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Gender discrimination and its impact on income, productivity, and technical efficiency: evidence from Benin

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Abstract This paper examines the occurrence and impact of gender discrimination in access to production resources on the income, productivity, and technical efficiency of farmers. Through an empirical investigation of farmers from Kousin-Lélé, a semi-collective irrigated rice scheme in central Benin, we find that female rice farmers are particularly discriminated against with regard to scheme membership and access to land and equipment, resulting in significant negative impacts on their productivity and income. Although women have lower productivity, they are as technically efficient as men. The findings suggest that there is considerable scope for improving the productivity of women through increasing their access to production resources.

Keywords Gender · Productivity · Technical efficiency · Irrigated rice · Benin

Introduction

For the majority of developing countries, women play an important role in agricultural production in general and in rice production in particular (Carney 1993; Dey 1984, 1981, 1982). It is reported that women contribute up to about 60% of agricultural production, 80% of food crop production and participate in more than 60% of rice production operations, processing, and marketing (CTA 2002).

Nevertheless, despite the important role of women in agriculture, their access and control of capital resources such as land is limited (Saito 2004). Even in those situations where women have access to production resources, they do not have full control over their use because men dominate any decision-making (Quisumbing 1996). For example, in the largely patriarchal society of Benin, women have limited access to land due to discriminatory laws and inheritance rights (Kidane et al. 2006; Dijoux 2002; Sohinto 2001; Honlonkou 1994; Biaou 1993, 1991). Although recent data are not available, Kidane et al. (2006) observes that in Benin the average size of men's land holdings was 1.76 ha in 1976, while that of women's was only 0.98 ha.

Such disparities are a cause of concern to development practitioners. In acknowledgement of the role of women in development, gender equity has been included as an important component of the "millennium development goals" (MDG). In conformity with the MDG, national policies have been formulated to reduce the current gender disparities by encouraging access to resources through increased participation by women in economic, political, and social-cultural development.

Rice is an important crop in West Africa and it is an important source of income and food for producers. In Benin, rice is believed to be one of the crops that have significantly contributed to food security and poverty reduction (Ahoyo 1996; Houndékon 1996; Kpobli 2000; Adégbola and Sodjinou 2003). However, any pro-poor policies that aim at reducing poverty through agriculture,

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particularly rice production, will not achieve their intended objectives if they fail to address the current inequalities in access to production resources between men and women.

The development of irrigated rice schemes managed collectively by groups of smallholder farmers is one strategy that governments have used to both increase smallholder farmers' access to production resources and reduce gender inequality. This strategy is consistent with the "gender and development approaches" (GAP), which may involve the use of collective action groups and which are strategic tools for transforming the social relations between men and women and between other social categories toward equality of rights and duties, social status, power, and responsibilities (Reeves and Baden 2000). Besides seeking to change existing gender roles and relations, the strategic goal of the GAP is to harmonize social relations and reduce inequalities for an equitable and sustainable development (Lambrou 2005; Juteau 2000; ICRA 1999; Quisumbing 1996; Boserup 1983).

However, unless they avoid replicating inequalities that exist in their communities, women will reap limited benefits from collective action groups. Indeed, as observed by Pandolfelli et al. (2007b), collective action programs that fail to address gender, or that target women as beneficiaries without a clear understanding of gender relations within the community, risk being ineffective and further disempowering women. Pandolfelli et al. (2007a) further observe that the complexity of both gender and collective action means that even if development practitioners, policymakers, and local stakeholders are genuinely interested in using collective action groups to reduce poverty and foster gender equity, favorable outcomes are not automatic.

The Koussin-Lélé irrigation scheme of Benin is an example of a collective action group. The scheme was established in 1969 by the Chinese mission in Benin to promote rice production and contribute to the development of the region. The scheme was managed for its first quarter century (1969–1994) as a collective. But, since 1995 farmers have adopted an organizational system of individual ownership and management of plots, while still retaining the collective management of the production materials and equipments. The scheme has been characterized by discrimination against women since its establishment in 1969. For example, only 16% of the members of the scheme are currently women, while their average land holding is a third that of the men (Kinkingninhoun-Mêdagbé 2003). The inequalities in access to land and equipment between men and women negatively affect the productivity of women farmers.

The principal objective of this paper is to examine the effect of gender discrimination in access to production resources among farmers from the Koussin-Lélé rice scheme. More specifically, the paper analyzes the effect of gender inequality in access to land and equipment on productivity, income, and technical efficiency.

The rest of the paper is organized as follows. Section "Methods and procedures" provides a brief description of the methodology used in the paper. The results of the analysis are detailed in section "Results", in which we describe the inequalities in access to land and use of equipment as well as their impact on the income, productivity, and technical efficiency of farmers. We discuss these results in section "Discussion" and offer conclusions and recommendations in section "Conclusion".

Methods and procedures

Description of the study site and historical background

The irrigation scheme of Koussin-Lélé is located in the central part of Benin. The scheme covers a total area of 106 ha which benefits from a water distribution network of 10,068 m in length and from a 610 m-long drainage network. It is irrigated using a gravitational irrigation system. Established in 1969 by the Chinese mission, the scheme has presently a total of 145 producers, including 23 women. The producers are subdivided into seven groups, six male groups and one female group. The seven groups constitute the Rice Farmers Union of Koussin-Lélé (UPR-KL), which is led by a management council (CA). Each farmer is allocated a rice plot which he or she manages individually. Other production factors such as equipment, fertilizer and credit are distributed to farmers through group leaders and are managed collectively.

The scheme has undergone several changes in terms of membership as well as in its management. In its first 25 years, all production activities (including access to capital and equipment) and all income generated were managed collectively. A multidisciplinary Chinese team initially led the management of the scheme before transferring it to farmers. The Chinese team recruited and trained exclusively male farmers,[1] organized them into a cooperative subdivided into teams and later into groups structured around rice production activities. Portions of land of varying sizes were delimited by posts and allocated by the Chinese to the different groups, with larger groups getting relatively more land. Later (in 1978), the Chinese transferred the management of the scheme to producers but still continued assisting them. Each team of producers had a leader elected by a general assembly while an executive

[1] The Chinese did not explicitly target men. But they ended up getting only men to work with them because in Benin (and most of Africa), men do not often authorize their wives or daughters to work with strangers.

committee of three elected members managed the groups. The teams and the groups were coordinated by a management committee (CA) that was responsible for the organization of the cropping season, the management of the infrastructure, and the equipment and financial aspects of the scheme. Until 1994, except for one individual, all women working in the scheme were employed as laborers by male members of the scheme.[2]

Due to governance problems and internal conflicts among cooperative members the collective form of organization of the Koussin-Lélé scheme has persistently failed to realize its potential production. A series of successive reforms in the collective management of the scheme took place without significant changes in the collective form of organization of the scheme.

The end result of the persistent failure of the cooperative form was a gradual decline in the scheme's activities and production that culminated in the withdrawal of many cooperative members in 1993. However, following exchange visits to other irrigated schemes in other parts of Benin, producers adopted in 1995 an organizational system based on individual management of the rice plots while maintaining the collective management of the equipment and infrastructure. The group leaders were given the responsibility of distributing the scheme's land allocated to each group. Thus, each group member received a portion of land that was allocated to its group with an obligation to pay fees to the union according to the number of cultivated plots. The women workers were, however, excluded from the land distribution because men wanted to continue using them as laborers. But, after repeated revolts and the intervention of district authorities, women were allowed in 1995 to form their own group and were allocated plots of land. The plots allocated to women were, nevertheless, fewer and smaller than those allocated to men.

Currently, all the agricultural equipment in the scheme is owned and managed collectively. The Union Management Council distributes the equipment to the groups, and group leaders decide on their utilization in their respective groups. For women groups, however, the Union Management Council decides on the use of the equipment. Fertilizer and insecticide supply is also usually arranged collectively and on credit through the communal union of farmers (UCP). Based on individual input requirements, the general secretary makes requests to the UCP after consulting with the president and the treasurer of the group. The same procedure is used for the cash credit that is also taken collectively from the local agricultural credit company (CLCAM). Both forms of credit (in-kind inputs and cash) are recovered in bags of rice equivalent to the value of credit.

Sampling and data collection

The data used in the study were collected from a sample of rice farmers in the scheme in August 2004 by the Programme d'Analyse de la Politique Agricole (PAPA) of the Institut National de la Recherche Agricole du Bénin (INRAB). The scheme's population of 145 farmers, of which 23 are women, constituted the sampling frame. A stratified random sampling technique was used to ensure adequate representation of women and men in the sample. Twenty women (almost all the women in the scheme) were selected from the female stratum and 25 men (about 20% of the men in the scheme) were selected from the male stratum, leading to a total sample size of 45.

The data were collected using structured questionnaires, non-structured discussions with individual farmers, semi-structured and structured focus group discussions, and through literature review. The questionnaire captured information for the 2003–2004 cropping season on quantities of inputs and outputs, prices of inputs and outputs, area cultivated, types and quantity of labor,[3] as well as some socio-demographic characteristics of the farmers. The focus group discussions were conducted in each of the seven groups to obtain qualitative information on their organization and functioning, on the history of the successive management forms used in the scheme and their bearing on the outcomes of the groups' management and on the production outcomes of members.

The study has some limitations with respect to the sampling, firstly, because of the small sample size. A second limitation of the study is the fact that the sample did not include farmers who are not members of the scheme. Therefore, only the discrimination against women who have access to the scheme (i.e., discrimination inside the scheme) can be studied using this sample. Extending the analysis to all women around the scheme area in general would reduce the potential bias associated with restricting the sample to participants in the scheme only.

The theoretical and empirical frameworks

Technical efficiency expresses the ability to obtain the maximum output from a given level of productive resources (Green 1997; Atkinson and Cornwell 1993; Atkinson and Cornwell 1994). Thus, technical efficiency corresponds

[2] This woman was integrated into the co-operative in 1989 following the death of her husband, a former co-operator. She came and worked with him in the scheme. She is currently the president of the women-only group.

[3] Norman conversion method adapted to the context and to the specificities of Koussin-Lélé scheme was used to estimate the quantity of labor.

to the efficiency in physical production and refers to the technical organization of a production activity. The level of technical inefficiency of a particular farmer is measured by the deviation of the observed farmer's output from the value of some potential or frontier production representing the potential or maximum possible output that any farmer can achieve using the same level of inputs and the same production technology (Battese 1992; Green 1993). Battese (1992) further defines technical inefficiency of a firm as the factor by which the level of production for the firm is less than its frontier output and gives updated accounts of frontier production functions associated with the estimation of technical inefficiency of individual firms.[4]

Two approaches are used in the literature to estimate the frontier production and the distribution of farmer technical efficiencies (Green 1997): the *deterministic* and *stochastic* frontiers production approaches. The deterministic production frontiers assume that all deviations from the production frontiers are due to inefficiency. The assumption that all deviations from the maximum output achievable are due to technical inefficiency is, however, unrealistic because there are several other unobserved factors farmers are not able to control (climate, temperature, etc.) and which can make observed output deviate from the potential. Measurement errors in the observed output and inputs are also not accounted for. In addition, statistical inferences cannot be made for the technical efficiency and production parameters estimated with the deterministic approach (Green 1997). These shortcomings have led to the development of the now widely used stochastic production frontiers approach, which decomposes the deviation of observed output from the potential into two unobserved components: a symmetric error term which corresponds to the usual measurement error and the inefficiency term. The present study uses the stochastic production frontiers approach to estimate the determinants and distribution of famer technical efficiency. The stochastic frontier production function (with a Cobb-Douglas functional form) is given by the following expression:

$$\ln y_i = \beta_0 + \sum_{k=1}^{K} \beta_k \ln x_{ik} + v_i - u_i \quad (1)$$

where y_i represents the observed output of the ith sample farm; $x_i = (x_{i1}, \ldots, x_{iK})$ is the vector of the observed basic inputs (land, labor, seed, fertilizer, etc.); $\beta_k, k = 1, \ldots, K$ are the parameters that define the production frontiers technology and which are to be estimated; u_i is a one-sided non-negative random variable (usually assumed to follow a truncated normal distribution) that measures the systematic deviation of log of output from the log of the potential; and v_i, is the usual symmetric measurement error (including the effect of non-observed factors that affect production).

The individual farm-level technical inefficiency index is estimated by:

$$TE_i = \exp(-\hat{u}_i) \quad (2)$$

where $\hat{u_i}$ is the estimated one-sided error in Eq. 1. Thus, the technical inefficiency index TE_i is always between 0 and 1. The farmer is technically efficient when TE_i reaches its maximum value, which is 1. Otherwise he or she is technically inefficient and therefore can potentially achieve higher output for the same level of inputs (or, equivalently, higher marginal productivity at all levels of input use).[5] With the Cobb-Douglas production frontiers, the farmer's realized marginal factor productivity for an input k (the increase in output resulting from a marginal increase in the input) is simply the average factor productivity (output per unit input) for the input, y_i/x_{ik}, multiplied by the corresponding coefficient β_k in Eq. 1.

In general, a large part of the technical inefficiency of a farmer is explained by some socio-demographic factors such as age, education, sex, and other household demographic factors (Kalirajan 1981; Pitt and Lee 1981; Battese 1992). Thus, following Battese and Coelli (1995), the dependence of the technical inefficiency of a farmer on the socio-demographic factors is formulated as:

$$u_i = \delta z_i + \varepsilon_i \quad (3)$$

where z_i is the vector of farmer socio-demographic variables, δ is a vector of parameters to be estimated, and ε_i is a normally distributed random variable with zero mean and truncation point defined by $\varepsilon_i \geq -\delta z_i$. The vector of parameters δ is estimated jointly with the technological parameters of the production function using a maximum likelihood estimation (MLE) procedure (Green 1997; Battese and Coelli 1995; Battese et al. 1996).

The present study focuses on the observed inequality in access to productive resources (land and farm equipment) between men and women in the Koussin-Lélé rice scheme and its effect on their productivities and technical efficiencies. For that purpose, we hypothesize the existence of significant discrimination in access to land and equipment between men and women in the scheme. We do not hypothesize any discrimination in the use of other inputs such as seed and fertilizer as they can be acquired through

[4] Technical efficiency does not imply allocative or economic efficiency, however. Allocative efficiency means that resources are used so that the value of an additional unit of output (the value of the marginal product) is equal to the cost of an additional unit of input. Thus, technically inefficient farmers may be allocatively efficient, vice versa (Green 1993). But, technical and allocative efficiencies are necessary for a farmer to be economically efficient. In this paper we focus only on technical efficiency.

[5] For more details about this method and the relatives basic equations, please see Green 1997; Battese et al. 1996; Battese and Coelli 1995.

other means, while land and equipment are acquired only through the scheme. We test discrimination on access to land directly by comparing the means of land holding size between the men and women groups. For access to equipment we use the fact that discrimination in the use of equipment causes delays in transplanting rice seedlings from the nursery to the main fields; this enables us to test for gender discrimination indirectly by comparing the mean ages of the nurseries of men and women on the day of transplanting.

One of the major hypotheses in this paper is that without discrimination on land and equipment there would be no difference in productivity and technical efficiency between men and women. We test this hypothesis by testing for the equality of means in the average and marginal productivities, net rice income, and technical efficiency indices between men and women. We also test the hypothesis that women are as technically efficient as men by testing the hypothesis that the coefficient for gender in the equation for the determinants of technical inefficiency (Eq. 3) is equal to zero. The Statistical software Stata version 9 was used to compute the summary statistics estimate the parameters of the stochastic production frontier and the technical efficiency equations and conduct the statistical tests described above. All the estimation and test procedures took into account the stratified sample design and small sample size.

Results

Characteristics of rice farmers

Table 1 presents the socio-demographic characteristics of the sample rice farmers disaggregated by gender and social status, with the probability indicating results from a difference of means test between men and women. The results indicate that women, who account for 45% of the sampled rice farmers, are on average older (55 years) than men (38 years).[6] The youngest rice farmer is a 21-year-old man and the oldest a 75-year-old woman. The average household size is six and is not significantly different across gender. On average, there are 2.51 active household members of working age in a household for 3.5 inactive ones.[7] The average dependency ratio is 1.48 and is not significantly different across gender of the farmer.[8] With regard to education, the overall primary school attendance rate from the Koussin-Lélé scheme is 45%; a school attendance rate lower than the regional average of about 59% (INSAE 2002). Only 7% of women had attended primary school compared to 56% of male farmers. In addition, 31% of the farmers had received some professional training in non-farm activities (sewing, carpentry, bricklaying, etc.), which constitute secondary activities for some of the farmers, rice farming being always the principal activity. The average length of experience in rice farming is 11 years, with no significant differences across gender.

Evidence of gender discrimination

Three forms of discrimination were observed in the scheme. The first form of discrimination relates to the low proportion of women participating in rice production in the scheme. Out of a total population of 145 rice farmers in the scheme, only 23 are women. There are six male groups against one female group, and the female population represents less than 16% of the total population of rice farmers in the scheme. Considering that women represent 52% of the Benin population and 40% of farmers (INSAE 2002), their low participation in this scheme appears to suggest that women are discriminated against.

Discrimination in access to land

The second form of discrimination relates to the land size, as shown by farmer access to resources and use of inputs. The results in Table 2 indicate that on average, rice farmers cultivate 0.51 ha of land. The comparison of these values across gender shows that women cultivate on average 0.24 ha of land, which is a third of the average of 0.72 ha cultivated by men. The difference is statistically significant at the 1% significance level (p-value less than 0.001). Hence, we reject the null hypothesis of no discrimination in access to land between men and women. In fact, the man with the smallest piece of land has the same area as the female with the largest land area (0.27 ha). Furthermore, while male group leaders are responsible for land redistribution to their members using performance criteria such as level of field cleaning and yield as a basis to allocate additional land to better performing farmers, women's group members are given land by the union management

[6] One rice farmer was eliminated because he had problems during the season and the data collected from him was not complete.

[7] In the study area, children start working in the rice farms when they are above 10 years old. The conversion of rice farm household members into equivalent-adult (Eq.adt) was made using the FAO/OMS scale. According to this scale, a man whose age is between 15 and 65 years is equal to 1 Eq.adt; a woman at the same scale of age is equal to 0.8 Eq.adt; a child of less than 15 years or a person older than 65 years is equivalent to 0.5 Eq.adt.

[8] The estimated average dependency ratio is similar to the 1.5 estimated ratio for part of the Republic of Benin by Floquet and Mongbo (1998).

Table 1 Socio-demographic characteristics of rice farms

Indicator	Total ($n = 45$)	Male ($n = 25$)	Female ($n = 20$)	Prob (F)**
Number of sampled farmers in each category	44	24	20	
Average age (years)	42 (14)	38 (13)	55 (11)	0.000
Size of household	5.93 (3)	5.95 (3)	5.86 (2)	0.917
Number of active members of a household	2.41 (1)	2.40 (1)	2.43 (1)	0.942
Number of active women	1.16 (1)	1.09 (1)	1.43 (1)	0.113
Dependence ratio	1.64	1.61	1.72	0.823
Literacy rate	45%	56%	7%	
Marital status				
Married (%)	79	85	57	–
Single (%)	10	13	00	–
Widowed (%)	10	00	43	–
Divorced (%)	01	2	00	–
Experience in rice farming (years)	14 (9.4)	13.8 (8.2)	14.3 (10.4)	0.523

Source: INRAB Koussin-Lélé Survey, 2004

Note: The numbers in parentheses indicate the standard deviation

** Probability statistic for the test of equality of mean values

Table 2 Summary statistics on farmer's access to resources and use of inputs

Indicator	Total ($n = 45$)	Male ($n = 25$)	Female ($n = 20$)	Prob (F)**
Total rice area in (ha)	0.51 (0.30)	0.72 (0.24)	0.24 (0.01)	0.000
Maximum rice area (ha)	1.23	1.23	0.27	
Minimum rice area (ha)	0.24	0.27	0.24	
Quantity of fertilizer per hectare (kg/ha)	381 (127)	361 (124)	406 (130)	0.123
Quantity of insecticide hectare (l/ha)	0.90 (0.45)	0.95 (0.46)	0.84 (0.44)	0.242
Quantity of seed per hectare (kg/ha)	171 (52)	134 (42)	215 (18)	0.000
Quantity of labor per hectare (man days/ha)	105 (23)	95 (26)	118 (22)	0.002
Date of planting (age of nursery) (days)	22 (5.3)	19 (3.4)	25 (5.5)	0.000
Level of irrigation (distance of plot from the main irrigation channel in meters)	2.61 (0.75)	2.7 (0.76)	2.55 (0.76)	0.695

Source: INRAB, Koussin-Lélé Survey, 2004

Note: The numbers in parentheses indicate the standard deviation

** Probability statistic for the test of equality of mean values

council (UMC), which has never applied the performance criteria to allocate more land to performing women farmers. Instead the later have experienced a further reduction in land size when they were forced to accept other women farmers into their group.

Gender discrimination in access to equipment

The third form of discrimination relates to the use of equipment. Equipments such as the motor-cultivators, used for both field plowing and rice transportation, are collectively managed by each group. Each group is given a motor cultivator and a driver to ensure timely plowing and timely transportation of paddy from the field to the storage rooms after the harvest. However, in contrast to men's groups, the women group is given a motor-cultivator but not a driver. This implies that they can not start plowing their fields until the drivers for the men's groups complete plowing the men's fields. This leads to a delay in plowing the women's fields, forcing them to plant late. Using the age of a nursery as a proxy for the timing of planting, the results in Table 2 indicate that on average women planted their rice much later (25 days) than men (19 days). The difference is statistically different from zero at the 1% significance level (p-value less than 0.001).

Planting late and subsequently harvesting late leads to significant yield losses for the women. Another consequence of the discrimination on access to plowing equipment relates

to the number of cropping seasons: Farmers often begin preparations for the first cropping season in October. The second cropping season starts soon after harvesting the first season's crop. Thus, farmers have the possibility of participating in two cropping seasons if they harvest the first season's crop early. However, due to delays in the plowing for the first season, women do not participate in the second cropping season, which negatively impacts both their annual incomes and total scheme incomes.

The patterns of use of other inputs (seed, fertilizer, insecticide, and labor) are also shown in Table 2. As explained above we do not make any hypothesis on the existence of gender discrimination on these inputs. The results indicate that, on average, rice farmers use 381 kg of fertilizer, 0.9 liters of insecticide, 171 kg of seeds and 105 man-hours of labor/ha. The results further indicate that while there are no significant differences in fertilizer application rates between men and women, significant differences are observed in their use of seed, labor, and insecticides. Women's fields have significantly higher seed densities (215 kg/ha) than men's fields (134 kg/ha). Women also use significantly higher amounts of labor (118 man days/ha) than men (95 man days/ha).

Gender differences in average productivity and net rice income

Table 3 presents productivity indicators for one cropping season disaggregated by gender. The average yield of farmers on the scheme is 4.47 tonnes/ha. The results indicate that men have higher productivity than women per unit of land, seeds, fertilizer, and labor. For example, the average yield of men is 4.95 tonnes/ha while that of women is 3.89 tonnes/ha and the difference is statistically significant at the 5% significance level.

Net average rice incomes disaggregated by category of farmer are also presented in Table 3. The results indicate that the average net rice income of farmers in the scheme is 229,000 CFA per farmer,[9] which is equivalent to an average of 432,000 CFA/ha. This is consistent with findings by Mongbo (2002) who reported incomes of 428,000 CFA/ha but higher than the finding of Agbazahou (2003) who reported incomes of 354,000 CFA/ha on the same scheme. This variation could be due to the difference in the methods used and the elements considered in the calculation of the net income.[10] The high net rice incomes obtained suggest that rice production is a viable activity. The finding is consistent with what was observed by Agbazahou (2003), who reported that rice cropping gave higher income than cotton cropping.

The results further show a significant difference between net rice incomes of men and women. On average, women generated only 85,000 CFA from rice farming against 350,000 CFA for men. Therefore men earn more than four times the women's average income.

Gender differences in technical efficiency and marginal productivity

Table 4 presents results of estimates of Eqs. 1 and 3, which are results of the frontier production function and the determinants of technical efficiency, respectively. Farm size, quantity of fertilizer, level of irrigation, and date of planting are the main determinants of rice production in the scheme. The results indicate that production increases with farm size and fertilizer, while it decreases with days of late planting and distance of the plot from the main irrigation channel. With regard to determinants of technical inefficiency, the results indicate no statistically significant difference in technical efficiency between men and women. The dependent variable in the inefficiency equation (Eq. 3) is the inefficiency index. Results indicate that highly experienced farmers are more technically efficient; the negative coefficient indicates that the more experience a farmer has, the less inefficient he or she is. Technical efficiency also declines as distance to the main water channel increases. Furthermore, the results indicate that late planting decreases technical efficiency; the positive coefficient indicates that the more the days of late planting, the more inefficient the farmer is.

Table 5 presents results of the marginal productivities and technical efficiency indices disaggregated by gender as predicted from the estimates of Eqs. 1 and 3. The results indicate that the men have higher mean marginal productivities of land and fertilizer than the women. However, the marginal productivities of seed and labor are negative for both men and women. The average technical efficiency for the whole sample is 0.84. This suggests that as a whole the farmers in the rice scheme have the potential to increase their productivity by 16% and consequently gain higher net incomes using the same level of inputs. The results also show that there are no statistically significant differences in the level of technical efficiency between men (0.86) and women (0.80) in the scheme.

Discussion

The results on discrimination against women in land distribution are consistent with the global Beninese context of

[9] One dollar US ($US) equal 550 CFA (15 March 2006).

[10] Mongbo and Agbazahou, as in this study, used the "gross margins" or "marges brutes" method whereas Kinkingninhoun-Medagbé (2003) who used the "net agricultural income net" (NAR) method or "revenu agricole net" (RAN) method obtained 294,491. The method used in this paper tends to account for fewer cost items.

Table 3 Average factor productivities and income of rice farmers

Average productivity of	Total ($n = 45$)	Male ($n = 25$)	Female ($n = 20$)	Prob (F)**
Land (tonnes/ha)	4.47 (1.03)	4.95 (0.78)	3.89 (1.02)	0.000
Seeds (kg/kg)	2.98 (1.37)	39.5 (10.9)	18.1 (4.4)	0.000
Fertilizers (kg/kg)	13.6 (9.0)	16.59 (11.3)	10 (2.4)	0.041
Insecticides (tonnes/ha)	5.59 (2.65)	5.97 (2.66)	5.10 (2.62)	0.192
Labor (kg/man day)	45.2 (15.4)	53.6 (11.2)	35.0 (13.5)	0.000
Date of planting (kg/day)	124.6 (100.9)	193.9 (87.7)	41.6 (20.6)	0.000
Income (thousands F CFA)				
Net agricultural income	229 (174)	350 (149)	85 (8)	0.000
Net agricultural income per hectare	432 (174)	502 (156)	348 (159)	0.000

Source: INRAB, Koussin-Lélé Survey, 2004

Note: The numbers in parentheses indicate the standard deviation

** Probability statistic for the test of equality of mean values

Table 4 Production frontier model parameters estimates

Production factors (in log)	Estimated coefficient	Standard error	Significant level
Land	1.06	0.130	0.000
Seed	−0.140	0.088	0.111
Fertilizer	0.080	0.042	0.058
Labor	−0.012	0.110	0.913
Date of planting	−0.582	0.151	0.000
Level of plots' irrigation	−0.147	0.067	0.028
Constant term	11.035	0.870	0.000
Number of observations = 44			
Wald $\chi^2(9) = 882.74$			
Prob > $\chi^2 = 0.0000$			
Determinants of technical inefficiency			
Gender	0.062	0.105	0.555
Experience in rice production	−0.009	0.004	0.012
Date of planting	0.025	0.009	0.007
Level of plots' irrigation	−0.218	0.072	0.007
Constant	0.239	0.390	0.539
/lnσ^2	−4.293	0.531	0.000
/ilgtgamma	0.585	1.118	0.601
σ^2	0.014	0.007	
Gamma	0.642	0.256	
sigma_u2	0.01	0.008	
sigma_v2	0.005	0.002	

Source: INRAB, Koussin-Lélé Survey, 2004

women's limited access to land. Several studies in Benin (Dijoux 2002; Sohinto 2001; Honlonkou 1994; Biaou 1993, 1991) indicate that the common cultural norms (local system of access to land) discriminate against women who do not inherit land. Female farmers don't cultivate their own land, but land borrowed from their husbands or from their family members. In the best cases, women can receive the marginal and small pieces of land. These findings are also consistent with observations made by Basile (2001), Dey Abbas (1997), Saito et al. (1994), Palmer (1991), and Lubbock (1988), who observe that in most of the sub-Saharan Africa countries, women are marginalized in land allocation both in terms of the quality and the quantity of the land. Similarly, Diemer and Van der Laan (1987) argue that large irrigation schemes bring some forms of inequality among the users. The most influential people end up acquiring more land to the detriment of the weakest.

The discrimination against women in the Koussin-Lélé scheme suggests that although one would expect social cultural norms leading to inequalities to disappear with the

Table 5 Marginal factor productivities and technical efficiencies by gender

Additional kilograms of paddy for an additional unit of	Total ($n = 45$)	Male ($n = 25$)	Female ($n = 20$)	Prob** (F)
Land (tonnes/ha)	4.74 (1.1)	5.25 (0.83)	4.13 (1.08)	0.000
Seeds (kg/kg)	−4.17 (1.92)	−5.53 (1.52)	−2.53 (0.61)	0.000
Fertilizer (kg/kg)	1.07 (0.71)	1.31 (0.89)	0.79 (0.20)	0.015
Labor (kg/man day)	−0.54 (0.18)	−0.65 (0.13)	−0.42 (0.16)	0.000
Date of planting (kg/day)	−72.51 (58.71)	−112.78 (51.01)	−24.18 (11.98)	0.000
Technical efficiency (TE)	0.84 (0.14)	0.86 (0.12)	0.80 (0.16)	0.172

Source: INRAB, Koussin-Lélé Survey, 2004

Note: The numbers in parentheses indicate the standard deviation

** Probability statistic for the test of equality of mean values

introduction of collective action groups, they seem to be replicated in such groups. The low participation of women in the scheme is considered as a form of discrimination against them because women wanting to join the scheme have been denied to do so since its establishment. This can be attributed to a number of factors. The first relates to the historical background of the scheme. At its establishment men were recruited to work as laborers on the scheme before it was handed over to them. It is unlikely in a male-dominated society that women will seek employment as laborers outside their home, a fact which probably led to the recruitment of men only.

The second factor is directly related to the patriarchal nature of the Beninese society. After the scheme was handed over to men, they employed women as laborers. These women started fighting for land in the scheme, but their efforts did not yield any results until an intervention by district officials which led to the acceptance of some women into the scheme. It would appear that male opposition to increased female participation in the scheme is attributed to the fact that women in the wider Benin community do not own land (Honlonkou 1994; Biaou 1993, 1991). When women become members of the scheme they automatically become land lords, which is against the norms and values in most communities in Benin. These facts and the findings of this paper suggest that, unless facilitated by external intervention, it will be very difficult for men to allow more women to participate in the scheme. The smaller land holdings awarded to women participants are also a great cause of concern particularly because it constrains them from increasing their production. The main reason for small land holdings for women is again rooted within the cultural norms of the Beninese society as discussed above.

The other reason for small land holdings by women relates to the lack of a mechanism of enforcement of laws and regulations that can help in reducing the inequalities in access to land between men and women. Contrary to the rules and regulations set out in the bylaws of the scheme, a farmer's production performance is rarely taken into consideration. In particular, the criteria of field management and yield, which should be used to justify the increase or reduction of land attributed to members, are not considered. Women in the scheme are awarded smaller plots of land by the scheme management regardless of their performance. The fact that historically women were allowed membership in the scheme only after an external intervention by district officials, suggests that it might be difficult for men in the scheme to enforce rules leading to women getting more land. Hence, in order to allow the enforcement of the existing performance-based land redistribution system in which better performers are supposed to get larger holdings, there is a need for some form of external intervention to facilitate the process.

There was also a general feeling among women during the focus group discussion that the late plowing of their fields resulting from their lack of timely access to the plowing equipment (the third form of discrimination described in Section "Results" above) is a deliberate attempt by men to frustrate them from participating in the scheme activities. Such delays affect the farming calendar as they end up harvesting late. The timing of planting is a very significant determinant of yield and of the possibility of having a second cropping season.

Further, as a result of this discrimination, disputes between men and women usually occur at the beginning of each cropping season when women demand an increase in their land size. These disputes inevitably lead to further delays in plowing the women's plots due to, among other factors, delays in resolving the disputes as well as alleged deliberate actions by the scheme leaders who are reported to instruct operators of motorized plowing equipment to delay the plowing of women's plots. This makes it difficult for women to abide by the farming calendar hence affecting their productivity and their income.

Also as a result of late plowing, women fail to practice double cropping which leads to significant losses in annual income. This is consistent with the observations made by

Haefele et al. (2002) who point out that the relatively demanding cropping calendar in West Africa leaves little room for delay in activities. The non-participation of women in the second cropping season implies a substantial financial loss to the scheme.

As a result of the small land holdings, farmers in the scheme tend to intensify their production through the intensified use of inputs. For example, fertilizer use patterns in the scheme show that the fertilizer application rates are higher (381 kg/ha) than the recommended application rates of around 200 kg/ha. This finding is consistent with the agricultural intensification theory which posits that smallholder farmers facing land constraints tend to intensify their production systems through intensive use of inputs. Nonetheless, as noted by Haefele et al. (2002), the high rates of fertilizer application in the scheme may also be attributed to high fertilizer losses incurred in most of the irrigated rice in West Africa. It is estimated that in the Sahel region, for example, about 70% of the fertilizer applied to rice plants is lost. The seeding densities are also higher (171 kg/ha) than the recommended (70 kg/ha). Seed intensification may also be attributed, in this case, to the low cost of seed.

The higher average yield in the scheme can be attributed to, among other reasons, long experience in rice farming since most farmers have been growing rice since their youth. Nonetheless, there still remains a significant yield deficiency as the potential yield from irrigated rice is around 8 tonnes/ha once relevant constraints are addressed. The marginal productivity of land is higher than its average productivity, suggesting that farmers in the scheme are experiencing increasing marginal returns associated with being in the early stage of the production function before the point of diminishing marginal returns is reached.

The reported productivities of women farmers in the scheme are significantly lower than those of men. The results also show that men had higher marginal productivities than women. By just looking at the marginal productivity, one could assume that men are more efficient than women as their marginal productivities are higher. However, a closer analysis shows that the larger marginal productivity among men is mainly due to the combined effect of larger land holding size and increasing marginal returns to land. Thus, since both men and women are experiencing increasing marginal returns to land, it follows that those with larger land holdings will have higher marginal returns and higher productivity. Standard results of production economics (see, for example, Chambers 1988) tell us that average product is equal to marginal product at the point where the average product curve is at its maximum, with the marginal product curve crossing the former from above. Our results so far show that the marginal product of land is higher than its average product, suggesting that the average product of land is still increasing and has not yet reached it maximum. Thus in this stage of the production function, those with large land holdings will have high average productivities than those with smaller land holdings. This explains why women who have smaller holdings have lower average and marginal productivities.

These findings are consistent with earlier observations by Jovanovic (1982), Kalaitzandonakes et al. (1992), Sharma et al. (1999), Lundvall and Battese (2000), and Alvarez and Arias (2004), who have all reported a positive relation between average total productivity and farm size. The utilization of some production factors such as labor, for example, often does not increase in a linear form with the farm size. The producers that have a small land area often tend to over-utilize labor and other inputs, thus affecting their productivity. These findings suggest that land is the main constraint to productivity for the farmers in the scheme and that the differences in productivity observed between men and women are mainly due to the discrimination on land to which women are subjected.

The comparison of the estimated technical efficiency indices between men and women, which shows that women are on average as technically efficient as men, provides further evidence that low productivity among women is not due to inefficiency in resource use but is rather due to their smaller land holdings. The high technical efficiency for women can be explained by the fact that although the women are newcomers in the scheme, they have a vast experience in rice farming based on their previous experience as laborers on the same scheme. This is consistent with observations by Moock (1976), Ram and Singh (1988), Bindlish and Evenson (1993), and Dey Abbas (1997), who measured gender differential productivity and found that women were as technically efficient as men.

Thus, the lower measured productivity of female rice farmers in the scheme is not due to technical inefficiency, but is mainly due to the discrimination against them in access to land and equipment. In the strict sense, gender differences are likely to be less important for married women whose husbands may compensate for the effects of gender discrimination. However, in this study about half of the women were married, and there were no significant differences in the productivity between married and unmarried women, suggesting that husbands did not contribute much to reducing the effect of discrimination on women. This finding is plausible because husbands' lack of membership in the scheme makes it difficult for them to influence the allocation of land that would benefit their wives from outside the scheme.

The findings of this paper and the discussion above suggest that allotting more land to women could increase

women's productivity and income. Allocating more land to women will have no effect on the overall scheme efficiency but will lead to improvements in the productivity and incomes of women and, therefore, to gender equity.

Conclusion

Collective action groups are believed to be a powerful development tool that can be used to reduce inequalities in several dimensions among the participating individuals while enhancing community development. However, unless carefully managed, they can potentially replicate inequalities that exist in the communities from which participants are drawn, leading to the exploitation of the marginalized groups and to inefficiency. This study tests this hypothesis by examining gender discrimination in access to production resources and its effects on productivity, income, and technical efficiency among rice farmers in a collective action rice scheme.

The study found evidence of inequality in membership, land distribution, and equipment use among rice farmers in the Koussin-Lélé irrigation scheme. The women in the communities served by the scheme are subjected to discrimination as evidenced by their low participation, smaller land holdings, and their limited access to equipment which leads to delays in plowing their plots. As a result of these delays, women cannot practice double cropping, leading to income losses for the scheme and for women in particular.

It is further observed that the discrimination against women affects their average productivity, their marginal productivity, and their income. But women are found to be as technically efficient as men. This observation implies that increasing land allocated to women, combined with an equitable access to equipment that enables women to plow their plots in time and to participate in the second cropping season, would lead to improvements in the productivity and incomes of women.

This discrimination appears to be partly driven by the socially constructed norms within Beninese culture, in which women have limited land rights. The existing bylaws which allow performance-based increments in allocated land can, if enforced, reduce this inequality. However, the sensitivity of land issues suggests the need for some sort of external intervention. Communal authorities and leaders of agricultural development projects can intervene to facilitate the process of land redistribution. A lesson from the findings of this study is that if not carefully managed, collective action groups may replicate inequalities in the society from which participants are drawn. Thus, unless complemented with good governance, they are not a panacea to inequality problems in access to productive resources among different social classes and genders.

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