Welfare impacts of technological change on women in southern Mali

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Abstract

It has often been hypothesized that new agricultural technologies could have an adverse impact on women because additional labor required of them reduces the time spent and therefore income earned from private-field activities. This study shows that the expansion of cotton cultivation on the household communal fields in southern Mali associated with the introduction of new technologies results in increased payments to women for their increased labor on the cotton fields. Unfortunately, these payments are small compared to the loss of revenue from private-plot production. Thus, the net effect of the expansion of household cotton cultivation is a reduction in incomes of women who cultivate private plots. Short-run policy implications of this study are that improving women's income requires concern with their private-plot earnings. For example, profitability of the private-field crops could be increased with higher input use. In the long run, as land becomes even more constrained, emphasis needs to be placed on institutional changes to increase women's bargaining power so that they obtain larger shares of the new income streams resulting from technological change on the communal field. Institutional changes already occurring in the region, with the apparent objective of increasing women's (and non-household head men's) bargaining power, include organized work teams and the movement toward smaller, nuclear families. © 1998 Elsevier Science B.V. All rights reserved.

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1. Introduction

In Mali, most resources and revenues of the farm household are managed by the male head of household. Household members work on the communal lands and, when sufficient land is available, are allocated private plots for their own income and for additional food-consumption. 'Communal land' refers

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to land cultivated collectively by the members of the household, and 'private plot' refers to individually operated fields. The principal cereal production and cash-crop activities of the household take place on the communal fields. Some of the private-plot products are sold but private-plot production is generally a secondary activity of the household, although very important to women. Family members can work on their private plots only after they have fulfilled their other household and communal-field labor obligations.

Since the introduction of most new technologies requires an increase in communal-field labor supply,

household members must reduce their labor in other activities or their leisure to meet the increased demand for communal labor. New agricultural technologies that increase labor demand on family fields may have an adverse impact on the income controlled by women resulting from the reduction of women's income from private-plot activities (Buvinic and Mehra, 1990; Kennedy and Cogill, 1987; Kumar, 1987; Lewis, 1988; von Braun, 1989).

Using 1994–1995 survey data from southern Mali, this study estimates the income gains and losses from reallocation of women's labor from private production to communal production. First, we compare income gains of the private plot-producer women and non-private plot-producer women from their increased labor contribution in communal production. These wage payments are based upon the coefficient estimates from the empirical model for the change in wage rate due to technological change (Lilja, 1996; Lilja et al., 1996). Second, the income losses due to the reduction in private-plot labor allocation are compared with the increased wage payments for the increase in communal labor allocation. Then, policy implications and a discussion of the dynamics of the technological-change process in southern Mali are presented. Finally, some concluding observations are made.

2. Labor and wages of private-plot and non-private-plot producers

Sixty-two percent of our sample of 52 women-cultivated private plots. In the more land-abundant area of Bougouni, all the women in the sample had access to a private plot. The production system in San is constrained by the scarcity of arable land, and only 10% of the women cultivated private plots there.

The average woman cultivating a private plot is 38 years old with three children. In contrast, the average non-private plot-producer woman is 24 years old with one child. The form of compensation for communal labor (land, money, in-kind) chosen by the head of household varies and may reflect each woman's personal characteristics. Older women with more dependents are less mobile to engage in off-farm activities and have a greater responsibility to produce family dietary supplements than younger women with fewer dependents.

In general, the private-plot producers work more days in communal production than the non-private-plot producers, except in Sikasso (Table 1). In Sikasso, the private-plot area cultivated by women is considerably larger than in other regions. Women in Sikasso are highly specialized in labor-intensive rice production. Women in the other regions produce a larger variety of crops on their private fields, especially groundnuts and vegetables.

Communal wages are undervalued by omitting the value of subsistence cereals given to all family members. If the subsistence allowance is added to the communal wages, the gap between communal and private-field wages is reduced. The total value of the subsistence allowance is 28 FCFA/day (500 FCFA/US$). This is based on the household caloric intake valued at local market prices, with 0.5 kg of cereal consumption per day for 365 days valued at 56 FCFA/

Table 1
Women's communal labor and average returns to labor

Region	Private-plot producers[a]			Non-private-plot producers[b]		
	L_c (days/years)	w_c (FCFA/day)	$w_c + s_c$ (FCFA/day)	L_c (days/years)	w_c (FCFA/day)	$w_c + s_c$ (FCFA/day)
Koutiala	90	18	132	46	110	332
Sikasso	38	47	316	87	59	176
Fana	114	34	124	64	179	339
Bougouni	54	39	228	–	–	–
San	–	–	–	45	77	304
Sample average	75	32	168	58	83	259

L_c = communal-field labor, w_c = communal-field wage, s_c = subsistance allowance.
[a] $N = 32$, 500 FCFA/US$.
[b] $N = 18$, 500 FCFA/US$.

kg (DNSI, 1994; Perquin, 1993). Given that the subsistence allowance is paid daily but communal labor is seasonal, the value of the subsistence allowance is adjusted to actual days worked (Table 1).

Family members are expected to work on the communal field in return for the subsistence cereal. However, it is unlikely that the head of the household will deny any member of the family his or her subsistence allocation even in the case of refusal to work on the communal field. Hence, the subsistence allowance is considered to be fixed and not influenced by the variables determining the wage rate for communal labor.

Except in Sikasso, the non-private-plot producers received considerably higher communal daily wages than the women who had access to private land. There is a high negative correlation between the area of private plot and the communal wages. Hence, the private-field area is apparently part of the compensation for work on the communal fields when there is sufficient land area to allocate private plots.

Although women do not own their private land, the women's user-rights for her private land confers some implicit land rent from private production. Social customs dictate that women must produce the vegetables and spices needed for the 'sauce' to supplement the household staple (cereals). This 'obligatory' production is a rent for use of a private field. Separating the obligatory production from private-plot production was not possible.

Returns to labor and land in private-plot production are very high in every region compared to the wage for labor in communal production (Table 2). In Bougouni, women grew considerable amounts of groundnuts and rice on their private fields and in Sikasso rice. In the other three regions, they concentrated on vegetable

production. After the devaluation of January 1994, domestic rice prices increased moderately but were still controlled by the government; groundnut prices were not controlled and increased substantially.

The average returns to women's labor in private production are clearly higher than the returns to their labor in communal production. The relevant questions are: Why would a rational woman allocate labor to communal production? Or why do we not see members of the extended family allocating their labor by equating the marginal returns in various income-generating activities? Apparently, the head of household is able to impose a minimum communal labor requirement on the members of the household. This minimum communal labor requirement is expected to depend upon the bargaining ability of the woman, her age, and the size of the total household labor pool.

3. Change in net income due to technological change

Assuming that women's labor allocation to all other activities is fixed, the relevant welfare question is whether, in the presence of the technological change in the communal field, the resulting income increases in communal field (Δy_c) are larger, smaller, or equal to the income reduction in the private field (Δy_p) due to the change in labor allocation from private to communal field.

The change in communal income due to technological change is measured by the change in the communal wage rate (Δw_c) multiplied by the days worked in the communal field prior to the technological change (L_c) plus the wage rate (w_c) multiplied by the change in communal days worked (ΔL_c).

$$\Delta y_c = \Delta w_c L_c + w_c \Delta L_c$$

where:

$$\Delta w_c = \frac{\partial w_c}{\partial a_c} \text{ and } \Delta L_c = \frac{\partial L_c}{\partial a_c}$$

The technological change in the communal field (∂a_c) considered in this study is the expansion of the area of cotton cultivation. The cotton parastatal, Compagnie Malienne pour le Développement des Textiles (CMDT), extends 'technology packages' to farmers. These 'packages' consist of new cultivars, higher

Table 2
Women's average and total returns to labor in private production

Region	y_p/L_p (FCFA/day)	y_p (FCFA/year)
Koutiala	751	14,920
Sikasso	790	99,943
Fana	912	6356
Bougouni	1738	65,060
Sample average	1049	37,446

y_p=private-plot income.
L_p=private-plot labor
N=34, 500 FCFA/US$.

levels of inorganic fertilizers and insecticides. Improved agronomic practices, including higher plant densities, also accompany the higher input levels. CMDT distributes the inputs to farmers, monitors and enforces the use of recommended input levels and agronomic practices, and markets the output.

The change in private-field income (Δy_p) resulting from the change in technology on the communal field is measured by the change in private-field labor allocation (ΔL_p) multiplied by the average returns to labor in private production (y_p/L_p). Using marginal returns to labor would be preferred for this calculation. However, obtaining marginal returns would require estimation of the private-field production function, which is not possible due to data limitations. Instead, our calculation uses average returns to labor, thus assuming constant returns to scale with average returns equal to marginal returns. The change in value of output from the private plot depends upon reduced labor on the private plot multiplied by the average net product, where gross private-plot output is q_p, input use is x_p, and p and c are their respective prices.

$$\Delta y_p = \Delta L_p \left(\frac{y_p}{L_p} \right)$$

where:

$$\Delta L_p = \frac{\partial L_p}{\partial a_c} \quad \text{and} \quad y_p = pq_p - cx_p$$

4. Communal income change due to technological change

The cultivation of a hectare of cotton in southern Mali requires approximately 597 h of human labor

Table 3
OLS results, determinants of women's communal wages

Variable	Estimate	T-ratio
Area under cotton	28.734	4.167[a]
Right to refuse	62.869	2.256[b]
Opportunity cost	0.00092	2.361[b]
Area of private plot	−77.302	−3.122[a]
Household size	−2.053	−1.993[b]
Constant	5.3178	0.225

Dependent variable: women's daily communal wage, $N=52$, R^2-adjusted=0.37.
[a]Significant at 1% level.
[b]Significant at 5% level.
The estimation using a sub-sample of women with private fields gives a coefficient of 16 for the area under cotton (significant at 1% level).

(Coulibaly, 1995). If the work load is equally distributed among the nine adult members of the family, an additional 64 h is required for each household member (or eight 8-h days).

The average cotton area cultivated in the sample households is 2.7 ha. For empirical illustration, the impacts of a 0.5 ha increase in the cotton area on the communal income for private plot-producer and non-private plot-producer women are estimated. The coefficients for the change in communal wage rate (Δw_c) due to the increase in cotton area are obtained from Lilja's work (Table 3; Lilja, 1996; Lilja et al., 1996). Significant determinants of the women's communal wages were: the cotton area, the woman's ability to bargain, and the opportunity cost of woman's time.

In Table 4, the first and second columns show the predicted communal income increases for private-plot and non-private-plot producers due to a cotton area increase of 0.5 ha associated with the technological

Table 4
Estimated changes in communal income due to an increase in cotton area

Region	Private-plot producers[a] Δy_c (FCFA/year)	Non-private-plot producers[b] Δy_c (FCFA/year)
	$\Delta L_c=4$	$\Delta L_c=4$
Koutiala	792	1084
Sikasso	492	1454
Fana	1048	1612
Bougouni	588	–
San	–	938
Sample average	728	1144

[a]$N=32$, $\Delta w_c=8$ FCFA, 500 FCFA/US$.
[b]$N=18$, $\Delta w_c=14$ FCFA, 500 FCFA/US$.

change package. Holding other determinants of women's wages constant, the benefits to each woman from the expansion of cotton production by 0.5 ha are very small.

5. Income gains and losses for private-plot producers

The opportunities for rural women to earn income from off-farm activities are very limited in all regions of southern Mali. If women have access to land, the cultivation of private plots is presently their most profitable alternative for their time.

If the increase in communal labor participation results in an equivalent reduction in the private-field labor participation, the women in all four regions are worse off in terms of net income change (Table 5, column 2). If only half of the increase in communal labor allocation is met by reduction in private-plot labor ($\Delta L_p = 2$) and the other half by reducing leisure or increasing efficiency in other activities, the women in all regions are still worse off in terms of net income gains (Table 5, column 3). However, if private-field labor in Koutiala and Fana is reduced only one-fourth or one day ($\Delta L_p = 1$), the income gains exceed the losses (Table 5, column 4). These two villages represent the older cotton-producing regions, and the higher communal wage payments there may reflect the gradual evolution of higher payments to women over time once the new technologies have been introduced.

If women in Sikasso and Bougouni increase their communal-labor participation by reducing work on their private fields even one day (one-fourth of the labor increase on the communal fields), they will be worse off. In Sikasso, net gains to women from the

expansion of cotton production are low because of relatively low total communal income. In Bougouni, net gains are low due to relatively high average returns to private-field labor.

The net income effects on women were not sensitive to reasonable changes in groundnut and rice prices. Also, the monthly rainfall pattern in the agricultural year, 1994–1995, was not unusual; hence, the yields represent output under normal conditions. Yields on private plots could be substantially increased with higher input use since there is practically no use of organic or inorganic fertilizers nor pesticides in private-plot production.

6. Policy implications

The Women-in-Development literature often recommends that women's welfare would be improved by increasing their access to land and inputs. The empirical results presented in this study support such recommendations. Returns to women's labor were higher in private than communal production. There is significant potential for increasing private-plot returns through increased input use. In Sikasso and Bougouni, women allocate relatively larger shares of their total private land to higher value crops. The development of marketing channels for women's cash crops, such as rice, groundnuts, and vegetables, would increase private-plot incomes. Women would be less constrained to market their output at the lower price at the local market. Sustained investment in rural infrastructure could promote market-led intensification and increase producer incentives for crops traditionally grown by women. Combining this with higher input use would substantially increase profitability of the

Table 5
Estimated income gains and losses for private-plot producers

Region	Income gains Δy_c (FCFA/year)	Income losses Δy_p (FCFA/year)		
	$\Delta L_c = 4$	$\Delta L_p = 4$	$\Delta L_p = 2$	$\Delta L_p = 1$
Koutiala	792	−3004	−1502	−751
Sikasso	492	−3160	−1580	−790
Fana	1048	−3648	−1824	−912
Bougouni	588	−6952	−3476	−1738
Sample average	728	−4196	−2098	−1049

[a]$N = 34$, $\Delta w_c = 8$ FCFA, 500 FCFA/US$.

private plots. However, men may then shift to cultivating some of the private-field crops when these become more profitable. Men shifting into activities which have become more profitable have been observed for agricultural and nonagricultural activities in other countries (von Braun, 1988).

Women do not own private land but have a right to use land allocated to them by the household head. Establishing land rights and providing formal titles for women's private plots would allow women to choose their production mix based on market conditions. Granting private-field land rights to women may also encourage investment in land and enable women to make more timely production decisions by reducing the uncertainty on the future rights to land.

Unfortunately, the expansion of private-plot production is limited in southern Mali. One-third of the women in our sample already had no access to private land. In San, women had practically no opportunities for private production. Men not heads of households were equally limited in their access to private land. As population pressure on land increases, the opportunity for increasing women's income through expansion of private production will decrease, making women more dependent on communal wages.

The benefits from technological change to women are greater if women increase their bargaining power. Women in our southern Mali sample who exhibited some bargaining power received a 126% higher level of communal wages (Lilja, 1996). However, only 15% of the women perceived that they had a right to bargain.

One justification for studying the impact of new technologies on the income directly controlled by women is empirical evidence that relative to women, men spend a greater proportion of their income on luxury goods, such as alcohol and tobacco. Women are more likely to purchase food and medicine, which directly benefit the well-being of household members (Bruce, 1989; Folbre, 1986; Guyer, 1988; Haddad et al., 1994; von Braun, 1988).

Our study considered the impact of technological change on income controlled by women. To determine the net welfare effect of technological change on women, further research needs to focus on: (1) evaluation of the impacts that technological change has on household head's expenditures, especially how these expenditures affect the welfare of women and children, and (2) analysis of the nutritional effects of change in labor allocation from private to communal fields.

7. Dynamics of technological change

Empirical analysis indicates that the net income controlled by women decreased with technological change. Adult men who are not household heads also received relatively low shares of increased income. Most of the increased income from technological change was kept by the household head. Since other family members, both men and women, are unlikely to be content with this concentration of income, institutional changes would be expected to contest the distribution of the new income streams.

Two noticeable institutional changes are occurring. As in East Africa, increasing separations from extended to nuclear families are beginning to occur in southern Mali. This change may principally affect the males who were not household heads.

Of more potential importance for women are changes occurring in the functioning of the traditional gender workgroups. With increased cotton area, the rapid completion of urgent seasonal tasks (weeding, harvesting) has a higher economic value, so farmers will increase their demand for services of seasonal labor workgroups. Presently, the women's workgroups often insist on being paid directly for their labor rather than having their wages accumulated for group social functions, as was the custom in the past. Increased participation in teams is apparently resulting from dissatisfaction with individual payments for communal work and from the realization that a team has more collective bargaining power than individuals.

8. Conclusions

Even though women are paid higher wages for additional labor on communal fields required by technological change, the consequent decline in their private-field labor input results in reduced total remuneration in almost all cases considered. Unless their labor time for increased communal work is taken

predominantly out of other activities besides their private plot, the income in cash and kind that women control is reduced by the introduction of the new technology. The net welfare of women (and children) may still be improved by technological change with the household head's increased expenditures from this increased income. The next phase of this study will investigate this possibility.

In the short run, improving the efficiency of production and/or the output prices of private-plot production appears to be the most effective way to increase the welfare of women. However, as land becomes scarcer, the determinants of communal wage payments will become increasingly important as an instrument to increase the welfare of women. Raising the opportunity costs of women and increasing their perception of their potential to bargain are priority areas for future attention.

Institutional changes stimulated by technological change are already occurring to contest the concentration of income streams to household heads. Examples are the movement to smaller household size and the shifts in payment patterns within the workgroups. Facilitating these changes is another public policy measure expected to increase the welfare of women (and children). A useful next step in the analysis would be further examination of the characteristics of the groups, participation in the groups, and the effect of these workgroups on the communal wage and the total income received by women.

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