Measuring Male-Female Productivity Differentials in Ethiopian Agriculture: Policy Implications for Improving the Livelihood of Female Farmers.

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The authors dedicate this paper to the memory of Kenea Yadeta
who passed away soon after this paper was written.

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Abstract

An understanding of the efficiency with which women farmers are operating, particularly where they account for the largest share of the labor force required for agricultural production, is essential for designing appropriate policies to improve the overall performance of agriculture as well as the livelihood of women farmers. This paper contributes to the gender productivity debate by drawing on crop production data collected in three districts (Ada, Akaki and Gimbichu) in East Shoa, Ethiopia during the 1999/2000 cropping season through detailed multi-visit surveys of 80 farm households of which 39 were female-headed households. Using the Tornqvist-Theil index, Total factor productivity (TFP) is measured to analyze crop production efficiency differentials between male and female headed households. The analysis demonstrates that there is little evidence that male-female differences per se account for productivity differentials in crop production. The results imply that the variation in overall TFP can only arise due to differentials in access to the quality of human and physical resources and services, and differential control of the benefits from output by women versus men. Hence, appropriate institutional frameworks that reduce cultural and social barriers associated with women farmers' access to such resources and benefits should be developed. Policies targeted towards increasing female farmers' access to education, extension services, credit, adequate amount of quality land and other resources including control over the benefits, will improve the overall productivity and livelihood of female farmers.

JEL codes: D2, Q12, and Q18.

Keywords: Agricultural efficiency, total factor productivity, gender, Ethiopian agriculture.

Introduction

Despite an increase in empirical studies on the relative efficiency of male and female farmers, empirical studies that actually measure productivity differences between male and female-headed households have been limited. Total factor productivity (TFP) – changes in output for a given level of total input – is a useful approach for measuring the relative differences in productivity between male and female farmers. This paper examines gender and productivity relationships by analyzing TFP differences across female[5] and male headed farm households in the central highlands of Ethiopia. In Ethiopia, women head about 22 percent of families, and account for 30-40% of the agricultural labor force (SIDA cited in Almaz, 2000). Women farmers provide around 50-58% of the total labor time required for crop production in most parts of the country (Wudnesh, 2000). By studying agricultural productivity differences, this paper attempts to shed light on appropriately designing policies not only to improve the overall performance of agriculture but also to identify suitable policy interventions for enhancing the productivity and livelihood of female farmers. The advantage of the household based approach is that it allows correcting for the difference over the control of benefit within a household, which could explain the efficiency differential between males and females within a household where differences over control of benefit do exist. This study is carried out in three districts in the eastern Shewa zone of Oromia Regional State, namely Ada, Akaki and Gimbichu, which are located 1900 meters above see level (masl), 2200 masl, and 2450 masl respectively and are relatively better positioned in terms of infrastructure and market access.

[5] Female headed households were those who were managed by a widow, or a single or divorced woman without the mediation of a husband, father or male relative in crop production, while male headed households were those where a husband was present and he made the final decision in the crop production process.

Estimating male-female differentials in total factor productivity

Total factor productivity is defined as the ratio of aggregate output produced within a given time period to aggregate inputs used in the production process during the same time period. The advantage of the total factor productivity method is that it allows estimation of the land productivity differential between male versus female headed households with multiple outputs while controlling for the difference in input levels. Growth accounting methods are preferred to econometric methods for three merits (Gavian and Ehui, 1999). First, they avoid the problem of degrees of freedom and statistical reliability in working with small samples, which consequently permits the use of detailed data with several inputs and output categories regardless of the number of observation. Second, they do not require the aggregation of outputs into a single index and the output and input separability assumption. Third, both econometric and index number methods are the same under certain technical and market conditions.

The major difficulty with the index number approach is to derive aggregate output and input measures that represent the numerous outputs and inputs involved in most production processes. An index number that is exact for linear homogenous flexible functional forms (Christensen et al., 1971) is used. The class of indices with this property has been termed "superlative" by Diewert (1976). The most popular indexing procedure is the Divisia index, which is exact for the case of homogenous translog functions (Capalbo and Antle, 1988). The translog function does not require inputs to be perfect substitutes, but rather permits all marginal productivities to adjust proportionally to changing prices.

To calculate total productivity measures, the paper makes use of equation (1) where the expression q_{io} is the Tornqvist–Theil approximation (Tornqvist 1936; Capalbo and Antle 1988) to the change in

productivity levels due at a particular point in time. The difference in the TFP of male versus female headed households is a function of the differences in the output differential (the first expression on the right hand side) and factor intensities (the second expression on the right hand side):

$$q_{io} = \frac{1}{2}\sum_{j}[r_{ji} + r_{jo}]\left[Ln\left(Q_j\right)_i - Ln\left(Q_j\right)_o\right] - \frac{1}{2}\sum[S_{ki} + S_{ko}][Ln(X_{ki}) - Ln(X_{ko})] \qquad (1)$$

where, r_{ji} and r_{jo} denote the jth output revenue share in systems *i* and *o*, respectively; Q_j denotes the jth output level; S_k represents the cost share for the kth input; and X is a vector of factor inputs. So it can be seen that the Tornqvist index, in equation (1), which is an approximation of the Divisia index is exact for a homogenous translog production function.

As explained above, TFP is the residual, or the portion of change in output levels not explicitly explained by changes in input levels. However, increases in factor intensities may occur without any increases in TFP. Changes in TFP levels and factor intensities are not independent but they are of different significance. Increases in TFP will occur if output increases proportionally more than increases in factor intensities. But increases in output that are due to increases in factor intensities are qualitatively (although not quantitatively) less significant than changes in TFP. Indeed output will increase if a farmer applies more purchased inputs. Unless there are improvements in the use of these inputs, this will be a change in factor intensity and not TFP. It is clear that with TFP changes, in contrast with factor intensity differentials, the farmer's capability to produce more with the same resources has improved.

Data collection and transformation

Data collection was carried out during the 1999/2000 cropping season. Farm households were identified using a multistage sampling procedure, where 41 development stations were first identified randomly and then 41 peasant associations (PA) were randomly selected, and finally a male headed household and a female headed household were randomly picked from each PA. The number of farm households sampled totaled 21 in Akaki, 29 in Ada and 30 in Gimbichu. In Akaki and Ada districts, female-headed households accounted for 48 % while in Gimbichu they accounted for 50 % of the sampled farm households.

A mixed crop-livestock production system is practiced in the study districts. Major crops include cereals and pulses, while the major livestock are cattle, small ruminants and equines. All types of crops produced are considered as output while inputs consist of land, ox power, chemical inputs, seed and labor. Grain and seed prices were drawn from the weekly survey of producer prices in three major markets nearby (Debre Zeit, Akaki and Chefedonsa); prices for labor and ox power were based on the average market rates; while prices for other inputs were obtained from the household survey. The implicit price indices for output were calculated by dividing the total output value by the implicit output quantity indices (derived by weighing individual output quantities by the revenue share of each output). Similarly, implicit input quantity indices were calculated by dividing the total cost of inputs by the implicit price indices of inputs (derived by weighing individual input prices by the cost share of each input). All inputs and outputs entered calculations on a per hectare basis so that output and input components are interpreted as land productivity and factor intensity, respectively.

Results

Table 1 shows TFP, land productivity and factor intensity levels for female-headed households relative to male-headed households. In terms of TFP, there is little difference between the two types of households. Female-headed households had a 3% lower TFP level than male-headed households meaning female-headed households produced 3% lower output than male-headed households using the same bundle of inputs. Female headed households produced 1% lower per hectare than male headed households in terms of land productivity. When land productivity is decomposed into outputs of different crops, female-headed households achieved a higher level of land productivity for other cereals and other pulses, which is 21% and 16% over the male-headed household levels respectively. In all other crops male-headed households produced relatively higher output per hectare than female-headed households. Differences between male and female-headed households with respect to land productivity for specific crops are attributed to higher intensity of inputs used.

Considering overall factor intensity levels, female-headed households used 2% more bundle of inputs than male-headed households with a lower intensity of chemical inputs (9%) and labor input (5%), but a higher intensity of seed use (6%) and 1% more use of ox power compared to male-headed households. The government (Ministry of Agriculture and Rural Development) provides most of the fertilizers, herbicides and insecticides on credit basis. The involvement of private traders in the distribution of these inputs is minimal. Thus, the lower intensity of chemicals for female-headed households may be due to lower access of female-headed households to private credit relative to male-headed households. Credit service in the informal sector is not competitive and charges a prohibitive interest rate that limits the access of female-headed households to this source of credit.

The overall implication of the TFP results is that female-headed households are almost equally efficient as male-headed households in crop production. This result is in agreement with the results of previous studies by Moock (1976) as well as Bindlish and Evenson (1993) in Kenya, Bindlish et al. (1993) in Burkina Faso, Saito et al. (1994) in Kenya and Nigeria, Adesina and Djato (1997) in Cote d'Ivoire, and Addis et al. (2000) in Ethiopia.

Farm household endowment of physical and human resources as well as access to services is analyzed to find out whether it provides supporting evidence for the productivity and input intensity results (table 2). The premise here is that as long as gender differences do not contribute to efficiency differentials, given equal endowments of all resources and equal access to all services, both male and female farmers are equally productive with similar intensity of inputs used. There is a significant difference in terms of the total cropland cultivated by male versus female headed households. Family size is also significantly different between the two groups, with larger families in male-headed households. A look at the ratio of cultivated crop farm to family size however shows no statistically significant difference between the two household groups. The significant difference between the two types of households in terms of the area under improved varieties of wheat, teff, lentil and chickpea may explain the higher intensity of chemical inputs on male-headed household farms since improved varieties require more chemical inputs than local varieties.

With regards to the quality of land, there is no statistical difference in terms of endowment of Merere (Vertisol) soil, which is the most productive of all soil types in the area. Significant difference is only observed in the endowment of Gombore soil (red light soil). Both groups had no difference in terms of the size of flat and gentle slopes although there was significant difference regarding steep slopes. The land tenure structure reveals statistically significant differences in

terms of farm area shared and rented-in, but together both account for a small and nearly the same proportion of the cultivated cropland across male and female headed households. Thus, the contribution of land tenure arrangements to the differences in production efficiency is expected to be minimal in this case, although empirical studies such as Gavian and Ehui (1999) and Corppenstedt and Abbi Mammo (1996) report mixed results.

Male-headed households had more numbers of livestock and oxen (both statistically significant). The importance of livestock capital in terms of its contribution to efficiency differentials and/or overall input intensity is expected to be limited. Although livestock capital may have an impact on access to credit (serves as collateral), other working capital and manure, most of the farms largely use manure for firewood and the government provides credit for inputs like fertilizer regardless of gender. A study by Addis et al. (2001), done in the same study area as that of this paper, reports that the amount of credit offered is based on the size of cultivated land owned by the farmer, and thus the amount of credit received varies with farm size. These authors show that female-headed households in Ada and Gimbichu areas received smaller amounts of credit from banks and cooperatives than their male counterparts, and that differences may exist in terms of access to private credit sources. With regards to the possible effect of the differences in oxen ownership, the mean oxen-to-cultivated-land ratio is almost the same between the two groups of households with no statistically significant difference. Hence the variation in production efficiency between male and female households that could possibly arise from differences in the endowment of oxen is limited.

In terms of access to the quality of human capital, which can be measured in terms of education levels and farming experience (for which the age of the farm household may serve as proxy), there is no statistically significant difference between the two groups of households. This implies that the

efficiency of decision making and the effect of this on production efficiency are similar across male and female headed households. There is however a statistically significant difference in terms of the proportion of farm household heads that can read and write. Similar differential access to education, endowment of farm size and the number of livestock has been reported in Addis et al. (2001) and elsewhere in Sub-Saharan Africa (Due and Gladwin, 1991; as well as Mollel 1986 and Sikapande 1988 cited in Gladwin, 1996).

Conclusion

This paper presented an application of the Tornqvist–Theil approximation to the Divisia index in male and female headed farm households in Ethiopia. The results indicate that there is little evidence that male-female differences per se account for productivity differentials in crop production. Both land productivity and factor intensity were nearly the same for both male and female headed households. An inventory of physical and human resources and access to services of male and female headed households revealed that they both had nearly equal access to the required physical and human capital as well as services. Overall TFP gaps can therefore only arise due to differentials in access to the quality of human and physical resources and services and the differential in control over the benefit by women versus male headed households. Thus, it is not the inability of women farmers to respond to economic incentives that results in the lower productivity of female headed farm households. Policies that increase female farmers' access to education, extension services, credit, adequate amount of quality land and other resources as well as the control over the benefits, will improve the overall productivity and thereby the livelihood of female farmers. Appropriate institutional frameworks that reduce cultural and social barriers associated with women farmers' access to such resources and benefits should be developed.

References

Adesina, A. A., K .K. Djato, 1997. Relative efficiency of women as farm managers: Profit function analysis in Cote d'Ivoire, Agric. Econ. 16, 47-53.

Addis Tiruneh, Teklu Tesfaye, Verkuiji, H., and Mwangi, W., 2000. Gender differentials in agricultural productivity among smallholders in Ada, Lume and Gimbichu weredas of the Central Highlands of Ethiopia. In: Yeshi Chiche and Teklu Tesfaye (Eds.), Proceedings of the National Workshop on Institutionalizing Gender Planning in Agricultural Technology Generation and Transfer Processes. Ethiopian Agricultural Research Organization (EARO), Addis Ababa, Ethiopia.

Addis Tiruneh, Teklu Tesfaye, Verkuiji, H., and Mwangi, W., 2001. Gender differentials in agricultural productivity among smallholders in Ada, Lume and Gimbichu weredas of the Central Highlands of Ethiopia. International Maize and Wheat Improvement Center (CIMMYT) and Ethiopian Agricultural Research Organization (EARO), Mexico, D.F.

Almaz Eshete, 2000. Why is gender a development issue? In: Yeshi Chiche and Teklu Tesfaye (Eds.), Proceedings of the National Workshop on Institutionalizing Gender Planning in Agricultural Technology Generation and Transfer Processes. Ethiopian Agricultural Research Organization (EARO), Addis Ababa, Ethiopia.

Bindlish, V., Evenson, R., 1993. Evaluation of performance of T& V Extension in Kenya. World Bank Technical papers 208, African Technical Department Series, The World Bank, Washington, DC.

Bindlish, V., Evenson, R., and Gbetibuou, M., 1993. Evaluation of T& V Extension based extension in Burkina Faso. World Bank Technical papers 226, African Technical Department Series, The World Bank, Washington D.C.

Capalbo, S. M., Antle, J. M., 1988. Agricultural productivity Measurement and Explanation.

Resources for the Future, Washington, DC.

Christensen, L. R., 1975. Concepts and measurement of agricultural productivity, American Journal of Agricultural Economics 57(5), 910-915.

Christensen, L.R., Jorgenson, D.W., and Lan, L.J., 1971. Conjugate duality and the transcendental logarithm production function, Econometrica 39, 255-256.

Coelli, T. J., 1993. Recent development in frontier modeling and efficiency measurement, Australian Journal of Agricultural Economics 39(3), 219-246.

Corppenstedt, A., Abbi Mammo, 1996. An analysis of the extent and causes of the technical efficiency of farmers growing cereals in Ethiopia: Evidence from three regions. Ethiopian Journal of Economics 5(1), 39-62.

Diewert, W.E., 1976. Exact and superlative index numbers. Journal of Econometrics 4, 115-145.

Due, J., Gladwin, C., 1991. Impacts of structural adjustment programs on African women farmers and female headed households, American Journal of Agricultural Economics 73(5), 1431-9

Gavian, S., and Ehui, S., 1999. Measuring the production efficiency of alternative land tenure contracts in a mixed crop-livestock system in Ethiopia. Agricultural Economics 20, 37-49

Gladwin, C.H., 1996. Gender in Research Design: Old Debates and New Issues. In: Breth, S. A. (Ed.), Achieving greater impacts from research investment in Africa. Mexico City: Sasakawa Africa Association.

Moock, P., 1976. The efficiency of women as farm managers: Kenya. American Journal of Agricultural Economics 58(5), 831-835.

Saito, K., Mekonnen, H., and Spurling, D., 1994. Raising productivity of women farmers in Sub Saharan Africa, Discussion paper 230, Washington, DC: World Bank.

Quisumbing, A. R., 1996. Male-female differences in agricultural productivity: Methodological issues and empirical evidence, World Development, 24(10), 1579-1595.

Tornqvist, L., 1936. The Bank of Finland's consumption price index. Bank of Finland Monthly

Bulletin 10, 1-8.

Udry, C., Hoddinott, J., Alderman, H., and Haddad, I., 1995. Gender difference in farm productivity: Implications for household efficiency and agricultural policy, Food policy, 20(5), 407-423.

Wudnesh Hailu, 2000. Who is a farmer? In: Yeshi Chiche and Teklu Tesfaye (Eds.), Proceedings of the National Workshop on Institutionalizing Gender Planning in Agricultural Technology Generation and Transfer Processes. Ethiopian Agricultural Research Organization (EARO), Addis Ababa, Ethiopia.

Table 1: Total factor productivity, land productivity and factor intensity of male versus female-headed farm households.

Indicator	Male-headed farm households	Female-headed farm households
Total factor productivity	1	0.97
Land productivity	1	0.99
By crop type:		
Teff	1	0.95
Wheat	1	0.75
Chickpea	1	0.95
Lentil	1	0.71
Other pulses	1	1.16
Other cereals	1	1.21
Residues	1	0.93
Factor intensity	1	1.02
Oxen power	1	1.01
Chemicals	1	0.91
Seed	1	1.06
Labor	1	0.95

Table 2: Physical and human resource endowment of male and female-headed farm households.

Resource	Mean resource endowment by household head		t-value	p-value
	Male	Female		
Cultivated crop land (ha)	3.87	2.72	2.72	0.008
Area under improved varieties (ha)	2.64	1.51	2.95	0.004
Family size	7.33	5.49	2.98	0.004
Cultivated land / family size (ratio)	0.57	0.65	-0.78	0.43
Oxen (number)	3.60	2.50	2.68	0.009
Livestock (TLU)	9.41	6.75	2.77	0.007
Oxen to cultivated land ratio	0.25	0.24	0.30	0.76
Soil types (ha)[6]:				
Merere	2.00	1.60	1.00	0.32
Gombore	0.66	0.33	1.95	0.055
Chere	0.87	0.54	1.63	0.107
Abolse	0.26	0.17	0.81	0.418
Farm with flat slope size (ha)	2.20	1.52	1.65	0.10
Farm with gentle slope size (ha)	1.20	1.08	0.47	0.64
Farm with steep slope size (ha)	0.46	0.12	2.10	0.041
Land tenure (ha):				
Shared in	0.68	0.23	2.173	0.033
Rented in	0.35	0.019	2.30	0.024
Owned	2.78	2.35	1.23	0.223
Number of male household members at elementary school	1.12	0.98	0.57	0.57
Number of male household members at secondary school	0.45	0.30	0.92	0.40
Number of female household members at elementary school	0.62	0.50	0.78	0.87
Number of female household members at secondary school	0.45	0.45	0.16	0.55
Number of male household members with age between 15-60	2.07	1.53	1.85	0.068
Number of female household members with age between 15-60	1.52	1.45	0.41	0.67
Education of household heads (percent that read and write)	92.9%	55%	χ^2 value 15.41	0.000

[6] Soil types are indicated based on farmers' indigenous classification.