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The Shift from Crop Production to Mining Activities in Arable Lands: Evidence from Ghana

by Camillus Abawiera Wongnaa, Emmanuel Kwame Nti, Patricia Pinamang Acheampong, Richard Kwasi Bannor, and Suresh Babu

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Abstract

Food crop production now competes with mining activities for land and labour in most farming communities in Ghana, resulting in a negative impact on food crop production profitability. This study identifies the constraints to food crop production and the factors influencing participation in mining activities using data from the Amansie West District of Ghana. Kendall's coefficient of concordance and the Cragg Doule-Hurdle model were employed in the analysis. The results revealed that the top constraints to food crop production are high input cost, experience in mining, low access to improved food crop varieties and poor access to credit. Also, whereas household size, membership in Farmer-Based Organization (FBO), access to credit, off-farm job and low crops yield were found to influence the decision to participate in mining, the intensity to participate in mining was more influenced by household size, membership in Farmer Based Organization, off-farm job and low crops yield. The study recommends that participants engaged in mining activities minimise their operations in the District, especially in communities where food crop production is the dominant economic activity. It is also recommended that the Government could improve access to credit and improved crop varieties by resourcing and leveraging of institutions responsible for provision of credit and improved crops varieties.

Keywords: Intensity of participation; Kendall's coefficient of concordance; Mining; Participation; Food crop production

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Abstract

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1. Introduction

Artisanal and Small Scale Mining (ASM) has seen a sudden rise in a significant level as a source of livelihood for people, and all over Sub-Saharan Africa, it has proven its very crucial source of gaining employment and income (Banchirigah, 2006). In Ghana, mining provides increased economic and social supports to the citizenry but violence and disputes, and accident-related deaths, are common challenges that characterise its operation. According to Kapstein and Kim (2011), almost 17,300 people in 2009 were openly employed resulting in a yearly growth since 2001 of about 4.3% in mining companies. Regardless of the outstanding benefits derived from mining, the rising concern is that mining has had considerable environmental and social impacts in rural communities (Mtero, 2017).

Mining, be it small-scale or large scale has impacted many communities in terms of their social and economic livelihoods especially in a District like the Amansie West in Ghana (Baffour-Kyei *et al.,* 2021). In as much as the area is home to many smallholder cocoa farmers (Boateng et *al.,* 2014) and other food crop producers due to the favourable climatic conditions, the stakeholders in the two main economic activities of the area, viz. farming and mining, compete over two significant resources which are land and labour. As noted by Akabzaa (2010), farming communities in the Amansie West District are under siege from all indications following illegal miners' activities in the District.

Studies conducted in major mining areas of Ghana such as Tarkwa, Bogoso, Kyebi and Obuasi, suggest that land used for food crop production has now been lost to mining activities (Ocansey, 2013). Most farmers in these communities have diversified resources to participate in mining activities within their communities resulting in a negative impact on food crop production profitability. As Wunder (2005) argued, the degradation of ecosystem services like land and water

may lead to conflicts among land users. Other studies have made known of the effects of contaminants and pollutants on many farm produce (Emberson et *al.,* 2001), and these studies revealed the strong decline in farm produce of principal crops. As emphasised by Aragon and Rud (2012), the yield reductions can be as high as 30% to 60% depending on the crop.

Food crop production benefits the country in terms of revenue, employment, industrialisation, improvement in the standard of living and socio-economic development. Farmers in the Amansie West District have switched to participating in ‘‘galamsey’’ a local Ghanaian term used for unregulated gold mining operations because they have realised there is more to gain in gold mining than food crop production. This has resulted in turning lands used for crop production by farmers into ‘‘galamsey’’ sites. Considering the problem’s dimension, this study seeks to provide a response to this question; what are the constraints in food crop production faced by farmers and the factors influencing the intensity of participation in mining activities in the Amansie West District?. The study makes the following contributions; first, it identifies food crop production constraints and reveals the most effective way to survive the adverse consequences that may arise. Second, the study contributes by identifying the determinants of participation and intensity of participation in mining activities. Third, the paper explores why food crop production is yet to be locally beneficial in terms of economic empowerment compared to mining activities to feature significantly in local poverty alleviation. Thus, this study echoes on the reason that aside from the growing importance of food crop production, why artisanal small scale mining seems to take over the local economic empowerment of farmers in arable lands in Ghana. The paper is organised as following. The literature review and the research methodology follows this section of introduction. The results are presented and discussed, and finally, we conclude and make policy recommendations.

2. Literature review

Artisanal and Small Scale Mining (ASM) in its basic sense is the mining activities known to be informal with the use of low technology and/or low machinery. In defining Artisanal and Small Scale Mining, importance should be made of its varying concept which is different from one country to the other based on many factors including employment level, output of production determined annually, the macroeconomic indicators, history of the mining as well as conditions to be met legally, geological framework, capital investment, artisanal processes and depth of mining operations (ILO, 1999).

Agriculture aims to produce food and supply of raw materials and serves as a means of employment for livelihoods (MoFA, 2007). Agriculture provides excellent support during economic shocks within a country. In Ghana, agriculture is among the relevant sectors that support poverty reduction and alleviation programs. With agriculture, Ghana can boast of halving the 1990 poverty rate by achieving the Millennium Development Goal (MDG1) before the target year of 2015 (Quiñones and Diao, 2011). Given that rainfalls are depended on in Ghana's agriculture, productivity is usually low due to low-input traditional farming systems and the irregular nature of rainfall pattern in the country (Quiñones and Diao, 2011).

The agriculture sector is faced by several factors including lack of infrastructure, illegal mining, food insecurity and irrigation among other challenges. Farmlands and vegetations are destroyed as a result of illegal mining operation within a farming community. Water sources which could have helped irrigation are also polluted, in the long run, agriculture productivity is limited. Many challenges are faced by the agriculture sector, therefore the need to strengthen agriculture policies is of relevance. Although Ghana may be considered as food secure, pockets of food

insecurity occur in certain parts of its population (Darfour and Rosentrater, 2016; Nkegbe et *al.*, 2017; Yue *et al.*, 2020). Due to the rapidly growing interest in mining, many farmers in the area are not producing many crops for the populace leading to food shortage as a result of the mining activities. This is to say that many of the arable farmlands are being used for mining activities and is worsening the global food security which is a very serious concern. Increased food shortage is happening in many parts of the world which in many instances leads to the escalation of food prices and possible malnutrition, hunger and death causes. However, the expedition for mineral resources in the land has resulted in destroying arable land for farming (Ocansey, 2013).

As noted by Oldeman (1998), the next direction that policies on agriculture should be concentrated on and debated over the next two decades has to do with the effects of land degradation and consequently its effect on food production. The shifting away from crop production to mining activities coupled with the introduction of chemicals in the work of mining minerals affect the soil and crop production. In farming communities, food production dominates but as many of the community members shift into mining as a result of the benefits in mining leading to low food production (Ocansey, 2013; Aborah, 2016).

Adu et *al.* (2016) explored the determinants for participation in mining activities in Ghana and revealed six significant factors that influence participation. The determinants were found to be the size of household, age, gender, level of education, peer influence and risk. According to Twerefou et *al.* (2015), many factors account for participation in illegal mining activities and various economic and environmental factors are very important in confirming individuals' shift from food production to participate in illegal mining. The community factor that was identified to be the determinant was livelihood loss due to degraded lands while individual age, household size, educational level and gender were identified as individual-level determinants.

3. Research methodology

3.1 Study Area

It was then Amansie District in 1988 that the current Amansie West District was carved out from. The Amansie West District share borders with eight administrative Districts in Ghana. To the west, the District shares boundary with Atwima Nwabiagya and Atwima Mponuah Districts. It shares boundary in the eastern part with the Bekwai Municipality, Amansie Central and Obuasi Municipal. Atwima Kwanwoma is also the District that it shares a border with to the north and also with Upper Denkyira and Bibiani to the southern part.

While the Amansie West District is noted to be among the largest districts in Ghana, its total land area covers about 5.4% spanning with a total area of about 1,364 square kilometres. Many of the settlements in the district are notable for crop production as well as mining and are Abore, Agroyesum, Ahwerewa, Ankam, Antoakrom, Aponapon, Datano, Esaase, Esuowin, Keniago, Mpatuam, Moseaso, Nipankyeremia, Odaho, Pakyi No. 1 and 2 and Watreso (MOFA, 2011). The District Capital of the Amansie West District is Manso Nkwanta which is about 65 km away from Kumasi, the regional capital of the Ashanti region. Figure 1 is the map of Amansie West District chosen for the study.

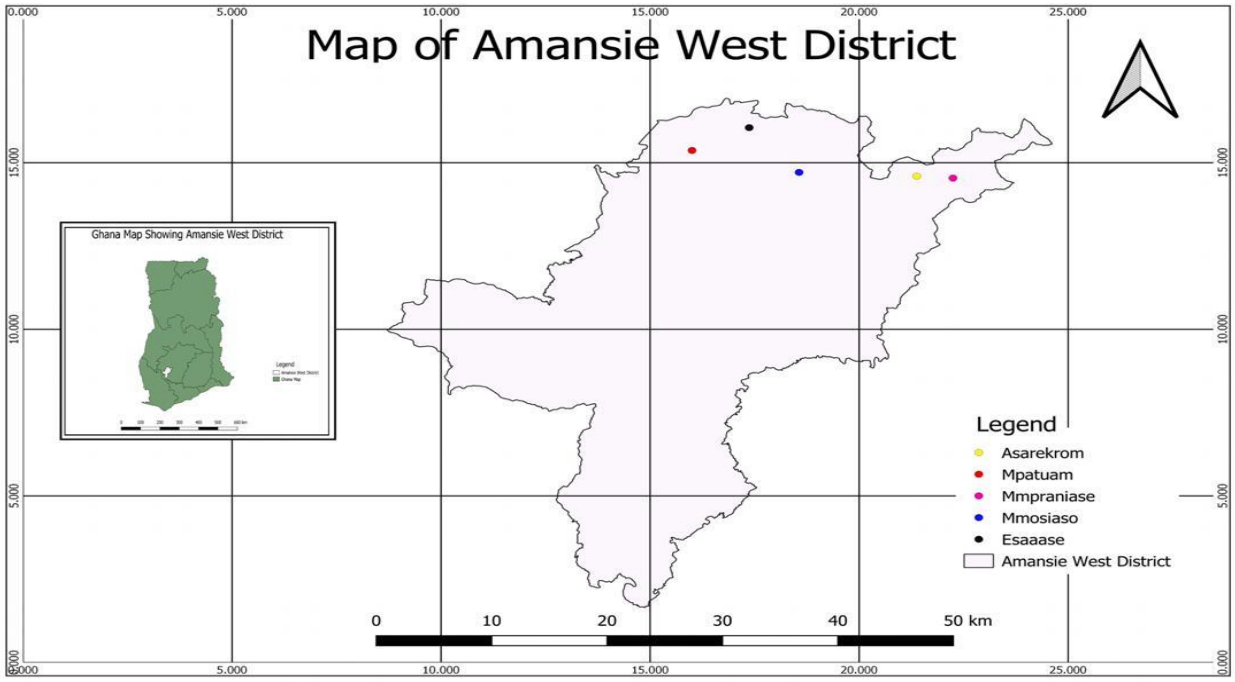

Figure 1: A map showing the Amansie West District

Source: Ghana Statistical Service, GIS

The study area focuses on crop producers in the study area in Ghana's Ashanti region. The region was selected because it is endowed with arable land that supports the production of food crops such as cassava, yam, sweet potato and plantain and also production of cash crops like cocoa and cereal crops such as maize (MoFA, 2014).

3.2 Data collection and sampling technique

The sample size was calculated for the study using the formula below:

$$n = \frac{N}{1+N(a)^2} \qquad (1)$$

Where n represents sample size; N represents total population; α represents a margin of error which is 0.05.

According to Ghana Statistical Service (2010), the District has a total population of 134,331. Nonetheless, the 2010 Population and Housing Census revealed that 76.5% of the population are found to be somewhere around the ages of 15 years and above and are known to be very active in the Amansie West District Analytical Study. In this study, the 76.5% of the total population in the District's was our target population where the sample size was calculated to be 398.

In the district, five farming communities in our second phase of the sampling who were mainly from operational mining communities were selected. These communities were Mpatuam, Mpraniase, Mmosiaso, Asarekrom, and Esaase. In these towns, farmers' participating in mining activities (treated group) and those who do not participate in mining activities (control group) were sampled. Importantly, these are localities defined by the District Assembly and the District Food and Agriculture Department as primarily the known communities who are into farming and are severely impacted by gold mining activities. Again, secondary information retrieved from the Ghana Statistical Service showed that 69.34% of the five communities' labour force was engaged in farming, while 30.66% were into small-scale mining activities.

During the third phase of the sampling procedure, we used the proportion of labour force who are into both farming and mining to determine from the survey the farmers to be selected and interviewed from the study's 398 calculated sample size. To know the total number of farmers to be interviewed, we multiplied the proportion of farmers by the calculated sample size and the result gave 276.

Having known the farmers to be interviewed, it is also important to know the farmers to be interviewed from each community. The selection was based on purposive sampling technique with opinion leaders and groups who were genuinely affected farmers. However, due to factors such as the unwillingness of some farmers to participate in the survey and incomplete responses, 250

farmers comprising 126 farmers who participate in mining and 124 who do not participate at a response rate of 90.58% was used for the study.

Table 1: Distribution of Respondents in Sampled Communities

Communities	Samples Size
Asarekrom	53
Mpatuam	42
Mpraniase	49
Mmosiaso	52
Esaase	54
Total	*250*

According to Baruch (1999), there is no norm as to what is an acceptable response rate in academic studies. However, a response rate of 80% and above is preferable.

3.3 Analytical framework

3.3.1 Method of analysing food crop production constraints faced by farmers

In identifying the constraints faced by farmers, Kendall's coefficient of concordance was used to find out the most significant factors that influence the respondent (Christy, 2014). In Kendall's coefficient of concordance, the constraints with the lowest score when calculating the ranks are regarded as most pressing while the least pressing is the constraints with the highest score. In calculating the coefficient of concordance, the Kendall's (W) ranges from zero (0) to one (1) and the score for the ranking is meant to achieve the possible degree of agreement. If (W) is 1, then there is a complete unanimous agreement such that the rank assigned by the survey respondents were precisely the same as those assigned by other respondents. If (W) is (0), then it is evident that there is a high disagreement level among the ranked constraints. In this study, a list of constraints was designed and the respondents ranked them according to the level of severity to

their activities. Thus, an assigned scales with a value coded as 1 which represents strongly agree; 2 which represents agree; 3 which represents neutral; and 4 representing disagreement in that order was ranked by the respondents following the most and least pressing constraints. Equation (2) defines Kendall's coefficient of concordance (W) as follows:

$$W = \frac{12\left[\sum T^2 - \frac{(\sum T^2)}{n}\right]}{nm^2\ (n^2-1)} \qquad (2)$$

Where T = denotes the sum of ranks for constraints ranked; m = denotes respondents interviewed; n = denotes total constraints number ranked.

In testing for the significance of Kendall's (W), the F distribution specified in Equation (3) was used as follows:

$$\mathrm{F} = \frac{(\mathrm{m}-1)\,\mathrm{W}}{1-W_c} \qquad (3)$$

Where W_c is the calculated (W). For the numerator, the F statistic has $V1 = (n-1) - \frac{2}{m}$ degrees of freedom, and $V2 = (m-1)[(n-1) - \frac{2}{m}]$ for the denominator. In applying the decision rule it is noted that if $Fcal > Fcrit$ then the null hypothesis is to be rejected and is accepted if $Fcal < Fcrit$. Thus, in rejecting the null hypothesis, then the calculated F – value should exceed the tabulated F – value, which suggests that the respondents agree with each other.

3.3.2 Method of analysing the determinants of participation and its intensity in mining activities.

Many techniques have been employed in the identification of the factors influencing participation and its intensity in mining activities. Following the utility maximisation theory (Rahm and Huffman, 1984), the individual's participation decision in small scale mining

operations is dichotomous where the individual participates or refuses to participate (Martey et *al.*, 2014; Bannor et *al.,* 2020).

Determinants of participation and its intensity in mining activities need to analysed such that it may not result in misleading policy recommendation. Importantly, there are two decisions to make and with jointly made decisions, the Tobit model accepted among other models (Amankwah et *al*., 2016). Thus, Tobit assumes that both discrete and continuous decisions are affected by the same factors of participation and its intensity in mining activities, resulting in double counting which has been criticised that it is not always the case that such decisions are jointly made but different factors could also be made separately (Wiredu et *al.,* 2015; Asante et *al.,* 2018). Cragg's two-step models and the Heckman model become appropriate when the two decisions are made separately (Katchova and Miranda, 2004). Whether the decisions were jointly or separately made, it is very important to apply the Tobit and compare with the Cragg and Heckman's models to determine which model is superior to the other since two different hypotheses are developed.

Whenever a farmer faces choices, we assumed that the alternative one that offers the highest utility would be selected (Greene, 2007; Greene and Henshe, 2010; Muthini et *al*., 2017; Bannor et *al*., 2019; Bannor et *al*., 2020). Thus, a farmer, k faces two choices, i and j with utilities U_i and U_j, shown in equations (4) and (5) as;

$$U_i = X_{i1}W_{i1} + X_{i2}W_{i2} + I_i \quad (4)$$

$$U_j = X_{j1}W_{j1} + X_{j2}W_{j2} + I_j \quad (5)$$

Where Wij are individual farmer's characteristics. The random terms known to be the farmer's unmeasured characteristics are denoted by Ii and Ij. Where the farmers choice of alternative i is represented by $Y = 1$, then $U_i > U_j$, which follows;

$$Prob\left[Y = 1: W_{i1}, W_{i2}, W_{j1}W_{j2}\right] = Prob\left[U_i > U_j\right] \quad (6)$$

$$Prob[x'\beta + I > 0: X] \quad (7)$$

Where $x'\beta$ represent the differences of the measured elements regarding the two elements where I as their differences (Muthini et *al.*, 2017). In employing the Cragg's two-step model, both probit and truncated regression models were used where the former dealt with the probability of participating in mining activities (Cragg, 1971; Muthini et *al*., 2017) and can be expressed in Equation (8) below where *y* is either 0 or 1 as follows;

$$Prob(y > 0) = \emptyset x'\beta \quad (8)$$

Afterwards, the farmer intensity of participation decision was investigated by employing truncated regression presented as follows;

$$E(y: y > 0) = x' + \beta + i\lambda(x'\beta/i) \quad (9)$$

For the term $x'\beta/i$ being an adjustment factor could be dropped anytime a farmer does not participate in small scale gold mining be dropped (Muthini et *al*., 2017). In this study, an analysis of separability and selectivity in participation and the intensity of participation was conducted. To confirm separability in participation and the intensity of participation, the log-likelihood ratio test statistic ʒ is conducted as follows;

$$ʒ = -2(LLProbit + LLTruncated - LLTobit) \quad (10)$$

As a way of justifying the use of any of the two-step models, the result of the log-likelihood ratio test statistic (ʒ) should be greater than the Chi^2 with degrees of freedom equal to the independent variables and the intercept (Bannor et al., 2020; Oppong-Kyeremeh and Bannor, 2020).

4. Results and discussion

4.1 Categories and background characteristics of respondents

Data were collected from two categories: food crop farmers (mining participants) and food crop farmers (non-mining participants) in the Amansie West District. Table 2 outlines the variables, expected priori and the mean values of the analysis variables and their description. It is evident from Table 2 that 50% of farmers participated in mining activities for the 2019 farming season, which is the dependent variable for the selection equation. Another dependent variable is the intensity of participation measured as the farmland allocated to mining which had a mean value of 2.396.

Table 2: Descriptive statistics for the study

Variable	Variable description	Expected priori	Mean	Std. Dev.
Dependent variables				
Participation in mining	=1 if farmer participates in mining activities, 0 otherwise	Nil	0.504	0.501
Intensity of participation	Actual farm size allocated to mining	Nil	2.396	3.423
Independent variables				
Age	Age of farmer (years)	+/-	28.204	8.710
Sex	=1 if farmer is male, 0 otherwise	+	0.8	0.401
Marital status	=1 if farmer is married, 0 otherwise	+	0.536	0.500
Number of household	Number of adult household members	+	2.916	2.086
Education	=1 if a farmer had formal education, 0 otherwise	+	0.408	0.493
FBO membership	=1 if the farmer was a member in farmers' group, 0 otherwise	+/-	0.78	0.415
Access to credit	=1 if a farmer is not liquidity constraint, 0 otherwise	+	0.524	0.500
Access to extension services	=1 if farmer gets access to extension services, 0 otherwise	+/-	0.568	0.496
Off-farm job	=1 if farmer participated in off-farm job, 0 otherwise	-	0.939	0.245
Yielding of food crop	=1 if a farmer food crop output is low, 0 otherwise	+/-	0.392	0.489

The age of a farmer was captured, and the mean value of age is 28 years. In explaining the shift from crop production to mining activities, the age variable is significant. Likewise, Adu et *al*. (2016) accepted that individual's age affects participation in mining activities. Also, the findings of Adjei et *al.* (2012) revealed that mining activities are for the youth because of the much strength needed while other careers are particularly for people advanced in age in the community due to less strength.

Education is measured as either having formal education or no formal education, which revealed a mean value of 0.408. Individual education is hypothesised to affect participation and the intensity of participation in mining activities as recognised by Adu et *al.* (2016) with the implication that farmers with education engage themselves more in mining activities as compared to their counterparts farmers with no education, particularly formal education. In particular, because households with many adult members may have more financial burden, they are more likely to participate in mining activities while household having fewer members may opt not to participate in mining activities (Adu et *al.*, 2016).

Participation in mining activities may be affected by credit constraint due to certain imperfections in both the agricultural and financial markets where liquidity constraint is classified as, if farmers received some credit and still show appreciable interest and the need for additional money by borrowing more or if credit was available. However, request applications have been rejected, or probably there was no access at all for credit even at a prevailing interest rate for farmers (Abdulai and Huffman, 2014).

From Table 3, the statistics of the differences in participants' characteristics and non-participants, with their t-values highlighting significant issues are presented. In the sample, the t-values put forward some of the highlighted differences amongst participants and nonparticipants

in mining activities. For example, when an off-farm job is considered, the proportion of participants in mining activities on food crop production was higher than nonparticipants in mining activities. While 63% of nonparticipants in mining activities had no access to credit, as much as 42% of participants had access to credit facility. It is evident that there appears to be significant differences between participants and non-participants in access to extension services, access to credit, and membership in farmers' organisations.

Table 3: Summary statistics of participants and non-participants in mining activities

Variable	Participant		Non-participant		Difference
	Mean	SD	Mean	SD	
Age	28.389	8.967	28.016	8.472	t = -0.3377
Sex	0.786	0.412	0.815	0.390	t = 0.5673
Marital status	0.484	0.502	0.589	0.494	t = 1.6604*
Number of household	2.595	1.781	3.242	2.318	t = 2.4763 **
Education	0.421	0.496	0.395	0.491	t = -0.4083
FBO membership	0.698	0.461	0.863	0.345	t = 3.1900***
Access to credit	0.421	0.485	0.629	0.485	t = 3.3595***
Access to extension services	0.492	0.501	0.645	0.480	t = 2.4631**
Off-farm job	0.897	0.305	0.976	0.154	t = 2.5746**
Yielding of food crop	0.421	0.496	0.363	0.483	t = -0.9327
Number of observations	126		124		

Note: the asterisks, *, **, and *** show the significance levels at 10%, 5%, and 1%

The average output for participants in mining activities in terms of yielding of food crop of 42% is relatively lower among participants in mining activities than that of non-participants with 48% indicating significant differences in yields. This difference suggests that low yielding food crop plays a significant role in shifting from food crop production into mining activities. Differences also exist between participants and non-participants with reference to education as well as access to an extension service where participants who are educated with contact to extension services are more than non-participants. Although Table 3 reveals the differences between participants and non-participants with credit, extension services, and off-farm job but the idea of average

differences cannot be sufficient to discuss the decisions on participation amongst sample farmers simply because it fails to account for the influence of other characteristics amongst farmers. The average differences presented between participants and nonparticipants differ significantly.

4.2 Constraints in food crops production faced by farmers

From Table 4 the most pressing problem faced by food crop farmers in the Amansie West District is high seed cost with a mean score of 4.9263. Also, a mean score of 6.7579 was ranked for mining experience as second constraints faced by farmers. This means that individuals who have gained much experience in the mining business pose much threat to the food crop farmers by

Table 4: Ranks of agricultural constraints faced by farmers

Constraints	**Mean Score**	**Rank**
High seed cost	4.9263	1
Mining experience	6.7579	2
Low improved variety of food crop	7.1158	3
Amount of credit received	7.2526	4
Access to credit	7.3895	5
Insecticide cost	7.8000	6
Membership to FBO	7.8632	7
Poor road network	7.9158	8
Off-farm jobs	8.2000	9
Income diversification	8.4632	10
Farm size	8.8947	11
Low yielding food crops	9.0211	12
Household size	10.0842	13
Low disease-resistant varieties	11.0000	14
Lack of ready market	11.4842	15
Lack of storage facilities	11.7895	16
Test Statistics		
N=95		
Kendall's W^a=0.150	Difference =15	
Chi^2=214.097	Asymp. Sig=0.000***	

Note: ***Significance at 1% level; Response code; 1 indicating the most pressing constraint and 16 is the least pressing constraint by ranking the mean scores.

Source: Authors' computation, 2020

degrading their lands. Farmers also ranked a low improved variety of food crop as the third pressing constraint with a mean score of 7.1158 which indicates that the traditional varieties of food crops are causing a reduced output or yield for farmers since demands and tastes and preferences of consumers keep on changing. Amount of credit received is the fourth most perceived problem by farmers in the Amansie West district with a mean rank of 7.2526. Also, access to credit constitutes the fifth-ranked problem with a mean score of 7.3895. Thus farmers in the Amansie West District ranked *high seed cost, mining experience, low improved variety, amount of credit received, and access to credit* to be the topmost five constraints (see Table 4).

Therefore, it can be seen that there is a reasonable degree of agreement between farmers in the constraints ranked among food crop producers in the District. The other low levels of agreement may be due to the heterogeneous nature of the farmers. No one constraint is very important than the other but depending on the community's strength, values and resources determine which characteristics are prioritised (Centre for Community Enterprise, 2000). The Kendall's Coefficient of Concordance (W^a) indicates that there was 15.0% agreement among rankings by crop farmers and the F-value showed the statistical significance of the constraints ranked at 1% implying the rejection of the null hypothesis in favour of the alternate.

4.3 Factors influencing participation and the intensity of participation in mining activities

It is to state that the decision of a farmer to participate is premised on two ways where a farmer decides to participate or not to participate as well as the intensity of participation. In order to avoid conflicts in reporting the results which could result in wrong policies in determining the factors influencing participation and the intensity of participation, a diagnostic test was done to ascertain which of these models - the Cragg's two-step model, standard Tobit model and Heckman two-stage is superior for our data and would be the best fit by the use of likelihood ratio test. This was

done by first testing the Cragg's double-hurdle against the standard Tobit to determine whether the decisions were taken jointly or separately using the likelihood ratio test. The Likelihood ratio (LR) statistic of 1103.62732 as shown in Table 5 is in favour of the two-stage regression models and rejects the standard Tobit which is bigger than the chi-square value of 18.31 at 5 per cent at 10 degrees of freedom, hence the appropriateness of selecting the two-stage against one stage Tobit model.

Table 5: Likelihood ratio statistic

Models	LR test				
	Probit	Truncated	Tobit	LR statistic	Decision
Participation	-154.6416	-642.35405	-245.18199	1103.62732	Two-stage model preferred to the Tobit model

The standard Tobit model becomes appropriate to be used when the decision is jointly made and where the decisions are made separately, then participation may be characterised by selectivity bias. The non-significant inverse Mills ratio from the Heckman two-step models suggests the nonexistence of selectivity bias. Thus, the set of factors responsible for food crop production farmer's discrete decision to participate in mining activities are different from the set of factors responsible for the continuous decision on the intensity of participation in mining activities in the study area. With that, the Cragg's Double-Hurdle model will provide unbiased and consistent estimate since the decisions were taken separately. Table 6 presents the factors influencing food crop production farmer to participate in mining activities and the intensity of participation in mining activities. From the Cragg's two-step model in Table 6, the discrete decision to participate is determined by the number of household size, FBO membership, access to credit, off-farm job, and low yielding food crop. However, the continuous decision on the intensity of participation is also influenced by age, the number of household size, FBO membership, off-farm job, and low yielding food crop. The results show that it is not always the case that a significant given factor in

the discrete decision may at the same time be significant in the continuous decision and the vice-versa. From the results, variables that are same across the two decisions are the number of household size, FBO membership, off-fam job and low yielding food crop while only access to credit varies for the two decisions and rather influence the discrete decision of participation more than the continuous decision of participation intensity.

For the household size, the result showed that both decisions of participation and intensity of participation in mining activities were identified as influencing the shift from crop production to mining activities. The household size recorded a negative and significant effect on participation and the intensity of participation of farmers in mining activities. This suggests that farmers who have more family members are more likely to participate in the mining activities as opposed to their counterparts who have small family size. The marginal effect of household size revealed that when the household size of a farmer increases by 2.916%, then it would also increase a farmer's decision to participate in mining activities. This finding is consistent with Adu et *al.* (2016) such that households having a large number of adult members may have more financial burden and are likely to participate than households having less members who may opt not to participate in mining activities.

Likewise, the FBO membership influences the shift from crop production to mining activities with negative effect on the decision to participate and the intensity of participation in mining activities. It is important to note that information on most food crop production for farmers are spread through farmer-based organisations and therefore not belonging to any farmer group will result in a low yielding (Wongnaa and Badu, 2020). FBO membership was significant at 10% for the discrete decision and 1% for the continuous decision which implies that the lack

Table 6: Factors influencing farmer's participation and the intensity of participation (Actual farm size allocated to mining)

Variable	Cragg's two-step model			Standard Tobit	Heckman selectivity model	
	Probit [a]	Truncated [b]			Probit [c]	OLS Regression [d]
	Coeff (SE)	Coeff (SE)	Marginal effects	Coeff (SE)	Coeff (SE)	Coeff (SE)
Age	0.011 (0.013)	0.040 (0.030)	28.204	0.007 (0.009)	0.011 (0.013)	0.067 (0.095)
Sex	-0.037 (0.211)	0.519 (0.505)	0.8	-0.018 (0.146)	-0.037 (0.211)	0.484 (1.264)
Marital status	-0.205 (0.169)	0.493 (0.405)	0.536	-0.141 (0.118)	-0.205 (0.169)	0.629 (1.568)
Number of household size	-0.071 (0.043)*	-0.262 (0.102)**	2.916	-0.051 (0.031)	-0.071 (0.043)*	-0.625 (0.474)
Education	0.194 (0.226)	0.139 (0.534)	0.408	0.130 (0.156)	0.194 (0.226)	0.080 (1.670)
FBO Membership	-0.494 (0.252)*	-2.550 (0.603)***	0.78	-0.318 (0.173)*	-0.494 (0.252)*	-4.990 (2.924)*
Access to credit	-0.884 (0.286)***	-0.297 (0.657)	0.524	-0.518 (0.182)***	-0.884 (0.286)***	-1.102 (4.787)
Access to extension service	-0.218 (0.206)	0.208 (0.503)	0.568	-0.156 (0.148)	-0.218 (0.206)	0.862 (1.739)
Off-farm job	-0.710 (0.418)*	-1.689 (0.878)*	0.936	-0.357 (0.243)	-0.710 (0.418)*	-3.219 (3.407)
Low yielding food crop	-0.617 (0.291)*	-1.138 (0.668)*	0.392	-0.318 (0.184)*	-0.617 (0.291)*	-2.807 (3.465)
Constant	1.870 (0.672)***	5.341 (1.438)***		1.227 (0.406)***	1.870 (0.672)***	6.732 (3.705)*
The number of obs.	250	250		250	250	250
Wald/LR x^2 (10)	37.27***	42.26***		33.94***	14.41	14.41
Prob>Chi^2	0.0001	0.0000		0.0002	0.1549	0.1549
Log-likelihood	-154.6416	-642.35405		-245.18199		
Pseudo R^2	0.1076			0.0647		
Sigma		3.160 (0.141)***		0.835 (0.061)	6.589	
Mills ratio *(λ)*					6.588 (9.088)	
Likelihood ratio statistic	**1103.62732**					

Notes: [a] 1st stage of Cragg's model, [b] 2nd stage of Cragg's model, [c] Stage I of the Heckman selection model, [d] Stage II of the Heckman selection model. The (SE) represents standard errors, *, **, and *** indicate 10%, 5%, and 1% significance levels respectively.

of a farmer's involvement in a farmer-based organisation as members will increase their decision to participate in mining activities and influence their intensity of participation in the mining activities. The marginal effect suggested that not belonging to a farmer-based organisation would lead to a 0.78% increase in the probability of shifting from crop production to participate in mining activities (Table 6). This is expected because not belonging to a farmer group exposes farmers to other activities, especially mining activities as perceived that its participation can help the financial difficulties of food crop farmer (Akudugu et *al.,* 2009).

Considering access to credit which is only significant in relation to the continuous decision had a negative effect on the probability of the intensity of participation and was statistically significant at 1% level. While credit access is not significant on the intensity of participation, farmers are less likely to participate in mining activities than those with credit constraints. The marginal effect revealed that not receiving credit would result in a 0.524% increase in the chances of a food crop production farmer participating in mining activities (Table 6). Although credit adds to the financial resources that a food crop farmer needs and allows him/her to meet the financial demands. While the negative effect of access to credit contradicts results reported by Abdulai and Huffman (2014) and Wongnaa and Badu (2020), the attention of this study falls on food crops in general unlike their study which focuses on specific crops.

Off-farm job had significant (negative) influences on both participation and intensity of participation in mining activities. Off-farm job was significant at 10% and had a negative effect on the two decision which suggest that food crop farmers' with additional funds possibly led to resources diversion away from farming (Rahman, 2008; Asante et *al.*, 2018) which may influence participation and intensity of participation in mining activities. The marginal effect revealed that having access to an off-farm job would result in a 0.936% increase in the chances of a food crop

production farmer participating in mining activities. It is important to note that the change of family labour into activities like mining rather than crops could possibly explain this finding which differs from that of (Babatunde and Qaim, 2010; Owusu et *al.*, 2011) who revealed the positive net effect of off-farm income on food security.

Finally, low yielding food crop was negatively related to farmer's decision to participate in mining activities and their intensity of participation in the mining activities. Low yielding food crops was significant at 10%. Low yielding food crop decreases the likelihood of farmers staying in their farming business and logical to infer that farmers experiencing low yielding food crops over some time in their farming seasons would be more likely to participate in mining activities. The marginal effect revealed that there is a 0.392% point decrease in the predicted value of participation in mining activities for a one-unit decrease in the yield of food crops. This implies that as the yield of food crops begin to decrease by one unit, chances are that farmers would put an end to their farming business and participation in mining activities will also increase in that proportion. This is consistent with Edward's (2014) study that small-scale mining can be attributed to getting higher revenue quickly compared to farming activities.

Surprisingly, variables such as age, sex, marital status, education and access to extension service neither influenced participation in mining activities nor the intensity of participation in mining activities. This attest that private companies as well as Non-Governmental Organisations (NGO's) came to their aid and rendered a little support to these farmers and that could be why it did not appear to be a significant factor when deciding on whether or not to participate in mining activities.

5. Conclusions and recommendations

Farmers in the District ranked high input cost as the first most pressing constraint to their agricultural production. Experience in mining was perceived to be the second constraint while low improved variety was ranked as the third constraint. Also, the amount of credit received was ranked fourth and access to credit as the final constraint. Results from the likelihood ratio tests show that the factors affecting the decision to participate in mining activities are different from the set of factors influencing the intensity of participation in mining activities in the Amansie West District. For this reason, since the test statistic value is more than the chi-square critical, the Cragg's two-step model was employed in the analysis. From Cragg's two-step model, five factors affected the decision to participate in mining activities while four factors affected the intensity to participate in mining activities in the Amansie West District. These factors are the number of household size, FBO membership, access to credit, off-farm job, and low yielding food crop affected the discrete decision to participate in mining activities while the factors that affect the continuous decision include the number of household size, FBO membership, off-farm job and low yielding food crop. The study recommends that participants engaged in mining activities minimise their operations in the District, especially in communities where food crop production is the dominant economic activity. It is also recommended that the Government could improve access to credit and improved crop varieties by resourcing and leveraging of institutions responsible for provision of credit and improved crops varieties.

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