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Specific Sessions

The Economics of the Farm Family
(T. W. Schultz, University of Chicago, Chairman)

The Efficiency of Women as Farm Managers: Kenya

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The purpose of the study on which this paper is based is to investigate possible differences between male and female farm managers in the possession of, and means of acquiring, technical information relevant to agricultural production of maize (*Zea mays* or corn), the staple commodity of the area. Technical information is taken to mean knowledge relating to the manner in which inputs are combined. Producers are said to differ in technical efficiency when they experience systematic differences in the output produced from a given combination of inputs.[1] Allocative decision making, which has to do with the quantities of inputs used as distinct from the techniques of input use (cf. Shapiro, p. 2), is excluded from the analysis because of the absence of farm-specific price data.

The section that follows describes the geographic area, giving an explanation of the high proportion of female farm managers (relative to the ratios found in most farming communities, in Africa and elsewhere). Next, the [illegible] are described, and the model is set out in [illegible] terms. The empirical analysis follows, and finally, some conclusions.

[illegible] for this session were Bruce E. Gardner of the [illegible] of Economic Advisors and G. Edward Schuh of Purdue [illegible]

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[illegible] differences, output may be subject to [illegible]

Women as Farm Managers in Vihiga Division

The sample (described more completely by Moock 1973) consists of 152 maize farmers in Vihiga, an administrative division of roughly 200 square miles and 300,000 people in western Kenya. Reflecting the high average population density, the typical holding consists of seven resident members and 2.5 acres.[2] The area's response to population pressure is a pattern of circular labor migration, especially by male household heads. In a random survey conducted in 1971, one-third of farm heads were found to be currently away from the family farm, engaged in or searching for work. The typical farm head has spent nearly a quarter of his total years away. The mean cumulative migration period is eleven years.

In the head's absence, farm management is relegated to another farm family member, usually the wife of the farm head. Vihiga is a notable farm community for its extent of female management. In 1971, 38% of the division's farms were managed by women. Whereas women perform a substantial portion of the physical work on farms throughout Africa, as farm managers the women of Vihiga have assumed considerably more decision-making responsibility than is generally the case.

The Model

The variable list appears in table 1. Wherever meaningful, variables are expressed as area

[2] These are median estimates derived from an earlier probability sample of farms in the division (P. Moock 1971).

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Table 1. Variable List and Summary Statistics

Name	Description	Sample	Male	Female
DV-YIELD	maize output per acre (200-lb bags)	17.6 (5.7)	17.8 (6.1)	17.1 (4.9)
Physical inputs and natural factors				
1. *SCALE*	area planted in maize (acres)	1.6 (1.1)	1.8 (1.2)	1.2 (0.7)
2. *PLNTP*	plant population per acre (1,000 plants)	9.6 (2.3)	9.8 (2.3)	9.2 (2.2)
3. *LABOR*	labor input per acre (hours)	983 (339)	974 (336)	1,002 (346)
4. *CFERT*	chemical fertilizer applied per acre (lbs.)	72.6 (57.8)	79.8 (59.1)	58.5 (52.9)
5. *HYBRD*	planted any of hybrid varieties (0,1)	0.89	0.92	0.84
6. *INSEC*	used insecticide (0,1)	0.31	0.39	0.16
7. *INTER*	interplanted legume among maize (0,1)	0.57	0.51	0.67
8. *SOIL*	Applied fertilizer or left field fallow previous season (0,1)	0.36	0.43	0.24
9. *HAIL*	hailfall damage (0,1)	0.82	0.80	0.84
10. *DAMG1*	moderate damage from erosion or striga weed (0,1)	0.22	0.25	0.18
11. *DAMG2*	severe damage from erosion or striga weed (0,1)	0.09	0.10	0.08
Information proxy variables				
12. *WOMAN*	manager a woman (0,1)	0.34	0	1
13. *SCHL1*	schooling, 1 to 3 years (0,1)	0.34	0.34	0.33
14. *SCHL2*	schooling, 4 years or more (0,1)	0.34	0.43	0.16
15. *MIGR*	migration experience (years)	9.4 (10.8)	12.6 (11.2)	3.0 (5.9)
16. *AGE*	age (years)	48.8 (12.3)	51.8 (12.6)	42.9 (9.3)
17. *XTNSN*	extension contact (index)	178 (92)	191 (98)	152 (72)
18. *LOAN*	loan recipient—special extension services (0,1)	0.43	0.50	0.29

Note: The summary statistics reported are means and, in parentheses, standard deviations. The full sample consists of 152 farm observations, of which 101 are managed by men and 51 by women.

rates, a procedure that reduces collinearity among inputs and transforms X_1 (area planted) into a measure of production scale. An estimate of *YIELD* (shelled and dried maize per acre) was obtained on each farm by sampling the stand and hand harvesting the selected parts of the crop. The mean was 17.6 "bags," which translates approximately as 63 bushels, per acre. All data were recorded during the principal planting season of 1971.

As a first approximation, the production model consists of the single multiplicative equation

$$(1)\quad YIELD = aX_1^{b_1} \ldots X_4^{b_4} e^{(b_5X_5 + \ldots + b_{11}X_{11} + u)},$$

where e is the base of natural logarithms and u is a random disturbance variable. The tractable inputs, i.e., those affected by farmer decisions ($X_1, \ldots, X_8$), and three indicators of natural phenomena (X_9, X_{10}, X_{11}) are defined in table 1.

This model is incorrectly specified if knowledge can be assumed to enter into the production process. If farm managers hold different levels of technical information, and the correlations are nonzero between information and variables X_1 through X_{11}, then the estimates of b_1 through b_{11} are biased. The variables specified as the direct and indirect sources of technical information are formal schooling (X_{13} and X_{14}), experience (X_{15} and X_{16}), and extension contact (X_{17} and X_{18}).[3] In general these are factors found to affect the allocative ability of farmers.[4]

The final information proxy (X_{12}) is the focus of this paper. The right-hand columns in

[3] The appropriate algebraic specification of these variables, in the model "corrected for management bias," is by no means obvious. The equations reported in the empirical section below are the "best performing" of many that were estimated.

[4] See the midwestern U.S. studies by Huffman and by Fane and the general review by Schultz. The effect of educational factors on technical efficiency has been called the "worker effect" of education, as distinct from the "allocative effect" (Welch).

table 1 allow comparison of means (and standard deviations) for the male and female subsamples. On the average, output per acre is smaller for women (17.1) than for men (17.8), but the difference is not significant even at the 0.10 probability level.[5] The absence of a significant difference is provocative when we observe that in general the women use smaller bundles of physical inputs, especially store-purchased inputs, than their male counterparts. They use noticeably less chemical fertilizer (X_4) on average and are less likely to plant one of the hybrid seed varieties (X_5) or to use insecticide (X_6), although the mean labor input (X_3) is marginally higher on female-managed farms than on male-managed ones.

The proof of the pudding, should anyone doubt that these women were more technically efficient maize farmers than the men, is the positive coefficient on X_{12} in a regression equation (not shown) that controls for physical inputs and natural factors, i.e., in the estimation of model (1), with the term $b_{12}X_{12}$ added to the expression in parentheses. The b_{12} estimate is 0.066, suggesting that a woman obtains 6.6% more output at the mean levels of input use than does a man. This coefficient is significant at the 0.10 level.[6]

[5] Geometric means were even closer numerically—16.4 and 16.7.

[6] It falls just outside the critical region for rejection of the null hypothesis at the 0.05 level; the t-statistic is 1.63, and the critical value, 1.66.

The empirical section to follow is an analysis of the male-female efficiency difference. Two questions are explored. (*a*) Do the men and women of Vihiga benefit differentially from schooling, experience, and extension contact? (*b*) Do we observe input-specific productivity differences in the production relationships, for the male and female subsamples, when we have accounted for information sources that shift the relationship neutrally?

Empirical Analysis

The analysis begins with three estimations of a production model in which information sources ($X_{13}, \ldots, X_{18}$) are assumed to affect inputs ($X_1, \ldots, X_{11}$) neutrally. The estimated equations are given in table 2. Equation (*a*) is based on observations of male management only; equations (*b*) and (*c*), on female.[7]

Comparisons of the regression coefficients in equation (*a*) with those in equation (*b*) or (*c*) suggest several intriguing interactions between variables in the equations and the manager's sex, the criterion used in partitioning the sample. Some of these interactions are "tested" in the following equation based on the full sample of 152 farms (a prime indicates

[7] In equation (*c*), the school-extension interaction term is omitted, since the correlation between *SCHL2* and the product variable is 0.998 for women (cf. 0.881 for men).

Table 2. Regression Estimates for Examining Male-Female Differences in Technical Efficiency

Variable	(a) Male (n = 101)		(b) Female (n = 51)		(c) Female (n = 51)	
CONSTANT	0.514		−0.565		−0.585	
SCALE'	−0.078	(−1.46)	0.097	(1.47)	0.097	(1.51)
FUNTP'	0.754	(6.49)	0.462	(3.96)	0.462	(4.02)
LABOR'	0.070	(0.939)	0.153	(1.81)	0.154	(1.86)
CERT	0.034	(2.63)	0.045	(3.01)	0.045	(3.08)
HYBRD	0.135	(1.41)	0.113	(0.996)	0.116	(1.07)
INSEC	0.039	(0.486)	0.278	(2.55)	0.277	(2.59)
FERTLR	0.102	(1.68)	0.053	(0.559)	0.050	(0.555)
SCH	0.097	(1.88)	0.128	(1.61)	0.128	(1.64)
EXH	−0.060	(−0.878)	−0.310	(−2.95)	−0.310	(−3.01)
EXMG1	−0.180	(−3.25)	−0.184	(−2.29)	−0.186	(−2.43)
EXMG2	−0.339	(−4.31)	−0.094	(−0.871)	−0.094	(−0.890)
EXH1	−0.119	(−1.81)	0.187	(2.08)	0.189	(2.13)
EXH2	0.177	(1.37)	0.382	(0.272)	0.209	(2.04)
WEAR	0.0031	(0.329)	−0.017	(−1.64)	−0.017	(−1.66)
EXT	−0.071	(−0.702)	0.325	(1.74)	0.330	(1.85)
EXSCH	0.029	(2.52)	−0.0072	(−0.406)	−0.0075	(−0.434)
EXTN	0.072	(0.721)	−0.440	(−3.38)	−0.444	(−3.58)
SCH2(XTNSN')	−0.033	(−1.45)	−0.034	(−0.122)		
R^2	0.853		0.889		0.889	

Dependent variable is log of *YIELD*. Regression coefficients are given first, followed by t-statistics in parentheses. A prime [illegible] the variable is entered in log form.

3

the variable is measured in logarithms; numbers in parentheses are t-statistics):[8]

$$
\begin{aligned}
(2)\quad YIELD' = {} & 0.461 - \underset{(-1.25)}{0.054}(SCALE') \\
& + \underset{(1.29)}{0.090}(WOMAN)(SCALE') \\
& + \underset{(7.10)}{0.733}(PLNTP') \\
& - \underset{(-1.85)}{0.280}(WOMAN)(PLNTP') \\
& + \underset{(0.998)}{0.056}(LABOR') \\
& + \underset{(2.15)}{0.108}(WOMAN)(LABOR') \\
& + \underset{(4.17)}{0.039}(CFERT') + \underset{(1.38)}{0.100}(HYBRD) \\
& + \underset{(1.58)}{0.098}(INSEC) + \underset{(1.90)}{0.091}(INTER) \\
& + \underset{(2.17)}{0.087}(SOIL) - \underset{(-2.16)}{0.121}(HAIL) \\
& - \underset{(-4.25)}{0.187}(DAMG1) - \underset{(-4.70)}{0.299}(DAMG2) \\
& - \underset{(-1.95)}{0.112}(SCHL1) \\
& + \underset{(1.98)}{0.167}(WOMAN)(SCHL1) \\
& + \underset{(2.02)}{0.215}(SCHL2) + \underset{(2.82)}{0.030}(XTNSN') \\
& - \underset{(-1.92)}{0.038}(SCHL2)(XTNSN') \\
& - \underset{(-1.50)}{0.028}(WOMAN)(XTNSN') \\
& - \underset{(-0.784)}{0.061}(LOAN), \quad R^2 = 0.705.
\end{aligned}
$$

Whereas a little schooling (one to three years) is associated with higher yields for the women in our sample, this does not apply to the males. In the men's case the relationship appears to be an inverse one between some schooling and technical efficiency. On the other hand, those who have attained four or more years in the formal system, men and women alike, do obtain more output per unit of input on average than do farmers who have not been to school.[9]

Equations (b) and (c) in table 2 suggest that migration experience (years away from home) is a detriment to a woman's technical skills as a farmer, though the coefficients on $MIGR'$ are not significant in two-tailed tests.[10] There is no indication in equation (a) that prior absence affects a male manager's skills in one direction or the other. A reasonable interpretation of this is that men, when they "go to town," typically leave the family at home and, through visits and correspondence, manage to keep informed about the farm. Women who migrate are usually accompanied by husband and children. With no immediate family left on the farm, they do not learn of new techniques in farming. The equations in table 2 indicate that the manager's age correlates positively with technical efficiency, as predicated, but only for women.[11] The correlation does not exist for men. These interactions, while interesting, are weak and do not hold up in any equation based on the full sample. Thus, the experience variables are left out of equation (2).

Equation (2) indicates that exposure to the Ministry of Agriculture is associated with greater technical efficiency, provided the farmer is male and not too well educated. The elasticity with respect to $XTNSN$ is 0.03 for males with three years or less of schooling, but the effect vanishes for men with four or more years attainment and is not present in the case of women.[12] All else being equal, the possession of a government loan for the purchase of maize inputs (seed, fertilizer, and insecticide) is associated, in table 2, with smaller yields for female managers—a paradox since loan recipients were to be given close supervision.

In table 2 there are some apparent differences between the male and female subsamples in the size of the effects of various inputs on the output measure. Two of the differences are significant, and one nearly so; these appear in equation (2). The women seem to have made better use of labor in the production of maize than the men; they benefited less from

[8] The dummy variable $WOMAN$ does not appear by itself in equation (2). When added, its coefficient, while positive, is not significant, nor is the coefficient on the female-labor product variable (the two are correlated at 0.997).

[9] Taking the partial derivative of equation (2) with respect to $SCHL2$ and using the mean value of $XTNSN'$ (4.348) yields $\partial YIELD'/\partial SCHL2 = 0.177 - 0.033(4.348) = 0.034$. Judging from table 2, this estimate probably understates the effect of $SCHL2$ for women, though not for men.

[10] The sign of b_{11} could not be predicted a priori, since the content of migration experience is nowhere indicated in the data set although this dimension is known to vary substantially across farm managers.

[11] Age (migration time held constant) serves as a measure of experience on the family farm and, at least as such, should be a direct indicator of production knowledge.

[12] The index $XTNSN$ is based on five binary indicators of extension contact. "Since this time last year, have you . . ." (a) been to consult a Ministry of Agriculture (MOA) instructor? (b) been visited by a MOA instructor? (c) attended a MOA crop demonstration? (d) attended a MOA animal demonstration? (e) attended a course at a Farm Training Center? The procedure used to weight indicators is described elsewhere (P. Moock 1973, pp. 160–65).

the density of the maize stand (*PLNTP*). The returns to production scale appear positive for women and negative for men, although in neither case is the effect significantly different from zero. *Ex post* explanations of these differences are highly speculative and are not attempted in this paper.

Conclusions

This paper has looked at sex-linked differences in production knowledge on the part of small-scale maize farmers in an area of Kenya. If such differences do exist, they are likely to be quite local and transitory. The hypotheses tested here relating to male-female differences in technical efficiency are nondirectional ones. To conclude, the findings are summarized and some interpretations are advanced.

First, the impact of schooling on output, other factors remaining the same, is greater for the women than for the men. The men who had been to school for just a few years performed worse on the efficiency criterion than those who had never been to school. The author concludes that literacy and numeracy, skills emphasized in primary education, are applicable to the acquisition of information used in small-scale farming, as evidenced by the schooling-output relationship for women.

The men who advance further in school are more likely to participate in the search for off-farm employment. Generally, it is only the more able individuals who find and keep jobs. Thus, men found managing farms despite educational credentials may have lower than average ability. This selection mechanism biases the male subsample with respect to the overall ability distribution but probably does not apply to the women, who are seldom expected to find work off the farm. It may also not apply to men with four or more years of school. These very educated men often find off-farm employment locally (e.g., as shopkeepers or primary teachers), which allows them to look after their farms at the same time (J. Moock).

Another striking finding has to do with the impact of the extension services on farming. The women seem not to benefit, as the men do, from extension contact, perhaps due to the marked male orientation of the services as provided by Kenya's Ministry of Agriculture. The staff consists almost entirely of men, the few exceptions dealing exclusively with "home economics" (nutrition and health). Moreover, much of the ministry's agricultural instruction takes place at the chiefs' *barazas* (regularly held meetings), attendance at which is seen particularly as the prerogative of male elders. Although women do attend, their participation is limited. The ministry makes scant use for instructional purposes of the churches, in which women play a much more active role.

Some farmers in the sample received maize input loans in 1971, granted through the ministry in conjunction with Kenya's Agricultural Finance Corporation. As credit recipients they qualified for special extension services. The loans were extended that year as part of an experimental rural development program. In planning the program, the government staff was divided, a vocal minority arguing against the inclusion of women, whose farming skills and whose obligation to repay debts (under existing laws) were considered dubious. Although this view did not prevail, and some women received credit, this skepticism may have exacted its toll, since the women with loans got smaller yields on average than did the women without them.

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5