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# Access and Control of Resources and Participation in Rice-Breeding Activities among Men and Women Farmers in Southern Ghana

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**Abstract:** This paper provides evidence of gender differences in the access and control of resources and their relation to participation in rice-breeding activities among men and women farmers in southern Ghana. We used a mixed methods design which involved the use of qualitative data collected through focus group discussions (FGDs) and key informant interviews (KIIs) and quantitative data collection through a survey. Using data collected from 315 smallholder rice farmers, perception analyses and probit and multivariate regression were employed in the analyses. Our findings indicate that higher levels of education, experience in rice farming, a favorable dependency ratio, larger farm size, more rice plots, access to extension services, and involvement with financial organizations positively influence participation in rice-breeding activities. On the other hand, distance to market is found to have a negative impact on participation. Moreover, years of education, experience in rice farming, farm size, number of rice plots, dependency ratio, and distance to market were found to negatively influence the control of production resources among both male and female participants in rice-breeding activities. From both the quantitative and qualitative results, men had more access to productive resources than women. Insights from this study will enhance gender equity in promoting the participation of both men and women in rice varietal development activities.

**Keywords:** rice-breeding activities; multivariate probit; access and control; resources

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## 1. Introduction

Agricultural development aims at ending poverty, increasing food security, and improving the livelihoods of rural farm households in developing countries [1,2]. Evidence indicates that men and women do not adopt new technologies at the same rate or do not benefit equally from their introduction [3]. Women in Ghana have been found to adopt high-yielding varieties and improved management systems at lower rates than men [4]. There is an urgent need for women farmers to participate meaningfully in the technology development process [5] in order to enhance the adoption of new technologies to enhance productivity and to improve the incomes and wellbeing of women. Empirical studies in African countries such as Benin [6], Ghana [4], Ethiopia [7], Malawi [8], and Nigeria [9] have all documented gender-based inequalities in the adoption of improved technologies.

A number of factors result in inequalities between men and women in the participation of rice-breeding varieties [3,10–12]. These include gender norms and cultural practices and uneven access to resources that affect participation in household decision making, agricultural activities resulting in low productivity, and low rates of adoption. Daplah [11] showed a profound role of culture (culture refers to the ideas, customs, and social behavior of a particular people or society) in women's participation in household decision making where their views are often not considered highly in such decision-making processes. Africa's patriarchal system that gives a lot of power to the man in household decision making is regarded as a bane to women's empowerment, and Ghana is no exception [13]. Although, in southern Ghana, the high dominance of the Akan matrilineal systems often enhances women's role in household decision making. Such decision making covers areas such as access and control over household recourses including productive assets such as land, labor, and capital, which has the capacity to enhance the ability of women to participate in agricultural development programs including rice-breeding activities (rice-breeding activities refer to participatory variety selection and on-farm evaluations by farmers towards the development of improved rice varieties). Access to important productive resources such as farmland, labor, agricultural inputs (e.g., quality seed and fertilizer), capital, and complementary rice-productivity-enhancing technologies (knowledge, equipment, etc.) is required by smallholder farmers—men and women—to be productive. Men and women also need equitable control over their farm outputs. Any imbalance in the gendered access to or control of these resources limits the development of the rice sector [10].

The concept of gender norms refers to ideas about how men and women should behave in a society [14]. These norms comprise everything from cultural beliefs to expected behaviors and practices. These invisible social structures constrain and shape the environment within which men and women operate [15]. Social norms (social norms are informal rules that govern the behavior of groups and societies) influence decision-making processes in the household, which in turn affect the ability of women to access training opportunities, as seen in seed potato multiplication and ware (ware potato refers to the one cultivated for consumption and not for the vines to be used as seed) potato production in Malawi [16]. Social norms require that women often respond to the views of men in most household decision making; hence, to a great extent women tend to rally with such decisions, which encompass training decisions including participation in rice-breeding activities. Asfaw et al. [17] suggested that social behavior and traditional rules of men and women have to be well considered. For example, when men receive information meant for women to take action on a given farm activity, it does not result in the intended productivity gains or reduction in stock losses. In spite of these developments, there is still a gap in information on the role of gender norms and practices—and access and control of resources and how they influence men's and women's participation in agricultural trainings and particularly rice-breeding activities such as on-farm evaluations and field days. In order to develop effective and efficient rice breeding programs that respond to the needs of men and women, these factors need to be analyzed and investigated.

Furthermore, some of the social norms and practices limit women's time in agricultural activities. For instance, women's participation in organized training activities has been seen to be constrained by lack of time due to heavy productive, reproductive, and community roles that they play. Women dedicate little time to crop production and other related farming activities because of extra responsibilities such as caregiving and engaging in full-time jobs [13]. In addition, women's role within the social context often goes unrecognized [15]. In Ghana, the situation is not different; for instance, women farmers tend to have access to and control of production resources mainly through their husbands or male children, especially with regards to resources such as land and labor [3,18–20].

The paper focuses on perceptions on rice breeding activities (on-farm trials and field days), factors influencing participation in these activities, factors influencing access to and control of resources among men and women rice farmers in Southern Ghana. Insights from the study will enhance gender equity in promoting the participation of both men and women in rice varietal activities. The paper is structured as follows: The next section presents the methodology, which includes the sampling technique, analytical methods, and the models. Section 3 presents the results and discussions, including discussions of both qualitative and quantitative results. Section 4 concludes the paper.

## 2. Materials and Methods

### 2.1. Study Area and Sampling

This study was conducted in the selected locations because they are major rice-production districts in Ghana.

A multi-stage sampling technique was used to purposively sample major rice-growing districts in the Ashanti and Volta regions, Specifically the Ejura Sekyedumasi and Atwima Nwabiagya districts from the Ashanti Region and the Kadjebi and Ketu North districts from the Volta Region. Four (4) major rice-growing communities were randomly selected from each district, and twenty (20) rice-producing households were randomly selected from each community from a list provided by the Ministry of Food and Agriculture (MoFA). However, due to non-response, a total of three-hundred and fifteen respondents were involved in the study (315).

This paper employed an exploratory mixed-methods design which involved the use of qualitative data collected through focus group discussions (FGDs) and key informant interviews (KIIs), and quantitative data were collected through a survey. Eight gender-disaggregated focus group discussions (FGD) were held in each district. Each FGD consisted of 10 people who were selected from the list provided by MoFA. Following FGDs and to provide more in-depth information, KIIs were held with a male community leader/community agricultural extension officer and one male and one female lead farmer from each region (6 total). The key informants were identified through the agricultural extension agents, based on their in-depth knowledge on rice production and breeding-related activities in the communities or districts. Data collected comprised demographic data, household power dynamics, access and control of production resources, production data, input and output quantities, and prices as well as participation in rice development activities.

The Ejura Sekyedumasi District covers an area of 1782.2 sq km with Ejura as its capital (Figure 1). Soils in the district are good for cultivation of a variety of crops such as yams, rice, maize, groundnuts, cowpea, cassava, and plantain. The Atwima Nwabiagya District lies approximately at latitude 6°75′ N and between longitude 1°45 and 2°00′ west. The district covers an estimated area of 294.84 sq km, and the capital is Nkawie. The soils are good for cultivation of a variety of crops such as maize, rice, sugar cane, coffee, cocoa, cassava, vegetables, cocoyam, yam, citrus, ginger, oil palm, and plantain (www.ghanadistricts.org, assessed on 20 December 2022).

In the Volta Region, the Ketu North District is noted widely in the West African sub-region for its production and marketing of exclusive quality palm oil, gari, and the famous Afife rice (Togo Marshal). With Dzodze as its capital, the district lies between latitudes 6°03′ N and 6°20′ N and longitudes 0°49′ E and 1°05′ E (Figure 2). The soil type in the area supports the cultivation of crops such as maize, groundnut, cowpea, cassava, rice, plantain, oil palm, mango, pear, and most vegetables. The Kadjebi District, with Kadjebi as its administrative capital, covers a total land area of 949 $km^2$. It lies between long. 0° S and 30° S and lat. 8° W and 30° W. The soil type in the area supports the cultivation of crops such as cocoa, plantain, cocoyam, cassava, yams, maize, and rice.

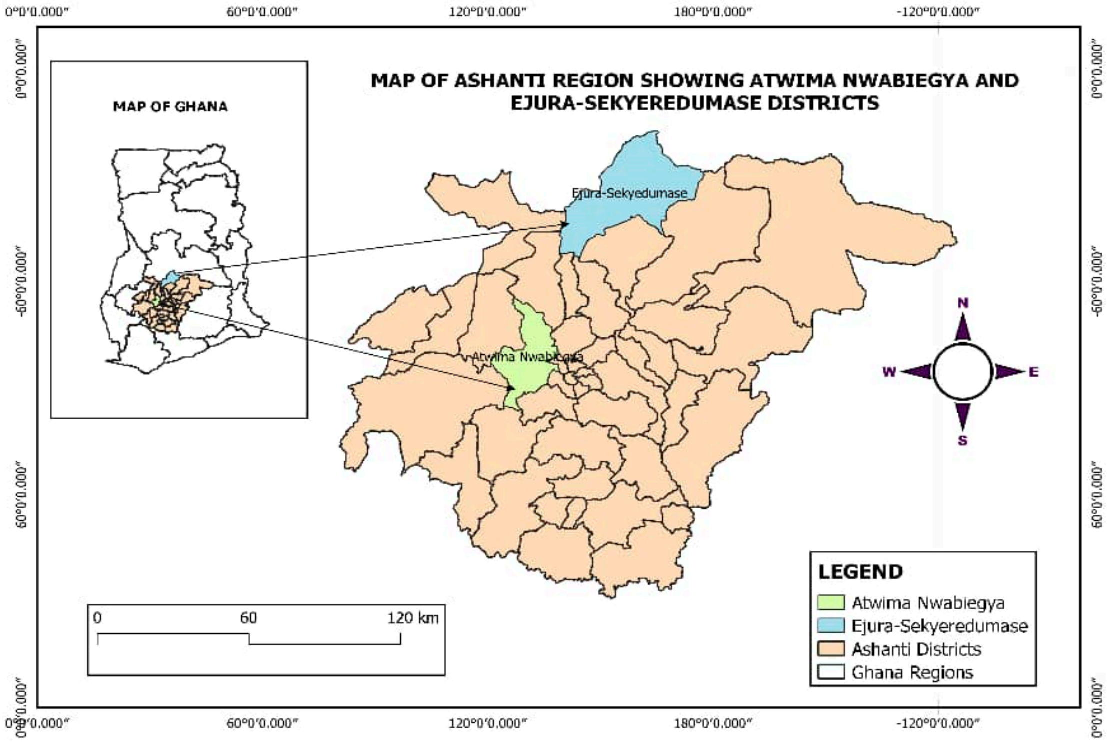


**Figure 1.** Map of Ashanti Region. Source: CERGIS, University of Ghana [21].

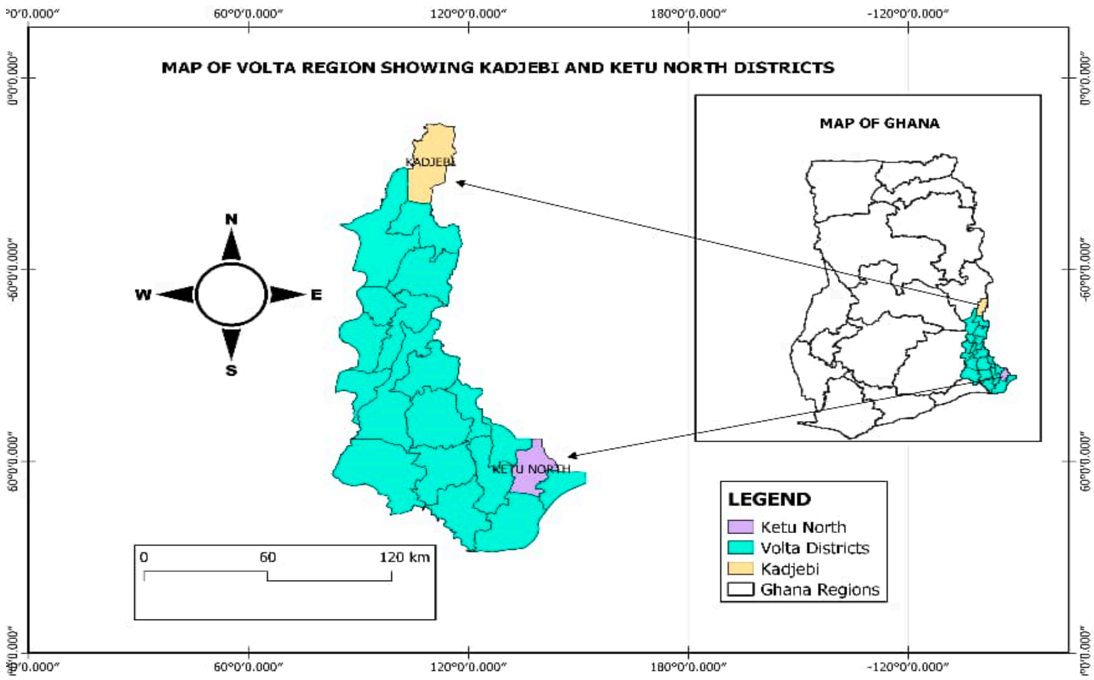


**Figure 2.** Map of Volta Region. Source: CERGIS, University of Ghana [21].

### 2.2. Analytical Methods

Descriptive statistics such as means, percentages, frequencies, tables, and graphs were used to summarize the quantitative data. The perceptions of men and women rice farmers were analyzed using a 5-point Likert scale with the mean perception index estimated as:

$$\overline{x} = \frac{\sum n_i - x_i}{N} \tag{1}$$

where $n_i$ = number of rice farmer who chose the $i$th response to a perception statement;

$x_i$ = the $i$th response;

$N$ = the total number of rice farmers.

Factors influencing participation of men and women farmers in rice-breeding activities were examined using the probit regression model. The participation decision of a farmer in this paper is based on the utility maximization theory [22]. A rice farmer thus would have to participate in a rice-breeding activity if the utility realized is greater than not participating ($U_{i1} > U_{i0}$). This decision is thus binary with a mutually exclusive outcome. This leads to a binary dependent variable, $P_1$, which assumes the values "1" if a farmer participates and "0" if otherwise. Subsequently, the decision to participate or otherwise depends on certain socio-demographic and external factors $X$ (such as sex, age, household size, years of schooling, farm size, farming experience, number of plots, FBO membership, distance to nearest market, and extension contacts) and an error term with zero mean:

$$U_{i1}(X) = p_1 X_i + \delta_{i1} \text{ for participation} \tag{2}$$

$$U_{i0}(X) = p_0 X_i + \delta_{i0} \text{ for non-participation} \tag{3}$$

Thus, observing a value, 1 will result in a probability as

$$P_r = (P_i = 1/x_i p_i) = 1 - G(-x_i p_i) \tag{4}$$

and, for observing 0, it could be estimated as

$$P_r = (P_i = 0/x_i p_i) = G(-x_i p_i) \tag{5}$$

where $G$ is a continuous and strictly increasing cumulative distribution function, which takes a real value and returns a value which ranges from 0 to 1.

Thus, the parameters in the model in Equations (4) and (5) are obtained using the maximum likelihood estimation approach. The dependent variable is an unobserved latent variable that is related to $P_i$ as

$$P_i = p_j X_{ji} + \delta_i \tag{6}$$

where $\delta_i$ is a random disturbance term.

The observed dependent variable is determined by whether the predicted $P_i*$ is greater than 1 or otherwise as:

$$P_i = 1 \; if \; P_i* > 0 \text{ , and } P_i = 0 \; if \; P_i* \leq 0 \tag{7}$$

where $P_i*$ is the threshold value for $P_i$ and is assumed to be normally distributed. The probit regression model adopted for this paper is specified as:

$$\text{Pr}_i = \text{Pr}(P_i* < P_i) = \text{Pr}_i = (P_i* < p_0 + p_j X_{ji}) \tag{8}$$

where $\text{Pr}_i$ is the probability that an individual will decide to participate in rice-breeding activities or not, and $P_i$ is the dependent variable.

Following Asante et al. [18] and Mulwa et al. [23], the access and control resources are modelled following the random utility framework. For example, an $i$th farmer faced the decision to gain access and control in a $j$th technique where $i$ = 1, 2, 3 . . . , $N$ and $j$ = 1, 2, 3 . . . , $J$, i.e., $j$ = access and control of resources such as land, labor, improved seed, weedicide, fertilizer, and insecticide. Let us consider that $P^*$ denotes the difference between the utility from access and control of resources $(U_{iA})$ and the utility from $(U_{iN})$ of specific access and control resources; thus, a randomly selected farmer from given household $i$ will choose to adopt particular access and control resources if $P^* = U_{iA} - U_{iN} > 0$. Subsequently, benefiting from having certain access and control resources is a latent variable, which is determined by observed covariates ($X_i$) and the error term ($\varepsilon_i$) as follows:

$$P_{ij}^* = X_i' \beta_j + \varepsilon_i \tag{9}$$

Then, the two utilities are unobservable but can be expressed for each access and control resource as a function of observable components in the latent variable, specified as:

$$P_{ij} = \begin{cases} 1 & \text{if } P_{ij}^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{10}$$

where $P_{ij}^*$ is a latent variable which denotes the observed and unobserved preferences associated with the $j$th access and control resources, and $P_{ij}$ denotes the binary dependent variables. $\beta_{js}$ are parameters to be estimated. $\varepsilon_k$ represents the multivariate normally distributed stochastic error term [24,25]. In the multivariate probit model, with the possibility of adopting multiple access and control resources, the error terms jointly follow a multivariate normal distribution (MVN) with zero conditional mean and variance normalized to unity, i.e., $(u_G, u_M, u_C, u_S, u_E) \approx \text{MVN}(0, \Omega)$, and the covariance matric $\Omega$ is given by

$$\Omega = \begin{bmatrix} 1 & \rho_{GM} & . & \rho_{GE} \\ \rho_{MG} & 1 & . & . \\ . & . & 1 & \rho_{SE} \\ \rho_{EG} & . & \rho_{ES} & 1 \end{bmatrix} \tag{11}$$

where $\rho$ signifies the pairwise correlation coefficient of the error terms with respect to any two of the estimated participation equations of access and control resources. Subsequently, the off-diagonal elements (e.g., $\rho_{GM}$, $\rho_{MG}$) in the covariance matrix signify the correlation between the stochastic components of the different methods of access and control of resources [23,25,26]. The non-zero value of these correlations in the off-diagonal elements supports the appropriateness of the use of the multivariate probit model. Table 1 presents the explanatory variables used in the model and their measurements.

**Table 1.** Explanatory variables used in the model.

| Variable | Measurement | Expected Sign | Source |
|---|---|---|---|
| Years of schooling | Years | + | [12,27] |
| Experience in rice farming | Years | + | [18,20,28] |
| Farm size | Acre | + | [12,29,30] |
| Dependency ratio | Number | + | [31] |
| Credit access | 1 = Yes and 0 = No | + | [32,33] |
| Participation FBOs | 1 = Yes and 0 = No | + | [27,34,35] |
| Extension contacts | 1 = Yes and 0 = No | + | [36,37] |
| Number of rice plots | Number | + | [29,30] |
| Market distance | Km | − | [38] |

For the qualitative data, the primary units for the research are men and women rice farmers in the rice-growing communities. Both investigative and descriptive approaches were used to examine the gender norms and power dynamics in rice-growing communities and their influence on differences in participation in men and women farmers in rice-breeding activities in southern Ghana.

Qualitative data were transcribed and coded. Codes included limited access and control over production resources, restrictions on participation in field days, restrictions in participation in on-farm evaluations, and involvement in household decision making on resource use. Analysis of the qualitative data was guided by the quantitative analysis in order to triangulate and provide more in-depth understanding of the findings.

## 3. Results and Discussions

### *3.1. Demographic, Institutional, and Farm-Level Characteristics of Farmers*

Table 2 presents the socio-demographic and institutional characteristics of the farmers by gender. Respondents averaged seven people per household, and the average age of the farmers was 46 years. With regards to years of formal education, the mean years of schooling for women farmers was four (4) years while that of men was seven (7) years. Moreover, the men had a higher average number of years in rice cultivation than the women farmers. Among all respondents, the average number of years in rice cultivation was 12. Men and women reported a significant difference in average years in rice cultivation: men averaged 13, while women averaged 10 years. There was also a significant difference in mean off-farm income/Yr (GHC); for women farmers, it was GHC 2,501 and GHC 3,754 for men.

**Table 2.** Socio-demographic and institutional characteristics of participants by gender.

| Variables | Gender | | | | | | t-Stat. |
|---|---|---|---|---|---|---|---|
| | Women (*N* = 146) | | Men (*N* = 169) | | Pooled (*N* = 315) | | |
| | Mean | SD | Mean | SD | Mean | SD | |
| Age | 46 | 11.51 | 45 | 12.95 | 46 | 12.29 | 0.57 |
| Years of schooling | 4 | 4.61 | 7 | 4.77 | 6 | 4.95 | −5.97 *** |
| Rice experience | 10 | 8.10 | 13 | 10.46 | 12 | 9.56 | −2.74 *** |
| Off-farm income/Yr. (GHC) | 2501 | 1.51 | 3754 | 1.56 | 3049 | 1.40 | −1.76 ** |
| Total HHM | 8 | 4.27 | 7 | 3.63 | 7 | 3.94 | 0.77 |
| [a] Credit access (Yes = 1) | 0.21 | 0.42 | 0.35 | 0.43 | 0.29 | 0.42 | −2.82 *** |
| Cash credit accessed (GHC) | 1100 | 0.90 | 1516 | 0.88 | 1341 | 0.90 | −2.53 *** |
| Extension visit/year | 2 | 2.65 | 2 | 2.25 | 2 | 2.44 | −0.62 |
| [a] FBO Membership (Yes = 1) | 0.39 | 0.50 | 0.53 | 0.50 | 0.47 | 0.50 | −2.54 ** |

HHM = household members; SD = standard deviation; [a] measured in percentages; the asterisks **, and *** denote significance at the 5%, and 1% significance levels.

Overall, 29% of respondents had access to credit. However, a greater proportion of men had credit (35%) than women (21%) ($p$-value= 0.000). This is consistent with Akpan et al. [39], who posited that men are more likely to access credit than women are. Women respondents also received less credit (GHC 1,100) than men (GHC 1,516). In most countries, credit accessed by women is 5 to 10% lower than that of men [40]. The ratio of extension officer to farmer is estimated at one extension agent to 1500 farmers [41]. There was a significant difference between men's and women's farmer-based organization (FBOs) participation, with 39% of the women being members whereas 53% of the men were. Factors such as socio-cultural norms, perceptions, access to assets and resources, and time affect women's participation in farmer-based organizations [37]. These factors restrict women from participating in such farmer group activities because of how they create gender-based constraints that limit the ability of women to anticipate in such interventions.

Table 3 presents a summary of the farm-level factors of rice farmers by gender. On average, every household has three (3) members involved in rice production. With regards to the total land size, women cultivate an average of two acres, which is significantly different from that of men, who average three acres. Overall, both women and men rice farmers cultivated an average of one plot of rice farm and cultivated an average of once per year. On the whole, most of the sampled rice farmers cultivated rice in lowland rice ecology (95%), and this was consistent among men and women rice farmers.

**Table 3.** Summary of farm-level factors by gender.

| Variables | Gender | | | | | | |
|---|---|---|---|---|---|---|---|
| | Women ($N$ = 146) | | Men ($N$ = 169) | | Pooled ($N$ = 315) | | t-Stat. |
| | Mean | SD | Mean | SD | Mean | SD | |
| HHM in rice production | 3 | 1.90 | 3 | 1.78 | 3 | 1.84 | −0.01 |
| Total land size (acres) | 2 | 1.71 | 3 | 1.86 | 2 | 1.80 | −1.66 ** |
| Number of plots | 1 | 1.09 | 1 | 0.57 | 1 | 0.85 | 0.82 |
| Number of cultivation times | 1 | 0.50 | 1 | 0.39 | 1 | 0.45 | 0.08 |
| Lowland rice ecology | 0.94 | 0.02 | 0.96 | 0.01 | 0.95 | 0.12 | −0.92 |

HHM = household members; SD = standard deviation; the asterisks ** denote significance at the 5% levels.

### 3.2. Perceptions of Rice-Breeding Activities among Men and Women Farmers

Table 4 illustrates the perceptions of men and women farmers on rice-breeding activities. The results show that the overall perception was 4.01 and 3.95 for men and women farmers, respectively. This indicates that, generally, both men and women had strong positive perception of rice-breeding activities, inferring that they generally perceive these activities as beneficial to production.

**Table 4.** Perceptions of rice-breeding activities among men and women farmers in southern Ghana.

| | Women ($N$ = 146) | | | | | | Men ($N$ = 169) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Perceptions** | **SD (1)** | **D (2)** | **N (3)** | **A (4)** | **SA ‡ (5)** | **Index** | **SD (1)** | **D (2)** | **N (3)** | **A (4)** | **SA (5)** | **Index** |
| Offers rice farmers opportunity to express their preference for a new rice variety | - | 4 (3) | 20 (14) | 85 (58) | 37 (25) | 4.06 | - | - | 20 (12) | 100 (59) | 49 (29) | 4.17 |
| Allows rice farmers to be actively involved in rice variety development process | - | 4 (3) | 23 (16) | 81 (56) | 38(26) | 4.05 | - | 1 (1) | 24 (14) | 97 (57) | 47(28) | 4.12 |
| Gives rice farmers a sense of owning the new variety | - | 2 (1) | 30 (21) | 82 (56) | 32(22) | 3.99 | - | 5 (3) | 27 (16) | 101 (60) | 36(21) | 3.99 |
| Involves the preferences of both men and women | - | 3 (2) | 28 (19) | 79 (54) | 36 (25) | 4.01 | 1 (1) | 3 (2) | 25 (15) | 87 (52) | 53(31) | 4.11 |
| Women's opinions are fully taken into consideration | 2 (1) | 10 (7) | 41 (28) | 63 (43) | 30 (21) | 3.75 | 1 (1) | 20 (12) | 37 (22) | 70 (41) | 41 (24) | 3.77 |
| There is high women involvement in this community | 1 (1) | 7 (5) | 44 (30) | 59 (40) | 35 (24) | 3.82 | - | 16 (10) | 37 (22) | 73 (43) | 43 (25) | 3.85 |
| Facilitates adoption of improved rice varieties | - | 3 (2) | 28 (19) | 87 (60) | 28 (19) | 3.96 | 1 (1) | 4 (2) | 26 (15) | 101 (60) | 37 (22) | 4.00 |
| Facilitates strong researcher–farmer collaboration for development | 1 (1) | 1 (1) | 25 (17) | 95 (65) | 24 (16) | 3.96 | - | 3 (2) | 26 (15) | 99 (59) | 41 (24) | 4.05 |
| **Overall Perception Index** | | | | | | **3.95** | | | | | | **4.01** |

‡ (SA) = strongly agree; (A) = agree; (N) = neutral; (D) = disagree; (SD) = strongly disagree. Figures in parentheses are percentages.

In relation to the perception that rice-breeding activity offers farmers the opportunity to express their preference for a new rice variety, 88% of the men and 83% of women were in agreement (either agreed or strongly agreed). Again, 85% of men and 82% of women agreed to the perception that rice-breeding activity allows rice farmers to be actively involved in rice variety development, respectively. The perception that rice-breeding activities give rice farmers a sense of owning the new variety was also agreed by a majority (78%) of the women farmers, whereas 60% and 21% of the men farmers agreed and strongly agreed, respectively, with a perception index of 3.99 for both men and women.

Moreover, on the perception that rice-breeding activity involves the preferences of both men and women, 52% of the men agreed, whereas 31% strongly agreed. However, for the women farmers, 54% agreed and 25% strongly agreed with this notion. This implies that, overall, women feel that when it comes to rice-breeding activities, both men and women are involved.

In relation to the perception that rice-breeding activity fully takes into consideration women's opinions, 13% of farmers disagree, whereas 65% agree. Moreover, with a perception index of 3.85, both the men and women farmers agreed that women are involved in rice-breeding activities in the community. However, it was evident that women are faced with certain hindrances such as being occupied with household chores and other household duties which limit their availability to participate and hence share their opinions during such breeding activities, coupled with their inability to freely express their opinions in the presence of men [42]. Furthermore, the majority of both men and women agreed that rice participatory breeding activities facilitate the adoption of improved rice varieties by stimulating strong researcher–farmer collaboration.

### *3.3. Access and Control of Resources by Men and Women Rice Farmers in Southern Ghana*

In this paper, we define access as having no restrictions on the ability to acquire and use the resource when needed. In other words, if the farmer wants to have land with available money, can she/he obtain it in this community? However, control goes beyond access to determine who can use and who cannot use the resource [33,43]. The distribution of access to production resources by men and women rice farmers is presented in Table 5a. These resources include land, labor, improved seeds, extension, fertilizers, weedicides, and insecticides. The result shows that access to production resources for rice-production activities between men and women varied significantly. Men are more likely to have access to production resources such as land, credit, and extension services [13,44]. The result shows that less than half (49%) of women farmers had access to land as compared to the 65% of men who had access to land for rice production, which is significant at the 1% level. Enwelu et al. [19] indicated that 98% of women had access to land through the involvement of a husband or a male relative in Nigeria. Again, compared to women, more men had significant access to labor than the women. According to Haile et al. [13], male-headed households have higher access to resources compared to female counterparts. Our results suggest that only 47% of the women have access to labor, and more than half of the men (63%) have access to labor. About 61% of women farmers had access to improved rice seeds compared to 71% of the men having access to improved seeds.

**Table 5.** (**a**) Access to resources among men and women rice farmers in southern Ghana. (**b**) Control of resources among men and women rice farmers in southern Ghana.

**(a)**

| Resource | Gender | | | | | | t-Stat. |
|---|---|---|---|---|---|---|---|
| | Women (*N* = 146) | | Men (*N* = 169) | | Pooled (*N* = 315) | | |
| | Mean | SD | Mean | SD | Mean | SD | |
| Land (acre) | 0.49 | 0.50 | 0.65 | 0.48 | 0.58 | 0.49 | −2.93 *** |
| Labor (man-days) | 0.47 | 0.50 | 0.63 | 0.48 | 0.56 | 0.49 | −2.98 *** |
| Improved seeds (kilo) | 0.61 | 0.49 | 0.75 | 0.43 | 0.69 | 0.46 | −2.76 *** |
| Fertilizers (kg) | 0.67 | 0.47 | 0.78 | 0.41 | 0.73 | 0.44 | −2.34 ** |
| Weedicides (liter) | 0.80 | 0.40 | 0.91 | 0.28 | 0.86 | 0.34 | −2.77 *** |
| Insecticides (liter) | 0.81 | 0.40 | 0.94 | 0.24 | 0.87 | 0.32 | −3.76 *** |

**Table 5.** *Cont.*

| Resource | Women (N = 146) | | Men (N = 169) | | Pooled (N = 315) | | t-Stat. |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | |
| Land | 0.62 | 0.49 | 0.67 | 0.43 | 0.70 | 0.46 | −2.76 *** |
| Labor | 0.49 | 0.50 | 0.61 | 049 | 0.56 | 0.50 | −2.16 ** |
| Improved seeds | 0.46 | 0.50 | 0.61 | 0.49 | 0.54 | 0.50 | −2.69 *** |
| Fertilizers | 0.42 | 0.50 | 0.56 | 0.50 | 0.50 | 0.50 | −2.45 ** |
| Weedicides | 0.44 | 0.50 | 0.54 | 0.50 | 0.49 | 0.50 | −1.66 * |
| Insecticides | 0.33 | 0.47 | 0.57 | 0.50 | 0.46 | 0.50 | −4.36 *** |

(b) Gender

SD = standard deviation; the asterisks *, **, and *** denote significance at the 10%, 5%, and 1% significance levels.

The variation in seeds access is statistically significant at the 1% level. Furthermore, at the 5% level of significance, 67% of women had access to fertilizers compared to 78% among the men. Similarly, but at a 1% significance level relatively, more men had access to weedicides and insecticides.

From the qualitative results, men had more access to productive resources than women. This ties in with the results obtained from the quantitative studies. The men have access and control of productive and household resources. In a case where a woman is able to source for her own resource, the use of that resource and when she can use it is subject to her husband's approval. Women cannot access farmlands by themselves. They have to obtain land for rice cultivation through their husbands as well as to provide the resources for rice production. The case with labor was also not different because the resources to source for labor were controlled by men; hence, men had more access than women in all the locations studied.

> " . . . men have more access but women are now trying to manipulate things for equality in resource access. But in general, its men because like I said earlier it's an existing norm and most women too feel inferior with regards to resource access."
>
> (Agricultural Extension Officer, Aframso)
>
> " . . . the men always have easy access to these inputs because men have the strength to work efficiently than women. And also men are always the decision makers in the household[.]"
>
> (Man farmer, Aframso)

According to men farmers in Dekpor, control of resources was dependent on the marital status of the woman, in that, for women farmers who were not married, they control their own resources unlike married women who took instructions from their husband, since culturally the man is seen as the head of the household. Even when couples cultivate separate farms, in most cases each has control of their own resources, but it is the man's own resources that are used to take care of the house. Men farmers in Aframso emphasizing a similar view stated that men's control of resources has been the tradition and not even modernization can change that overnight.

Control over the use of farm resources among men and women in a household is illustrated in Table 5b. From the results depicted in the table, a significant variation at the 1% level is shown between the gender groups with regards to land control. It is shown that men have control over land resources in the household, as a higher percentage of them as compared to the women controlled the land use in their households. Only a few women actually have control over the land they cultivate [45,46], partly because men are traditionally seen as the head of the household and hence control the use of production resources. With regards to labor use, men are again seen to have a significant upper hand in the household as compared to women. Moreover, 61% of the men have control over improved seeds for production, whereas a lower percentage (42%) of the women have control over improved seeds in their households. Furthermore, 58% of women do not have control over fertilizers in their households, whereas 56% of men have control over fertilizers used in the household. This variation is significant at 1% among the gender groups. The situation is no different with regards to control over the usage of weedicides and herbicides in the household. Significantly, the majority of men have control over these resources, unlike among the women where the majority do not have control. This is further reiterated by a 45-year-old respondent from the women FGDs in the Dekpor community who indicated that:

> "Men are more superior and the head of the family in this our community so they tend to have an upper hand when it comes to control over resources."

This finding is supported by a female key informant when asked the question "among men and women who have control over production resources in the household in this community and why?" She stated that:

> " . . . Men have control, because it has been the tradition and moreover modernization as to superiority just started in the community unlike the tradition/norm which has been there for centuries and just can't be changed at once. So, as it stands now men have control over resources of production."

A similar response was also given by Malik during a focus group discussion for men in the Aframso community who stated also that:

> "...Even if they are in the same family, the men still have the advantage to use the land because definitely, the male will be the household head in his nuclear family, and also society has made it so."

These findings correspond with Enwelu et al. [19] who found that most women have access to land for crop-farming activities through the involvement of a husband or a male relative. Similar conclusions were reached by FAO [45] that men strongly dominate decision-making processes and leadership in households, hence dominating in terms of access and control of production resources. In a case where a woman is able to source for her own resources, the use of that resource and when it is used are most often subject to her husband's approval.

### *3.4. Participation in Rice-Breeding Activities among Men and Women Farmers*

Presented in Table 6 is the summary of statistics of participation in rice-breeding activities among men and women farmers. The t-statistic indicates a significant difference at the 1% level between the men and women with regards to participation in on-farm evaluations and field days. Specifically, the porportion of women who participated in both breeding activities was significantly lower than that of men.

**Table 6.** Participation in on-farm evaluations and field days.

| Rice-Breeding Activities | Gender | | | | | | t-Stat. |
|---|---|---|---|---|---|---|---|
| | Women ($N$ = 146) | | Men ($N$ = 169) | | Pooled ($N$ = 315) | | |
| | Mean | SD | Mean | SD | Mean | SD | |
| [a] On-farm Evaluation | 0.38 | 0.04 | 0.53 | 0.03 | 0.47 | 0.03 | −2.56 *** |
| [a] Field Days | 0.37 | 0.04 | 0.58 | 0.04 | 0.49 | 0.02 | −3.67 *** |

SD = standard deviation; [a] measured in percentages; the asterisks *** denote significance at the 1% significance levels.

This implies that participation in rice-breeding activities among women farmers is indeed lower compared to men. This could be due to constraints and cultural reservations, which are major hindrances to women participating in extension activities such as field days and on-farm evaluations [47]. Moreover, a lack of access to resources can be another setback to why women fail to engage in agricultural development projects, as it hinders them from obtaining the necessary tools to participate [13]. Kaaria et al. [37] also revealed that women dedicated little time to crop production and other related farming activities because of the extra responsibilities at the household level such as taking care of children and husbands and taking up full-time jobs.

In relation to participation in research activities in general, both men and women farmers in the Aframso community indicated they had equal opportunities to participate in on-farm evaluations. As much as it was open to all, women were constrained by the numerous household chores they had to attend to; hence, they either went to such activities late or had to leave early to attend to housekeeping activities.

### *3.5. Factors Influencing Participation in Rice-Breeding Activities among Women and Men Farmers in Southern Ghana*

Table 7 presents the factors influencing participation in rice-breeding activities among men and women farmers in southern Ghana. In this study, the rice-breeding activities were grouped into field days and on-farm evaluations. The results show the statistical significance of the model and Wald chi-square values of 85.64 and 115.28 for women and men, respectively. Rice-farming experience, dependency ratio (this is the ratio of the number of dependents to the number of economically active household members), years of schooling, FBO participation, distance to market, extension contacts, number of rice plots, farm size, and extension contacts are the major factors identified to influence participation in rice-breeding activities.

**Table 7.** Factors influencing participation in rice-breeding activities among men and women rice farmers in southern Ghana.

| Variable | Women | | Men | |
|---|---|---|---|---|
| | Field Days | On-Farm Evaluation | Field Days | On-Farm Evaluation |
| | ME † | ME | ME | ME |
| Years of Schooling | 0.0153 *** | 0.0018 | −0.0005 | 0.0107 *** |
| | (0.0043) | (0.0047) | (0.0039) | (0.0041) |
| Experience in rice farming | −0.0021 | 0.0049 * | −0.0005 | 0.0042 ** |
| | (0.0025) | (0.0026) | (0.0017) | (0.0019) |
| Credit access | −0.0107 | −0.0260 | 0.0735 * | 0.1160 *** |
| | (0.0515) | (0.0538) | (0.0380) | (0.0404) |
| Participation FBOs | 0.1755 *** | 0.2596 *** | 0.2077 *** | 0.2466 *** |
| | (0.0403) | (0.0457) | (0.0357) | (0.0399) |
| Extension contacts | 0.0391 *** | 0.0056 | 0.0349 *** | 0.0003 |
| | (0.0085) | (0.0086) | (0.0073) | (0.0074) |
| Number of rice plots | 0.2265 *** | 0.1878 *** | 0.1551 *** | 0.1048 ** |
| | (0.0489) | (0.0568) | (0.0580) | (0.0422) |
| Farm size (acre) | 0.0452 *** | 0.0250 ** | 0.0356 *** | 0.0390 *** |
| | (0.0117) | (0.0120) | (0.0113) | (0.0107) |
| Market distance (km) | −0.0158 *** | −0.0158 *** | −0.0115 *** | −0.0178 *** |
| | (0.0049) | (0.0038) | (0.0034) | (0.0040) |
| Dependency ratio | 0.3903 *** | 0.2098 *** | 0.7511 *** | 0.4239 *** |
| | (0.1092) | (0.0710) | (0.0954) | (0.1048) |
| Observations | 146 | | 169 | |
| Wald chi2(9) | 85.64 | | 115.28 | |
| LR test | 87.8484 | | 206.17 | |
| Prob > chi2 | 0.000 | | 0.000 | |

† ME denotes marginal effect. the asterisks *, **, and *** denote significance at the 10%, 5%, and 1% significance levels.

More years of formal schooling enhance rice farmers' probability to participate in rice-breeding activities. Literate farmers are more likely to seek improved technology or knowledge as they are better able to understand and hence adopt and put new ideas to use [18]. According to Farid et al. [27], educated farmers are able to decipher the benefits of improved technologies faster and are able to decide which innovations will optimally benefit their production when adopted.

Experience in rice farming was positively related to participation in rice-breeding activities. This implies more experienced rice farmers are more likely to participate in field days and on-farm evaluations. Experienced rice farmers tend to be more conversant with most of the cultural practices in rice production and are hence more likely to try improved varieties [20].

This finding is consistent with Martey et al. [48] who posited that farmers who have worked for longer years are usually more experienced and endowed; hence, they may have either experienced or observed the benefits of participating in an agricultural project. Similarly, the dependency ratio was significant among both gender groups, indicating that the higher the number of dependents, the more likely it is for a farmer to participate in rice-breeding activities. This implies that dependents serve as an additional work force for farmers and may help activities (field days and on-farm evaluations) of the gender groups.

Distance to the nearest market significantly and negatively influenced participation in rice-breeding activities in both gender groups. This implies that the farther the market from the community, the less likely a farmer will participate in rice-breeding activities. A farmer who has frequent contact with extension services is more likely to participate in breeding activities. In addition to breeders and researchers, extension agents are an important source of information about breeding activities for farmers, as they inform and organize farmers for breeding-related events. This is also evident by the response of a male participant when asked of their source of information on breeding activities during the focus group discussion in Dekpor community: "The extension officer tells us when breeding activities will take place". The participation of farmer-based groups positively and significantly influenced participation in rice-breeding activities among women and men. Mostly, participant farmers who are members of FBOs seeks the technical advice and benefits of participating in rice activities, as stated in a comment by a female participant in Aframso community.

Farm size positively and significantly influenced participation in rice-breeding activities among both men and women rice farmers. It is more likely for farmers with larger farm sizes to participate in such activities, as they have the capacity to allocate a portion of their plots to try improved varieties. Moreover, farmers with numerous plots of rice are more likely to participate in rice-breeding activities, and this was greatly significant among women than men.

### *3.6. Factors Influencing Access to Resources in Rice-Breeding Activities among Men and Women Farmers in Southern Ghana*

Table 8 presents the multivariate probit estimates of the factors influencing access to resources in rice-breeding activities among men and women rice farmers in southern Ghana. The positive years of schooling among men in accessing resources in rice breeding imply that more educated farmers are more likely to participate in rice-breeding activities. For instance, educated farmers have the ability to understand the benefits of participation in rice breeding than uneducated farmers. Moreover, women were noted to adopt new technologies much slower than men [18,20,28,44].

**Table 8.** Factors influencing access to resources in rice-breeding activities among men and women rice farmers in southern Ghana.

| Variables | Women | | | | | | Men | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Land | Labor | Improved Seed | Fertilizer | Weedicide | Insecticide | Land | Labor | Improved Seed | Fertilizer | Weedicide | Insecticide |
| | ME | ME | ME | ME | ME | ME | ME | ME | ME | ME | ME | ME |
| Years of Schooling | 0.0058 | 0.0017 | 0.0029 | 0.0039 | 0.0021 | 0.0057 | 0.0065 | 0.0074 * | 0.0154 *** | 0.0113 *** | 0.0027 | 0.0054 ** |
| | (0.0053) | (0.0051) | (0.0054) | (0.0051) | (0.0045) | (0.0044) | (0.0042) | (0.0043) | (0.0041) | (0.0039) | (0.0026) | (0.0023) |
| Experience in rice arming | −0.0039 | 0.0085 *** | 0.0004 | 0.0003 | −0.0036 | −0.0022 | −0.0014 | 0.0013 | −0.0003 | 0.0009 | 0.0001 | −0.0002 |
| | (0.0029) | (0.0028) | (0.0029) | (0.0028) | (0.0025) | (0.0024) | (0.0019) | (0.0020) | (0.0020) | (0.0018) | (0.0012) | (0.0011) |
| Credit access | 0.1616 *** | 0.1958 *** | 0.0857 | 0.0034 | 0.0642 | 0.0305 | 0.0561 | 0.0027 | 0.1538 *** | 0.0731 * | 0.0558 ** | 0.0576 *** |
| | (0.0601) | (0.0584) | (0.0618) | (0.0577) | (0.0513) | (0.0505) | (0.0410) | (0.0418) | (0.0405) | (0.0377) | (0.0252) | (0.0223) |
| Participation FBOs | 0.2249 *** | 0.1133 ** | 0.0197 | 0.1790 *** | 0.1391 *** | 0.1790 *** | 0.2242 *** | 0.0606 | 0.0527 | 0.1428 *** | 0.0426 * | −0.0091 |
| | (0.0510) | (0.0496) | (0.0526) | (0.0490) | (0.0436) | (0.0429) | (0.0404) | (0.0412) | (0.0403) | (0.0372) | (0.0249) | (0.0220) |
| Extension contacts | 0.0294 *** | 0.0165 * | 0.0104 | 0.0151 | 0.0088 | 0.0065 | 0.0272 *** | 0.0262 *** | 0.0181 ** | 0.0013 | 0.0116 ** | 0.0055 |
| | (0.0096) | (0.0093) | (0.0096) | (0.0092) | (0.0082) | (0.0081) | (0.0075) | (0.0077) | (0.0077) | (0.0069) | (0.0046) | (0.0041) |
| Number of rice plots | 0.1203 * | 0.1943 *** | 0.0222 | 0.2936 *** | 0.0292 | 0.0595 | 0.0655 | 0.0766 * | −0.1200 ** | −0.0702 * | −0.0115 | −0.0219 |
| | (0.0635) | (0.0617) | (0.0646) | (0.0610) | (0.0542) | (0.0534) | (0.0428) | (0.0436) | (0.0495) | (0.0394) | (0.0263) | (0.0232) |
| Farm size | −0.0037 | 0.0525 *** | −0.0101 | −0.0308 ** | −0.0332 *** | −0.0002 | 0.0244 ** | 0.0028 | 0.0076 | 0.0061 | −0.0071 | −0.0128 ** |
| | (0.0135) | (0.0131) | (0.0144) | (0.0129) | (0.0115) | (0.0113) | (0.0109) | (0.0111) | (0.0110) | (0.0100) | (0.0067) | (0.0059) |
| Market distance (km) | −0.0009 | −0.0039 | −0.0137 *** | −0.0008 | −0.0014 | −0.0023 | 0.0005 | 0.0051 | −0.0093 ** | −0.0048 | −0.0066 *** | −0.0006 |
| | (0.0042) | (0.0041) | (0.0046) | (0.0041) | (0.0036) | (0.0035) | (0.0040) | (0.0041) | (0.0044) | (0.0037) | (0.0025) | (0.0022) |
| Dependency ratio | 0.1330 * | 0.1463 * | −0.0351 | −0.0704 | −0.0326 | −0.0651 | 0.6847 *** | 0.3565 *** | −0.1439 | −0.1039 | −0.0857 | −0.0139 |
| | (0.0793) | (0.0771) | (0.0862) | (0.0762) | (0.0678) | (0.0667) | (0.1062) | (0.1083) | (0.1061) | (0.0977) | (0.0654) | (0.0577) |
| Observations | 146 | | | | | | 169 | | | | | |
| Wald chi2(9) | 322.03 | | | | | | 402.83 | | | | | |
| LR test | 54.65 | | | | | | 233.50 | | | | | |
| Prob > chi2 | 0.000 | | | | | | 0.000 | | | | | |

The asterisks *, **, and *** denote significance at the 10%, 5%, and 1% significance levels.

Experience in rice farming was significant and positive among women in rice-breeding activities. Experienced women are more likely to have access to labor as a resource than their male counterparts. Generally, most women farmers tend to support workers on rice farms by providing food and water [19,20]. However, there was no relationship between access to resources and experience in rice farming among men.

Credit access was positive and significant among both women and men in accessing resources such as land, labor, improved seeds, fertilizer, weedicides, and insecticides. The results show that men had access to four out of six resources significantly higher than two out of six resources among women. This implies that men generally tend to have access to most of the rice-breeding resources compared to the difficulty in accessing resources among women. Moreover, women have limited access to agricultural credit and an especially low amount without a husband as a guarantor [32,33,49,50].

With regards to women's access to resources such as land, labor, fertilizer, weedicide, and insecticide, rice farmers who are FBO participants tend to influence such resources positively and with a significance level of 1%. For instance, the likelihood of rice-breeding farmers obtaining fertilizer, weedicide, and pesticide increases marginally by 17%, 13%, and 17%, respectively. On the other hand, men who are participants in FBOs are more likely to access all resources except insecticide and improved seed. Generally, high access of resources for rice-breeding activities is associated with formations of rice farmer groups, which the government and NGOs believe to be able to work efficiently and effectively with rice farmers.

Extension contacts are one of the variables that influence rice farmers' breeding activities among women and men. Out of the six resources provided, only two resources (land and labor) were found to be positive and significant among women. However, four of the resources (land, labor, improved seed, and weedicide) were found to be significantly positive among men. In Ghana, extension agents play a key role in terms of giving technical advice when it comes to accessing resources. For instance, frequent visits from extension agents among men's rice-breeding activities encourage access to improved seed by 1.8%. This is consistent with Haile et al. [13] and Dittoh et al. [36], who found out that male extension officers further constrained women's access to resources.

Farm size and number of plots are among the factors that influence rice-breeding access to resources among women and men. Women with a number of rice plots are more likely to access fertilizer, labor, and land. Moreover, smaller farm size tends to decrease rice farmers' probability of accessing fertilizer and weedicide; however, this increases access to the labor resources. Few numbers of rice plots decrease the likelihood of men rice farmers accessing improved seeds and fertilizers. Further, men tend to access less of the insecticide, but they have a high likelihood of obtaining large farm size.

Distance to markets is a key variable influencing rice-breeding activities among women and men in southern Ghana. Among women, market distance was negative and significantly affected access to improved seed. This implies that an additional distance to the market discourages access to improved seed. However, the men's results show that market distance has a negative effect and significantly affects access to improved seeds and weedicide. Usually, longer distance discourages resources access in rice-breeding activities for both genders [38,51]. The dependency ratio showed a positive and significant effect on land and labor resources among women and men, implying that a high dependency ratio tends to increase the likelihood of accessing labor and land resources. For instance, a low ratio means that both women and men rice farmers in breeding activities could have a lot of household members engaged in economically active activities, thus increasing the general involvement in rice-breeding activities.

### *3.7. Factors Influencing Control of Resources in Rice-Breeding Activities among Men and Women Farmers in Southern Ghana*

Table 9 presents marginal effects of the multivariate probit estiamtes of the factors influencing the control of resources in rice-breeding activities among men and women rice farmers in southern Ghana, i.e., the control of resources such as land, labor, improved seed, fertilizer, weedicide, and insecticide.The coefficiencts of these estimates are presented Appendix A. The LR test was significant at 1% with a Wald chi2 of 439.50 and 289.89 among women and men, respectively. The results show that years of schooling influence the control of resources among women and men. Among women, years of schooling likely have a negative and significant effect on land and fertilizer but a positive and significant effect on improved seed. With men, years of schooling have a negative and significant effect on fertilizer and insecticide. Generally, rice farmers control of such resources; thus, land, fertilizer, and insecticide are in the hands of elderly people, whose education years mostly did not matter in terms of control.

The negative and significant effect of experience in rice-breeding activities among women implies that women are less likely to control resources such as land and fertilizer. Experience in rice-breeding activities plays a role, as rice farmers have acquired deep knowledge about breeding activities, but it is not a sign of control of resources. However, all control variables were not significant among men, implying that, generally, experience does not guarantee resources control. Farm size was positive and significant for men with regards to control of land. However, among women it was found out that farm size has a negative influence and significant effect on three (3) out of six (6) control resources including land, weedicides, and insecticides. This implies that women's control of such resources in rice farming decreases as long as women farmers operate with a small farm size. Moreover, the number of rice plots has a positive and significant influence on land but decreases women's control of resources such as labor and improved seed. On the other hand, men farmers especially, had a surprising number of rice plots, which decreased control of land and was significant at 1%.

**Table 9.** Factors influencing control of resources in rice-breeding activities among men and women rice farmers in southern Ghana.

| Variables | Women | | | | | | Men | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Land | Labor | Improved Seed | Fertilizer | Weedicide | Insecticide | Land | Labor | Improved Seed | Fertilizer | Weedicide | Insecticide |
| | ME | ME | ME | ME | ME | ME | ME | ME | ME | ME | ME | ME |
| Years of Schooling | −0.0165 *** | −0.0029 | 0.0104 * | −0.0116 ** | 0.0011 | 0.0037 | −0.0019 | 0.0030 | −0.0058 | −0.0160 *** | −0.0056 | −0.0105 ** |
| | (0.0051) | (0.0054) | (0.0056) | (0.0054) | (0.0055) | (0.0055) | (0.0040) | (0.0043) | (0.0045) | (0.0045) | (0.0046) | (0.0046) |
| Experience in rice farming | −0.0115 *** | −0.0028 | −0.0018 | −0.0051 * | −0.0028 | −0.0041 | 0.0020 | 0.0004 | 0.0030 | 0.0008 | 0.0026 | 0.0017 |
| | (0.0028) | (0.0029) | (0.0031) | (0.0029) | (0.0030) | (0.0030) | (0.0020) | (0.0020) | (0.0021) | (0.0021) | (0.0021) | (0.0021) |
| Credit access | 0.1349 ** | 0.2374 *** | 0.1120 * | 0.1591 *** | 0.2671 *** | 0.0328 | 0.1332 *** | 0.1252 *** | 0.1330 *** | 0.1008 ** | 0.0139 | 0.1042 ** |
| | (0.0590) | (0.0617) | (0.0639) | (0.0613) | (0.0622) | (0.0621) | (0.0398) | (0.0420) | (0.0442) | (0.0440) | (0.0447) | (0.0445) |
| Participation FBOs | 0.1785 *** | 0.0942 * | −0.0471 | 0.2463 *** | 0.1031 * | 0.0504 | 0.1780 *** | 0.1412 *** | −0.0315 | 0.0019 | 0.0857 * | 0.1453 *** |
| | (0.0499) | (0.0524) | (0.0543) | (0.0521) | (0.0528) | (0.0527) | (0.0380) | (0.0414) | (0.0436) | (0.0434) | (0.0441) | (0.0440) |
| Extension contacts | 0.0293 *** | 0.0011 | 0.0002 | 0.0346 *** | 0.0013 | 0.0041 | 0.0194 *** | 0.0232 *** | 0.0019 | 0.0223 *** | 0.0123 | 0.0013 |
| | (0.0109) | (0.0099) | (0.0102) | (0.0098) | (0.0099) | (0.0099) | (0.0070) | (0.0077) | (0.0081) | (0.0081) | (0.0082) | (0.0082) |
| Number of rice plots | 0.3203 *** | −0.1225 * | −0.1724 ** | 0.0781 | 0.0047 | 0.0378 | −0.1188 *** | −0.0553 | −0.0455 | −0.1812 *** | −0.1029 ** | −0.0682 |
| | (0.0703) | (0.0652) | (0.0675) | (0.0648) | (0.0657) | (0.0656) | (0.0363) | (0.0438) | (0.0461) | (0.0459) | (0.0467) | (0.0465) |
| Farm size | −0.0229 * | 0.0133 | −0.0058 | −0.0181 | −0.0615 *** | −0.0306 ** | 0.0372 *** | 0.0061 | 0.0124 | 0.0320 *** | −0.0113 | 0.0174 |
| | (0.0132) | (0.0138) | (0.0143) | (0.0137) | (0.0139) | (0.0139) | (0.0107) | (0.0111) | (0.0117) | (0.0117) | (0.0119) | (0.0118) |
| Market distance (km) | −0.0145 *** | −0.0133 *** | −0.0059 | 0.0043 | −0.0021 | −0.0089 ** | −0.0001 | −0.0015 | 0.0061 | −0.0021 | 0.0145 *** | −0.0007 |
| | (0.0040) | (0.0043) | (0.0045) | (0.0043) | (0.0044) | (0.0044) | (0.0037) | (0.0041) | (0.0043) | (0.0043) | (0.0044) | (0.0044) |
| Dependency ratio | 0.0600 | 0.0700 | 0.1216 | −0.0923 | −0.0641 | −0.0639 | −0.1366 | −0.0365 | −0.0009 | −0.1275 | −0.2579 ** | −0.2426 ** |
| | (0.0787) | (0.0814) | (0.0844) | (0.0809) | (0.0821) | (0.0820) | (0.1048) | (0.1088) | (0.1144) | (0.1139) | (0.1158) | (0.1154) |
| Observations | 146 | | | | | | 169 | | | | | |
| Wald chi2(9) | 439.50 | | | | | | 289.89 | | | | | |
| LR test | 489.205 *** | | | | | | 642.654 *** | | | | | |
| Prob > chi2 | 0.000 | | | | | | 0.000 | | | | | |

The asterisks *, **, and *** denote significance at the 10%, 5%, and 1% significance levels.

Credit access plays an important role in rice farmers' participation and control of resources in rice-breeding activities. For instance, both men and women rice farmers have credit access to positively and significantly influence five (5) out of six (6) control resources, implying that credit access gives rice farmers the opportunity to own and control resources for farming activities. Generally, having control signals the greatest degree of ownership of resources. In addition, FBO participation among women was found to influence the control of land, labor, fertilizer, and weedicides.

Thus, there is a higher probability of women rice farmers having control of land, labor, fertilizer, and weedicide. With regards to men, participating in FBOs influences the control of land, labor, weedicide, and insecticide positively and significantly. Thus, men rice farmers are more likely to control such resources in rice-breeding activities. The positive effect of extension contacts for both women and men influences land and fertilizer, land, and labor and fertilizer, respectively. Generally, extension contacts give rice farmers the ability to tap into technical advice and support in rice-breeding activities. The negative effect of distance to market implies that a greater distance to market discourages women's control of resources such as land, labor, and insecticide.

## 4. Conclusions and Policy Recommendations

This paper examined the access and control of resources and participation in rice-breeding activities among men and women farmers in southern Ghana using mixed methods. Further, the perceptions of men and women farmers about breeding activities and major production constraints were also examined.. The result show that as some farming activities are labeled as activities for men while others as activities solely for women. Men dominated activities that included land preparation, weeding, spraying, and harvesting, whereas women's related activities are transplanting, gathering during harvesting, winnowing, help with milling, packaging, and marketing.

The results again revealed that there are significant differences in the access and control of resources for rice-production activities including rice-breeding activities between men and women within farm households in favor of the men. Generally, men tend to have more control and access to resources such as land, labor, improved seeds, fertilizers, weedicides, and pesticides than women for rice-production activities. This is because their role as household heads influences household production decisions.

With regards to participation in the on-farm evaluation of rice varieties and field days, the men significantly participated more in these activities than their women counterparts. Both men and women rice farmers in general have positive perceptions about breeding activities and their implications. Years of schooling, dependency ratio, rice-farming experience, farm size, number of rice plots, extension contacts, credit access, and FBO participation were found to positively influence participation in breeding activities, whereas distance to market was negative. Moreover, there was a clear gender differential in variables such as number of plots, years of schooling, dependency ratio, rice-farming experience, farm size, extension contacts, credit access, and FBO participation. These factors significantly and positively influenced access to production resources but negatively influenced control of production resources in rice-breeding activities among the men and women in southern Ghana.

To promote equitable access and control of resources, as well as encourage participation in rice-breeding activities among farmers, especially women rice farmers in southern Ghana, there is a need for gender analysis to understand the needs of men and women and promotion of gender responsive rice-breeding activities. This can be achieved through integrating gender perspectives into all aspects of the breeding program's design and implementation.

In addition, equitable access and control of farm resources such as land, labor, improved seeds, and chemicals among men and women farmers should be duly addressed. Factors such as education, credit access, and FBO membership, which positively influenced the control and access of farm resources among women farmers, should be promoted and taken into consideration by policy makers and stakeholders to develop and implement gender-friendly policies.

Further, gender-sensitive land tenure policies should be promoted at the community level by the relevant stakeholders to ensure equitable land distribution and access for both men and women farmers. The significant effect of extension delivery on participation in rice breeding programs suggests the need to promote gender-responsive extension services

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**Institutional Review Board Statement:** The necessary consent was sought for in engaging therespondents for the study, however, ethics approval for the study was not required in accordance with local/national legislation in Ghana particularly concerning survey data collection.

**Informed Consent Statement:** Written informed consent has been obtained fromall subjects involved in the study.

**Data Availability Statement:** The data from which the study was conducted are available from the corresponding author upon request.

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**Conflicts of Interest:** The authors declare that there is no known conflict of interest associated with this submission.

## Appendix A

**Table A1.** Coefficient estimates of the factors influencing access to resources in rice-breeding activities among men.

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| **Seed access** | | | | | | |
| Years of schooling | −0.047 | 0.012 | −3.96 | 0 | −0.07 | −0.024 |
| Rice-farming experience | −0.001 | 0.005 | −0.16 | 0.874 | −0.011 | 0.01 |
| Credit access | −0.458 | 0.127 | −3.6 | 0 | −0.708 | −0.209 |
| FBO | 0.157 | 0.117 | 1.34 | 0.18 | −0.072 | 0.385 |
| Extension visits | −0.054 | 0.024 | −2.25 | 0.025 | −0.101 | −0.007 |
| Number of plots | −0.347 | 0.138 | −2.52 | 0.012 | −0.618 | −0.077 |
| Farm size (acre) | 0.023 | 0.034 | 0.67 | 0.503 | −0.044 | 0.089 |
| Market distance (km) | −0.028 | 0.013 | −2.18 | 0.029 | −0.052 | −0.003 |
| Dependency ratio | −0.427 | 0.303 | −1.41 | 0.16 | −1.021 | 0.168 |
| Constant | 0.715 | 0.286 | 2.5 | 0.012 | 0.155 | 1.275 |
| **Labor access** | | | | | | |
| Years of schooling | 0.02 | 0.012 | 1.6 | 0.11 | −0.004 | 0.044 |
| Rice-farming experience | 0.005 | 0.005 | 0.96 | 0.335 | −0.005 | 0.016 |
| Credit access | 0.004 | 0.121 | 0.03 | 0.974 | −0.233 | 0.241 |
| FBO | 0.209 | 0.116 | 1.8 | 0.071 | −0.018 | 0.435 |
| Extension visits | 0.088 | 0.023 | 3.8 | 0 | 0.043 | 0.134 |
| Number of plots | 0.271 | 0.119 | 2.27 | 0.023 | 0.038 | 0.505 |
| Farm size (acre) | −0.001 | 0.034 | −0.03 | 0.979 | −0.067 | 0.065 |
| Market distance (km) | 0.013 | 0.012 | 1.09 | 0.275 | −0.01 | 0.036 |
| Dependency ratio | 1.043 | 0.322 | 3.24 | 0.001 | 0.412 | 1.674 |
| Constant | −0.921 | 0.267 | −3.45 | 0.001 | −1.444 | −0.397 |
| **Land access** | | | | | | |
| Years of schooling | 0.018 | 0.012 | 1.42 | 0.156 | −0.007 | 0.042 |
| Rice-farming experience | −0.007 | 0.006 | −1.22 | 0.221 | −0.019 | 0.004 |
| Credit access | 0.14 | 0.12 | 1.16 | 0.247 | −0.096 | 0.375 |
| FBO | 0.69 | 0.12 | 5.76 | 0 | 0.455 | 0.925 |
| Extension visits | −0.088 | 0.023 | −3.92 | 0 | −0.132 | −0.044 |
| Number of plots | 0.313 | 0.14 | 2.23 | 0.026 | 0.037 | 0.588 |
| Farm size (acre) | 0.076 | 0.033 | 2.32 | 0.02 | 0.012 | 0.141 |

**Table A1.** *Cont.*

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| Market distance (km) | 0.002 | 0.013 | 0.12 | 0.903 | −0.024 | 0.027 |
| Dependency ratio | 1.999 | 0.321 | 6.24 | 0 | 1.371 | 2.627 |
| Constant | −1.437 | 0.303 | −4.74 | 0 | −2.031 | −0.843 |
| **Fertilizer access** | | | | | | |
| Years of schooling | 0.034 | 0.013 | 2.68 | 0.007 | 0.009 | 0.06 |
| Rice-farming experience | 0.001 | 0.007 | 0.22 | 0.824 | −0.011 | 0.014 |
| Credit access | 0.219 | 0.128 | 1.71 | 0.088 | −0.033 | 0.47 |
| FBO | 0.517 | 0.133 | 3.9 | 0 | 0.257 | 0.777 |
| Extension visits | −0.007 | 0.022 | −0.31 | 0.758 | −0.05 | 0.036 |
| Number of plots | −0.21 | 0.121 | −1.73 | 0.083 | −0.447 | 0.027 |
| Farm size (acre) | 0.021 | 0.032 | 0.64 | 0.522 | −0.042 | 0.083 |
| Market distance (km) | −0.016 | 0.012 | −1.37 | 0.172 | −0.04 | 0.007 |
| Dependency ratio | −0.407 | 0.337 | −1.21 | 0.227 | −1.066 | 0.253 |
| Constant | 0.667 | 0.286 | 2.33 | 0.02 | 0.107 | 1.227 |
| **Insecticide access** | | | | | | |
| Years of schooling | 0.042 | 0.015 | 2.75 | 0.006 | 0.012 | 0.071 |
| Rice-farming experience | 0.003 | 0.008 | 0.36 | 0.716 | −0.012 | 0.018 |
| Credit access | 0.355 | 0.171 | 2.08 | 0.038 | 0.02 | 0.69 |
| FBO | −0.079 | 0.146 | −0.54 | 0.59 | −0.365 | 0.208 |
| Extension visits | 0.075 | 0.033 | 2.27 | 0.023 | 0.01 | 0.139 |
| Number of plots | −0.075 | 0.111 | −0.68 | 0.5 | −0.291 | 0.142 |
| Farm size (acre) | −0.103 | 0.035 | −2.9 | 0.004 | −0.172 | −0.033 |
| Market distance (km) | −0.004 | 0.014 | −0.27 | 0.785 | −0.032 | 0.024 |
| Dependency ratio | −0.308 | 0.312 | −0.99 | 0.323 | −0.921 | 0.304 |
| Constant | 1.545 | 0.319 | 4.84 | 0 | 0.919 | 2.17 |
| **Weedicide access** | | | | | | |
| Years of schooling | 0.006 | 0.015 | 0.43 | 0.664 | −0.023 | 0.036 |
| Rice-farming experience | 0.003 | 0.007 | 0.38 | 0.703 | −0.012 | 0.017 |
| Credit access | 0.249 | 0.156 | 1.59 | 0.111 | −0.057 | 0.555 |
| FBO | 0.37 | 0.152 | 2.44 | 0.015 | 0.073 | 0.668 |
| Extension visits | 0.102 | 0.036 | 2.86 | 0.004 | 0.032 | 0.172 |
| Number of plots | −0.089 | 0.118 | −0.75 | 0.45 | −0.319 | 0.142 |
| Farm size (acre) | −0.045 | 0.042 | −1.07 | 0.284 | −0.128 | 0.038 |
| Market distance (km) | −0.031 | 0.011 | −2.75 | 0.006 | −0.054 | −0.009 |
| Dependency ratio | −0.693 | 0.316 | −2.2 | 0.028 | −1.312 | −0.075 |
| Constant | 1.576 | 0.275 | 5.74 | 0 | 1.038 | 2.114 |

**Table A2.** Coefficient estimates of the factors influencing access to resources in rice-breeding activities among women.

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| **Seed access** | | | | | | |
| Years of schooling | 0.008 | 0.015 | 0.540 | 0.587 | −0.021 | 0.037 |
| Rice-farming experience | 0.001 | 0.008 | 0.120 | 0.901 | −0.015 | 0.017 |
| Credit access | −0.234 | 0.170 | −1.380 | 0.168 | −0.568 | 0.099 |
| FBO | 0.054 | 0.144 | 0.380 | 0.707 | −0.228 | 0.336 |
| Extension visits | −0.028 | 0.026 | −1.080 | 0.281 | −0.080 | 0.023 |
| Number of plots | 0.061 | 0.177 | 0.340 | 0.731 | −0.286 | 0.407 |
| Farm size (acre) | −0.028 | 0.040 | −0.700 | 0.484 | −0.105 | 0.050 |
| Market distance (km) | −0.037 | 0.013 | −2.890 | 0.004 | −0.063 | −0.012 |
| Dependency ratio | −0.096 | 0.236 | −0.410 | 0.684 | −0.559 | 0.366 |
| Constant | −0.076 | 0.262 | −0.290 | 0.773 | −0.589 | 0.438 |
| **Labor access** | | | | | | |
| Years of schooling | 0.002 | 0.005 | 0.320 | 0.746 | −0.008 | 0.012 |
| Rice-farming experience | 0.008 | 0.003 | 3.040 | 0.002 | 0.003 | 0.014 |
| Credit access | 0.196 | 0.058 | 3.350 | 0.001 | 0.081 | 0.310 |
| FBO | 0.113 | 0.050 | 2.280 | 0.022 | 0.016 | 0.211 |
| Extension visits | 0.017 | 0.009 | 1.770 | 0.076 | −0.002 | 0.035 |
| Number of plots | 0.194 | 0.062 | 3.150 | 0.002 | 0.073 | 0.315 |
| Farm size (acre) | 0.053 | 0.013 | 4.020 | 0.000 | 0.027 | 0.078 |
| Market distance (km) | −0.004 | 0.004 | −0.940 | 0.346 | −0.012 | 0.004 |
| Dependency ratio | 0.146 | 0.077 | 1.900 | 0.058 | −0.005 | 0.297 |
| Constant | −0.110 | 0.091 | −1.210 | 0.225 | −0.288 | 0.068 |
| **Fertilizer access** | | | | | | |
| Years of schooling | −0.004 | 0.005 | −0.770 | 0.444 | −0.014 | 0.006 |
| Rice-farming experience | 0.000 | 0.003 | 0.120 | 0.902 | −0.005 | 0.006 |
| Credit access | −0.003 | 0.058 | −0.060 | 0.952 | −0.117 | 0.110 |
| FBO | 0.179 | 0.049 | 3.650 | 0.000 | 0.083 | 0.275 |
| Extension visits | 0.015 | 0.009 | 1.640 | 0.102 | −0.003 | 0.033 |
| Number of plots | 0.294 | 0.061 | 4.810 | 0.000 | 0.174 | 0.413 |
| Farm size (acre) | −0.031 | 0.013 | −2.380 | 0.017 | −0.056 | −0.005 |
| Market distance (km) | −0.001 | 0.004 | −0.200 | 0.843 | −0.009 | 0.007 |
| Dependency ratio | −0.070 | 0.076 | −0.920 | 0.356 | −0.220 | 0.079 |
| Constant | 0.388 | 0.090 | 4.320 | 0.000 | 0.212 | 0.564 |
| **Insecticide access** | | | | | | |
| Years of schooling | −0.006 | 0.004 | −1.290 | 0.196 | −0.014 | 0.003 |
| Rice-farming experience | −0.002 | 0.002 | −0.910 | 0.363 | −0.007 | 0.003 |
| Credit access | 0.031 | 0.051 | 0.600 | 0.546 | −0.068 | 0.130 |
| FBO | 0.179 | 0.043 | 4.170 | 0.000 | 0.095 | 0.263 |
| Extension visits | 0.007 | 0.008 | 0.810 | 0.419 | −0.009 | 0.022 |

**Table A2.** *Cont.*

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| Number of plots | 0.059 | 0.053 | 1.110 | 0.265 | −0.045 | 0.164 |
| Farm size (acre) | −0.000 | 0.011 | −0.020 | 0.986 | −0.022 | 0.022 |
| Market distance (km) | −0.002 | 0.004 | −0.660 | 0.510 | −0.009 | 0.005 |
| Dependency ratio | −0.065 | 0.067 | −0.980 | 0.329 | −0.196 | 0.066 |
| Constant | 0.745 | 0.079 | 9.480 | 0.000 | 0.591 | 0.899 |
| **Weedicide access** | | | | | | |
| Years of schooling | 0.002 | 0.005 | 0.460 | 0.646 | −0.007 | 0.011 |
| Rice-farming experience | −0.004 | 0.002 | −1.480 | 0.138 | −0.008 | 0.001 |
| Credit access | 0.064 | 0.051 | 1.250 | 0.211 | −0.036 | 0.165 |
| FBO | 0.139 | 0.044 | 3.190 | 0.001 | 0.054 | 0.225 |
| Extension visits | 0.009 | 0.008 | 1.070 | 0.286 | −0.007 | 0.025 |
| Number of plots | 0.029 | 0.054 | 0.540 | 0.590 | −0.077 | 0.135 |
| Farm size (acre) | −0.033 | 0.011 | −2.890 | 0.004 | −0.056 | −0.011 |
| Market distance (km) | −0.001 | 0.004 | −0.380 | 0.700 | −0.008 | 0.006 |
| Dependency ratio | −0.033 | 0.068 | −0.480 | 0.630 | −0.165 | 0.100 |
| Constant | 0.815 | 0.080 | 10.210 | 0.000 | 0.658 | 0.972 |
| **Land access** | | | | | | |
| Years of schooling | −0.006 | 0.005 | −1.100 | 0.272 | −0.016 | 0.005 |
| Rice-farming experience | −0.004 | 0.003 | −1.350 | 0.178 | −0.010 | 0.002 |
| Credit access | −0.162 | 0.060 | −2.690 | 0.007 | −0.279 | −0.044 |
| FBO | 0.225 | 0.051 | 4.410 | 0.000 | 0.125 | 0.325 |
| Extension visits | 0.029 | 0.010 | 3.060 | 0.002 | 0.011 | 0.048 |
| Number of plots | 0.120 | 0.063 | 1.890 | 0.058 | −0.004 | 0.245 |
| Farm size (acre) | −0.004 | 0.013 | −0.280 | 0.782 | −0.030 | 0.023 |
| Market distance (km) | −0.001 | 0.004 | −0.200 | 0.840 | −0.009 | 0.007 |
| Dependency ratio | 0.133 | 0.079 | 1.680 | 0.094 | −0.023 | 0.288 |
| Constant | 0.149 | 0.094 | 1.590 | 0.112 | −0.035 | 0.332 |

**Table A3.** Coefficient estimates of the factors influencing control of resources in rice-breeding activities among men.

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| **Land control** | | | | | | |
| Years of schooling | −0.003 | 0.013 | −0.230 | 0.818 | −0.028 | 0.022 |
| Rice-farming experience | 0.008 | 0.006 | 1.260 | 0.207 | −0.004 | 0.020 |
| Credit access | 0.412 | 0.131 | 3.150 | 0.002 | 0.155 | 0.669 |
| FBO | 0.581 | 0.124 | 4.670 | 0.000 | 0.337 | 0.825 |
| Extension visits | −0.055 | 0.023 | −2.370 | 0.018 | −0.100 | −0.009 |
| Number of plots | −0.374 | 0.127 | −2.940 | 0.003 | −0.624 | −0.125 |
| Farm size (acre) | 0.109 | 0.033 | 3.280 | 0.001 | 0.044 | 0.174 |
| Market distance (km) | 0.003 | 0.013 | 0.210 | 0.835 | −0.022 | 0.028 |

**Table A3.** *Cont.*

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| Dependency ratio | −0.438 | 0.335 | −1.310 | 0.191 | −1.094 | 0.219 |
| Constant | 0.612 | 0.294 | 2.080 | 0.038 | 0.035 | 1.189 |
| **Labor control** | | | | | | |
| Years of schooling | 0.015 | 0.013 | 1.220 | 0.224 | −0.009 | 0.040 |
| Rice-farming experience | 0.001 | 0.006 | 0.120 | 0.902 | −0.011 | 0.012 |
| Credit access | 0.403 | 0.122 | 3.300 | 0.001 | 0.164 | 0.642 |
| FBO | 0.379 | 0.118 | 3.210 | 0.001 | 0.148 | 0.611 |
| Extension visits | 0.070 | 0.023 | 3.130 | 0.002 | 0.026 | 0.115 |
| Number of plots | −0.148 | 0.123 | −1.200 | 0.232 | −0.389 | 0.094 |
| Farm size (acre) | 0.029 | 0.034 | 0.870 | 0.383 | −0.036 | 0.095 |
| Market distance (km) | −0.004 | 0.012 | −0.310 | 0.754 | −0.027 | 0.019 |
| Dependency ratio | −0.108 | 0.343 | −0.310 | 0.753 | −0.780 | 0.564 |
| Constant | 0.032 | 0.296 | 0.110 | 0.913 | −0.548 | 0.613 |
| **Improved seed control** | | | | | | |
| Years of schooling | −0.010 | 0.012 | −0.810 | 0.417 | −0.034 | 0.014 |
| Rice-farming experience | 0.007 | 0.005 | 1.250 | 0.211 | −0.004 | 0.017 |
| Credit access | 0.364 | 0.121 | 3.000 | 0.003 | 0.126 | 0.601 |
| FBO | −0.064 | 0.116 | −0.560 | 0.579 | −0.292 | 0.163 |
| Extension visits | 0.001 | 0.022 | 0.050 | 0.961 | −0.042 | 0.044 |
| Number of plots | −0.168 | 0.119 | −1.410 | 0.159 | −0.401 | 0.066 |
| Farm size (acre) | 0.019 | 0.031 | 0.590 | 0.555 | −0.043 | 0.080 |
| Market distance (km) | 0.015 | 0.011 | 1.330 | 0.184 | −0.007 | 0.037 |
| Dependency ratio | 0.059 | 0.324 | 0.180 | 0.856 | −0.576 | 0.694 |
| Constant | 0.172 | 0.273 | 0.630 | 0.529 | −0.363 | 0.706 |
| **Fertilizer control** | | | | | | |
| Years of schooling | −0.042 | 0.013 | −3.280 | 0.001 | −0.066 | −0.017 |
| Rice-farming experience | 0.002 | 0.006 | 0.300 | 0.765 | −0.009 | 0.013 |
| Credit access | −0.262 | 0.121 | −2.170 | 0.030 | −0.499 | −0.025 |
| FBO | 0.036 | 0.119 | 0.300 | 0.761 | −0.197 | 0.269 |
| Extension visits | −0.064 | 0.023 | −2.800 | 0.005 | −0.109 | −0.019 |
| Number of plots | −0.510 | 0.109 | −4.660 | 0.000 | −0.724 | −0.295 |
| Farm size (acre) | 0.073 | 0.031 | 2.350 | 0.019 | 0.012 | 0.134 |
| Market distance (km) | −0.004 | 0.012 | −0.370 | 0.711 | −0.027 | 0.019 |
| Dependency ratio | −0.292 | 0.330 | −0.880 | 0.376 | −0.938 | 0.355 |
| Constant | 1.149 | 0.279 | 4.120 | 0.000 | 0.603 | 1.696 |
| **Weedicide control** | | | | | | |
| Years of schooling | −0.016 | 0.012 | −1.280 | 0.199 | −0.040 | 0.008 |
| Rice-farming experience | 0.005 | 0.006 | 0.900 | 0.367 | −0.006 | 0.016 |
| Credit access | 0.037 | 0.119 | 0.310 | 0.756 | −0.197 | 0.271 |
| FBO | 0.211 | 0.118 | 1.780 | 0.075 | −0.021 | 0.443 |

**Table A3.** *Cont.*

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| Extension visits | −0.044 | 0.023 | −1.930 | 0.053 | −0.088 | 0.001 |
| Number of plots | −0.302 | 0.112 | −2.690 | 0.007 | −0.522 | −0.082 |
| Farm size (acre) | −0.033 | 0.030 | −1.100 | 0.270 | −0.093 | 0.026 |
| Market distance (km) | 0.037 | 0.011 | 3.270 | 0.001 | 0.015 | 0.060 |
| Dependency ratio | −0.759 | 0.332 | −2.290 | 0.022 | −1.408 | −0.109 |
| Constant | 0.683 | 0.283 | 2.410 | 0.016 | 0.128 | 1.237 |
| **Insecticide control** | | | | | | |
| Years of schooling | −0.027 | 0.013 | −2.120 | 0.034 | −0.052 | −0.002 |
| Rice-farming experience | 0.003 | 0.006 | 0.470 | 0.639 | −0.008 | 0.013 |
| Credit access | 0.319 | 0.120 | 2.650 | 0.008 | 0.083 | 0.555 |
| FBO | 0.416 | 0.121 | 3.450 | 0.001 | 0.179 | 0.653 |
| Extension visits | 0.002 | 0.023 | 0.100 | 0.924 | −0.042 | 0.047 |
| Number of plots | −0.267 | 0.114 | −2.340 | 0.019 | −0.490 | −0.044 |
| Farm size (acre) | 0.047 | 0.032 | 1.500 | 0.134 | −0.015 | 0.109 |
| Market distance (km) | −0.002 | 0.012 | −0.140 | 0.885 | −0.024 | 0.021 |
| Dependency ratio | −0.728 | 0.330 | −2.200 | 0.028 | −1.375 | −0.081 |
| Constant | 0.495 | 0.285 | 1.740 | 0.082 | −0.063 | 1.053 |

**Table A4.** Coefficient estimates of the factors influencing control of resources in rice-breeding activities among women.

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| **Land control** | | | | | | |
| Years of schooling | −0.049 | 0.014 | −3.410 | 0.001 | −0.078 | −0.021 |
| Rice-farming experience | −0.031 | 0.010 | −3.050 | 0.002 | −0.050 | −0.011 |
| Credit access | −0.404 | 0.175 | −2.300 | 0.021 | −0.747 | −0.060 |
| FBO | 0.510 | 0.146 | 3.500 | 0.000 | 0.224 | 0.796 |
| Extension visits | 0.101 | 0.030 | 3.340 | 0.001 | 0.042 | 0.160 |
| Number of plots | 0.966 | 0.169 | 5.700 | 0.000 | 0.634 | 1.298 |
| Farm size (acre) | −0.070 | 0.035 | −2.000 | 0.045 | −0.138 | −0.002 |
| Market distance (km) | −0.042 | 0.012 | −3.430 | 0.001 | −0.066 | −0.018 |
| Dependency ratio | 0.117 | 0.158 | 0.740 | 0.461 | −0.194 | 0.427 |
| Constant | −0.344 | 0.233 | −1.480 | 0.140 | −0.800 | 0.113 |
| **Labor control** | | | | | | |
| Years of schooling | −0.008 | 0.015 | −0.580 | 0.562 | −0.037 | 0.020 |
| Rice-farming experience | −0.004 | 0.008 | −0.490 | 0.625 | −0.020 | 0.012 |
| Credit access | 0.641 | 0.191 | 3.360 | 0.001 | 0.267 | 1.015 |
| FBO | 0.197 | 0.145 | 1.360 | 0.174 | −0.087 | 0.482 |
| Extension visits | −0.001 | 0.030 | −0.040 | 0.970 | −0.061 | 0.058 |
| Number of plots | −0.331 | 0.151 | −2.200 | 0.028 | −0.627 | −0.036 |
| Farm size (acre) | 0.031 | 0.037 | 0.830 | 0.406 | −0.042 | 0.105 |
| Market distance (km) | −0.037 | 0.012 | −3.210 | 0.001 | −0.060 | −0.014 |

**Table A4.** *Cont.*

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| Dependency ratio | 0.109 | 0.252 | 0.430 | 0.666 | −0.385 | 0.603 |
| Constant | 0.530 | 0.262 | 2.020 | 0.043 | 0.017 | 1.043 |
| **Improved seed control** | | | | | | |
| Years of schooling | 0.029 | 0.015 | 1.980 | 0.048 | 0.000 | 0.057 |
| Rice-farming experience | −0.004 | 0.007 | −0.550 | 0.585 | −0.019 | 0.010 |
| Credit access | 0.342 | 0.164 | 2.080 | 0.037 | 0.020 | 0.665 |
| FBO | −0.177 | 0.139 | −1.270 | 0.203 | −0.449 | 0.096 |
| Extension visits | −0.001 | 0.029 | −0.050 | 0.960 | −0.057 | 0.055 |
| Number of plots | −0.408 | 0.183 | −2.230 | 0.026 | −0.767 | −0.049 |
| Farm size (acre) | −0.004 | 0.034 | −0.110 | 0.913 | −0.071 | 0.064 |
| Market distance (km) | −0.016 | 0.012 | −1.390 | 0.165 | −0.040 | 0.007 |
| Dependency ratio | 0.275 | 0.149 | 1.840 | 0.065 | −0.018 | 0.568 |
| Constant | 0.250 | 0.250 | 1.000 | 0.317 | −0.240 | 0.739 |
| **Fertilizer control** | | | | | | |
| Years of schooling | −0.025 | 0.015 | −1.710 | 0.087 | −0.055 | 0.004 |
| Rice-farming experience | −0.006 | 0.007 | −0.830 | 0.407 | −0.020 | 0.008 |
| Credit access | 0.391 | 0.166 | 2.360 | 0.018 | 0.066 | 0.716 |
| FBO | 0.645 | 0.143 | 4.520 | 0.000 | 0.366 | 0.925 |
| Extension visits | 0.139 | 0.033 | 4.210 | 0.000 | 0.074 | 0.203 |
| Number of plots | 0.234 | 0.173 | 1.350 | 0.176 | −0.105 | 0.572 |
| Farm size (acre) | −0.053 | 0.036 | −1.480 | 0.139 | −0.124 | 0.017 |
| Market distance (km) | 0.013 | 0.012 | 1.060 | 0.289 | −0.011 | 0.038 |
| Dependency ratio | −0.310 | 0.216 | −1.440 | 0.150 | −0.733 | 0.112 |
| Constant | −0.554 | 0.270 | −2.050 | 0.040 | −1.083 | −0.025 |
| **Weedicide control** | | | | | | |
| Years of schooling | 0.020 | 0.015 | 1.300 | 0.195 | −0.010 | 0.050 |
| Rice-farming experience | −0.007 | 0.008 | −0.990 | 0.323 | −0.022 | 0.007 |
| Credit access | 0.874 | 0.173 | 5.070 | 0.000 | 0.536 | 1.212 |
| FBO | 0.289 | 0.148 | 1.950 | 0.051 | −0.001 | 0.579 |
| Extension visits | −0.008 | 0.029 | −0.280 | 0.777 | −0.066 | 0.049 |
| Number of plots | 0.050 | 0.181 | 0.280 | 0.782 | −0.305 | 0.405 |
| Farm size (acre) | −0.205 | 0.045 | −4.540 | 0.000 | −0.293 | −0.116 |
| Market distance (km) | −0.008 | 0.012 | −0.650 | 0.515 | −0.030 | 0.015 |
| Dependency ratio | −0.370 | 0.257 | −1.440 | 0.151 | −0.874 | 0.134 |
| Constant | 0.369 | 0.266 | 1.390 | 0.166 | −0.152 | 0.890 |
| **Insecticide control** | | | | | | |
| Years of schooling | 0.012 | 0.015 | 0.820 | 0.413 | −0.017 | 0.041 |
| Rice-farming experience | −0.011 | 0.007 | −1.530 | 0.126 | −0.025 | 0.003 |
| Credit access | 0.009 | 0.164 | 0.050 | 0.958 | −0.312 | 0.329 |
| FBO | 0.127 | 0.142 | 0.900 | 0.371 | −0.151 | 0.404 |
| Extension visits | 0.011 | 0.030 | 0.370 | 0.708 | −0.047 | 0.069 |

**Table A4.** *Cont.*

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| Number of plots | 0.156 | 0.179 | 0.870 | 0.384 | −0.195 | 0.506 |
| Farm size (acre) | −0.089 | 0.040 | −2.210 | 0.027 | −0.168 | −0.010 |
| Market distance (km) | −0.028 | 0.012 | −2.330 | 0.020 | −0.051 | −0.004 |
| Dependency ratio | −0.108 | 0.245 | −0.440 | 0.660 | −0.588 | 0.372 |
| Constant | −0.102 | 0.259 | −0.390 | 0.693 | −0.610 | 0.406 |

**Table A5.** Factors influencing participation in rice-breeding activities among men.

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| **Field days** | | | | | | |
| Years of schooling | 0.011 | 0.013 | 0.820 | 0.413 | −0.015 | 0.037 |
| Rice-farming experience | 0.002 | 0.006 | 0.280 | 0.776 | −0.011 | 0.014 |
| Credit access | 0.265 | 0.127 | 2.080 | 0.037 | 0.015 | 0.515 |
| FBO | 0.750 | 0.121 | 6.190 | 0.000 | 0.513 | 0.987 |
| Extension visits | 0.093 | 0.024 | 3.850 | 0.000 | 0.046 | 0.141 |
| Number of plots | 0.546 | 0.143 | 3.810 | 0.000 | 0.265 | 0.827 |
| Farm size (acre) | 0.131 | 0.035 | 3.690 | 0.000 | 0.061 | 0.200 |
| Market distance (km) | −0.042 | 0.012 | −3.570 | 0.000 | −0.066 | −0.019 |
| Dependency ratio | 2.302 | 0.340 | 6.770 | 0.000 | 1.635 | 2.969 |
| Constant | −2.184 | 0.314 | −6.950 | 0.000 | −2.800 | −1.568 |
| **On-farm evaluation** | | | | | | |
| Years of schooling | 0.042 | 0.013 | 3.230 | 0.001 | 0.017 | 0.068 |
| Rice-farming experience | 0.013 | 0.005 | 2.420 | 0.016 | 0.003 | 0.024 |
| Credit access | 0.383 | 0.132 | 2.890 | 0.004 | 0.123 | 0.642 |
| FBO | 0.697 | 0.124 | 5.620 | 0.000 | 0.454 | 0.941 |
| Extension visits | 0.001 | 0.022 | 0.060 | 0.952 | −0.041 | 0.044 |
| Number of plots | 0.285 | 0.130 | 2.190 | 0.028 | 0.030 | 0.540 |
| Farm size (acre) | 0.104 | 0.035 | 2.990 | 0.003 | 0.036 | 0.172 |
| Market distance (km) | −0.047 | 0.011 | −4.230 | 0.000 | −0.069 | −0.025 |
| Dependency ratio | 1.100 | 0.348 | 3.160 | 0.002 | 0.418 | 1.781 |
| Constant | −1.590 | 0.308 | −5.160 | 0.000 | −2.194 | −0.986 |

**Table A6.** Coefficient estimates of the factors influencing participation in rice-breeding activities among women.

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| **Field days** | | | | | | |
| Years of schooling | −0.046 | 0.015 | −2.990 | 0.003 | −0.077 | −0.016 |
| Rice-farming experience | −0.004 | 0.009 | −0.390 | 0.694 | −0.022 | 0.015 |
| Credit access | −0.037 | 0.181 | −0.210 | 0.836 | −0.392 | 0.318 |
| FBO | 0.793 | 0.157 | 5.040 | 0.000 | 0.485 | 1.102 |

**Table A6.** *Cont.*

| | Coef. | Std.Err. | z | P > z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| Extension visits | 0.116 | 0.028 | 4.150 | 0.000 | 0.061 | 0.170 |
| Number of plots | 0.905 | 0.164 | 5.520 | 0.000 | 0.584 | 1.226 |
| Farm size (acre) | 0.175 | 0.045 | 3.870 | 0.000 | 0.086 | 0.264 |
| Market distance (km) | −0.088 | 0.020 | −4.460 | 0.000 | −0.127 | −0.049 |
| Dependency ratio | 1.706 | 0.423 | 4.030 | 0.000 | 0.877 | 2.535 |
| Constant | −2.727 | 0.337 | −8.100 | 0.000 | −3.386 | −2.067 |
| **On-farm evaluation** | | | | | | |
| Years of schooling | 0.014 | 0.016 | 0.900 | 0.368 | −0.017 | 0.044 |
| Rice-farming experience | 0.015 | 0.008 | 1.770 | 0.077 | −0.002 | 0.031 |
| Credit access | 0.078 | 0.175 | 0.440 | 0.658 | −0.266 | 0.421 |
| FBO | 0.885 | 0.162 | 5.450 | 0.000 | 0.566 | 1.203 |
| Extension visits | −0.004 | 0.036 | −0.110 | 0.911 | −0.075 | 0.067 |
| Number of plots | 0.621 | 0.191 | 3.250 | 0.001 | 0.246 | 0.996 |
| Farm size (acre) | 0.102 | 0.044 | 2.340 | 0.019 | 0.017 | 0.187 |
| Market distance (km) | −0.102 | 0.021 | −4.940 | 0.000 | −0.143 | −0.062 |
| Dependency ratio | 1.404 | 0.351 | 4.000 | 0.000 | 0.717 | 2.091 |
| Constant | −2.301 | 0.305 | −7.540 | 0.000 | −2.899 | −1.703 |

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