal of Agricultural Economics* 58, 559-583.

Navera, E.R. (1978) The allocation of household time associated with children in rural households in Laguna, Philippines. *The Philippines Economic Journal* 17, 203-223.

Price, E.C. and Barker, R. (1978) The time distribution of crop labor in rice based cropping systems. *The Philippines Economic Journal* 17, 224-243.

Quisumbing, A.(1996) Male-female differences in agricultural productivity. Methodological issues and empirical evidence. *World Development* 24, 1579-1595.

Saito, K.A., Mekkonen, H. and Spurling, D. (1994) *Raising the productivity of women farmers in Sub-Saharan Africa.* World Bank.

Salami, A.K (1988) The impact of formal agricultural credit on small scale farm development in the Ashante region of Ghana. *Eastern African Economic Review* 4, 1-7.

Udry, C., Hoddinot, J., Alderman, H and Haddad, L. (1995) Gender differentials in farm productivity: implications for household efficiency and agricultural policy. Food Policy 20, 407-423.

Wollenberg, E. (1988) An evaluation of methodologies used in time allocation research. In: *Gender Issues in Farming Systems Research and Extension. (Edited by Poats, S., Schmink, M. and Spring, A.)* Westview Press Inc. pp 127-148.

Yao, S. and Liu, Z. (1998) Determinants of grain production and technical efficiency in China. *Journal of Agricultural Economics* 49, 171-184.