ORIGINAL ARTICLE

ENTRY AND PARTICIPATION BARRIERS IN DRY SEASON IRRIGATION FARMING: EVIDENCE FROM TONO AND VEA IRRIGATION SCHEMES

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|Received | 23 October 2016| |Accepted | 02 November 2016| |Published 10 November 2016 |

ABSTRACT

Background: The Upper East region is characterized by low income level, increased food insecurity, high emigration and seasonal unemployment. Against this backdrop, the Tono and Vea irrigation schemes were developed in the Upper East region to overcome the high incidence of poverty. However, over 70% of Tono and 72% of Vea irrigable lands have been underutilized due to the complexity of the nature of barriers farmer face. There are no empirical studies which explore the nature of farmers' barriers in the Tono and Vea irrigation schemes. **Objectives:** The main objective of the study was to explore the differential barriers facing farmers' entry and participation in dry season irrigation farming and effects on livelihood outcomes. **Materials and Methods:** The study used a simple random sampling technique to select 300 farmers. Questionnaire and in-depth interview guide were the main instruments used for data collection. Gender, education status and wealth status were the main attributes used for categorizing farmers in the schemes. Data was entered into the Predictive Analytical Software for Spearman's Rank Order Correlation, Chi-square and t-text analysis. **Results:** The findings indicate that while farmers' entry and participation in dry season irrigation farming was negative and significantly correlated for economic barriers (r = -0.06), institutional barriers (r = -0.04) and technical barriers (r = -0.02), a positive and significant correlation (r = 0.013) was realized for socio–cultural barriers. **Conclusion:** The evidence gathered from the study shows that dry season irrigation farming is profitable and contributes very high to welfare and wellbeing of farm families. In order to help address all forms of entry and participation barriers in dry season irrigation farming to ensure project sustainability, it is recommended that the schemes be run on a public-private-partnership basis.
Key words: *Sustainability, agro-chemicals, profitability, livelihood outcomes, indicators*

1. INTRODUCTION

According to Asare (2002), 70% of the population of Upper East Region of Ghana engages in agriculture as a major source of livelihood [1]. However, agriculture in the region is beset with a single and unreliable rainfall pattern which leads to poor crop yields and renders most farmers seasonal unemployment especially during the prolonged dry season. In order to promote all year round farming, the Government of Ghana with support from international organizations and institutions provided irrigation schemes to some communities in the Upper East Region to improve food production [2]. Available evidence suggests that 70% and 72% of irrigable lands at Tono and Vea irrigation schemes respectively have been underutilized. The under-utilization of these irrigation facilities for dry season farming has contributed to deficits in agricultural outputs, increased food insecurity, high rate of unemployment and high emigration from the region [3].

According to Mendola (2007) smallholder farmers find it difficult to enter and participate in profitable or risk reducing diversification economic activities as a result of barriers they face in venturing in new enterprises [4]. The economic theory on barriers to entry states how various barriers influence decisions of new entrants into opportunities and how these barriers influence their profit rates and livelihood outcomes. Blees et al. (2003) found that barriers to entry have a strong effect on the entry decision of potential entrepreneurs and that if the barriers to entry are high, new entrepreneurs might decide not to enter [5]. Though entry barriers are crucial factors that influence entry into an opportunity, very little empirical research has investigated the nature of barriers to entry into dry season irrigation farming among different categories of farmers in the Upper East Region. The lack of knowledge on entry and participation barriers serve major hindrance to the understanding of the under-utilization of irrigation schemes in the region.

Therefore, this study explores the nature of entry and participation barriers in dry season irrigation farming in the Tono and Vea irrigation schemes. The main objective of this study was to explore different barriers farmers face in

entry and participation in dry season irrigation farming and effects on livelihood outcomes. The study seeks to achieve the following specific objectives *i) assess the nature of barriers different categories of farmers face in entering into dry season irrigation farming; ii) determine if differential barriers to entry have an influence on farmers' participation in dry season irrigation farming; iii) examine the relationship between personal characteristics of farmers and participation in dry season irrigation farming; and iv) describe the framework of profit maximization and livelihood outcomes of dry season irrigation farming.*

This study is justifiable because irrigation is indispensable to poverty reduction, employment creation, enhancement of income and economic growth. Therefore, attempts to examine the nature of barriers to entry and participation in dry season irrigation farming among different categories of farmers is of policy importance since empirical findings would provide insights into why people will participate in or not in irrigation farming.

2. MATERIALS AND METHODS

The study was conducted in six communities benefiting from the Tono and Vea irrigation schemes. These specific communities were Bonia, Gworie, Korania, Nangalikinia, Vea and Yorogo. A simple random sampling technique was used to obtain data from 300 farmers. The selection of farmers in each community was proportional to the population of the community. The main research instruments used were questionnaire and in-depth interview guide. Areas of data collection covered are i) social, demographic and economic characteristics (i.e. gender, age, education status of respondent, wealth status of respondents, sources of income, income level, number of labour used, residential status, etc), ii) information on farmers' participation and practices in dry season irrigation farming (e.g., years of farming experience, farm size, land tenure, extension service access and use, land preparation, ploughing, nursery, sowing/transplanting, weeding, use of watering cans, knapsack sprayers and simple equipment/tools like rakes, hoes, cutlass, hand fork, etc.), iii) availability, access, quantity, and input prices (e.g., seeds/seedlings, insecticides, pesticides, herbicides, fertilizer, manure, etc), iv) expenditure and output prices (e.g., water levy, transportation, wages, commission on sales, purchase of consumables, and value of crop outputs. Finally, data were obtained on contribution of dry season irrigation farming to farm families (e.g., major and minor indicators on welfare, wellbeing, income and food security).

2.1 Data Analysis

Data was entered into the Predictive Analytical Software (version 20). Data analysis involved the use of Spearman's Rank Order Correlation (r_s) to test the association between different groups and between different rankings of barriers. The most important barrier was assigned a rank of 1 and the ranks were assigned separately for each barrier. Tied scores were assigned a rank equal to the average of all the tied positions. The formula for Spearman's Rank Order Correlation (rs) is given below. Also, a Chi-square test was used to test for difference between independent variables (e.g., personal characteristics) and dependent variables (e.g., participation in dry season irrigation farming). Furthermore, the net returns (that is the difference between value of outputs (revenue) and total cost of production (fixed cost, variable cost and operational expenses)) on dry season irrigation farming using equation 1 to 6 was estimated (see equation below). To describe the contribution of dry season irrigation farming to farmers' livelihood outcomes, a three point scale (0-1 = low contribution; 2-3 = high contribution; 4-5 = very high contribution) was designed for scoring major indicators, whiles a five level scale (1= very poor; 2 = poor; 3 = fair; 4 = good; 5 = very good) was designed for scoring minor or sub-indicators.

$$r_s = 1 - \frac{6\sum D^2}{n(n^2-1)}$$

Where;
D is the difference between ranks and n is the total number of constraints. The correlation coefficient (ρ) ranges from -1.0 to +1.0. The closer ρ is to +1 or -1, the more closely the two variables are related.

Value of outputs of all crops in dry season irrigation (1)

Total fixed cost: (2)
Seeds/seedlings
Watering can
Snap sack sprayer
Land rent
Membership dues

Total variable cost/labour input cost: (3)

Fertilizer
Manure
Water levy
Insecticide
Pesticides
Herbicides
Land preparation
Ploughing
Nursery
Planting
Weeding
Harvesting

Operating cost/expenses: (4)
Transportation
Tax
Sales' commission

Total cost = Eq2 + Eq3 +Eq4 (5)

Net return = Eq1–Eq5 (6)

3. RESULTS

3.1 Economic barriers facing different categories of farmers

Table 1 presents the ranking of economic barriers by different categories of farmers. The results show that the ranking of economic barriers by educated and uneducated farmers, poor and rich farmers was not statistically significant implying that ranking was apart and differed. Generally, the findings show that both male and female farmers, uneducated and poor farmers ranked high cost of agricultural inputs as most pressing economic barriers to entry and participation in dry season irrigation farming (Table 1). The ranking of high cost of agricultural inputs by male and female farmers was significant and highly correlated. The second ranked economic barrier for female and poor farmers was lack of access to credit. This finding agrees with Adam (2009) that female entrepreneurs in rural communities face difficulties accessing credit and other forms of financial assistance due to lack of collateral security and unfavourable credit conditions [6].

Table 1: The table shows economic barriers facing different categories of farmers.

Category of farmers	Lack of access to credit	Low price of output	High cost of inputs	Market price fluctuations	High cost of transportation	Limited access to irrigated land	Unavailable for dry season farming	r_s
Gender								
Male	3.5	2	1	5	6	3.5	7	.80
Female	2	4	1	6	5	3	7	
Education status								
Educated	3.5	1	3.5	6	5	2	7	.68
Uneducated	3	5	1	6	4	2	7	
Wealth								
Poor	2	3	1	6	4	5	7	.30
Rich	5	2	3	4	6	1	7	

3.2 Institutional barriers faced by different categories of farmers

Table 2 presents the results of institutional barriers to entry and participation in dry season irrigation farming by different categories of farmers. The study findings show that all categories of farmers ranked lack of access to regular extension services as the most pressing institutional barriers to entry and participation in dry season irrigation farming. This finding agrees with Dinye and Ayitio's (2013) assertion that poor extension services at the Tono irrigation scheme makes farmers to rely mostly on their accumulated experience rather than the usual extension service [7]. The ranking of other institutional barriers were not correlated and thus differed among all categories of farmers. For example, whereas male and educated farmers ranked unfair land allocations as second most pressing institutional barriers, female and poor farmers ranked high water levy as second most pressing institutional barriers.

Table 2: The table shows institutional barriers facing different categories of farmers.

Category of farmers	Lack of access to regular extension service	Unfair land allocations	Unfair water distribution	High water levy charges	r_s
Gender					
Male	1	2	3	4	.40
Female	1	3	4	2	
Education status					
Educated	1	2	3	4	.30
Un educated	1	4	2.5	2.5	
Wealth					
Poor	1	3	4	2	.20
Rich	1	3	2	4	

3.3 Socio – cultural barriers faced by different categories of farmers

Table 3 shows the results of socio-cultural barriers facing different categories of farmers. The findings indicate that except for male and rich farmers, all categories of farmers ranked land inheritance as the most pressing socio-cultural barrier. The results show that male and rich farmers ranked high family responsibilities as the most pressing socio-cultural barriers to entry and participation in dry season farming. The ranking of socio-cultural barriers by gender and wealth status of respondents was not significantly correlated.

Table 3: The table shows socio-cultural factors faced by different categories of farmers.

Category of farmers	Too much work load	High family responsibility	Inheritance of land	Control of income	Discrimination in remuneration	r_s
Gender						
Male	3.5	1	2	5	3.5	.30
Female	3	2	1	5	4	
Educational status						
Educated	3	4	1	5	2	.60
Un educated	2	3	1	5	4	
Wealth						
Poor	2	3	1	5	4	.70
Rich	4	1	2	3	5	

3.4 Technical barriers faced by different categories of farmers

Table 4 shows the technical barriers different categories of farmers face in dry season irrigation farming. The findings indicate that lack of storage and processing facilities is the most pressing technical barrier to entry and participation in dry season irrigation farming facing all categories of farmers. This finding is similar to Adam et al. (2016) that lack of storage and processing facilities hamper the production of perishable vegetables in Bolgatanga Municipal [8]. The results also indicate that apart from rich farmers, all the categories of farmers ranked unavailability of labour as the second most pressing technical barriers to participate in dry season farming. The lack of available labour is largely attributed to the migration of the economic active youth to other sectors of the economy (e.g., mining, road construction, etc.).

Table 4: The table presents the technical barriers facing different category of farmers.

Category of farmers	Crop infestation by pest and diseases	Unavailability of fertilizer	Lack of storage and processing facilities	Inadequate knowledge of appropriate use of technology	Lack of knowledge of agrochemical use	Unavailability of labour	r_s
Gender							
Male	4	5	1	6	3	2	1.0
Female	4	5	1	6	3	2	
Education status							
Educated	3	4	1	5	6	2	.83
Uneducated	3	5	1	6	4	2	
Wealth							
Poor	3	4	1	6	5	2	.89
Rich	2	5	1	6	4	3	

3.5 Relationship between barriers and participation in dry season irrigation farming

The correlation results show that economic, institutional and technical barriers have a significant and negative relationship with farmers' participation in dry season irrigation farming (Table 5). This means that the more barriers farmers face, the lesser the probability of them participating in dry season irrigation farming. The specific economic, institutional and technical barriers that affect farmers' participation in dry season irrigation farming include high cost of inputs, lack of access to regular extension services and lack of storage and processing facilities, respectively. The results also indicate that socio-cultural barriers have a significant and positive relationship with farmers' entry and participation in dry season irrigation farming. Specifically, family responsibilities was found to have a positive effect on farmers' decision to enter and participate in dry season irrigation farming. This is because the more family responsibilities a farmer has, the higher the probability that the farmer will participate in dry season irrigation farming. The logic is that people in rural communities generally will undertake irrigation farming to reap in additional income to meet household needs.

Table 5: The table shows correlation matrix.

Barriers	Participation in dry season irrigation farming
Economic	-0.06**
Institutional	-0.04*
Technical	-0.02**
Socio-cultural	0.01**

5 percent Significant Level (**), 10 percent Significant Level (*).

3.6 Personal characteristics and farmers' participation in dry season irrigation farming

Table 6 presents the chi-square results of personal characteristics and farmers' participation in dry season irrigation farming. The p-value of the chi-square analysis show that there is statistically significant difference between gender, education status and participation in dry season irrigation farming. The results show that 54% of female and 52% of male farmers, 53% and 47% of educated and uneducated farmers, respectively participate in dry season irrigation farming. The results also indicate that there is no statistically significant difference between age, wealth status and participation in dry season irrigation farming. The results show that 36% of the youth, 51% and 49% of poor and rich farmers respectively, participate in dry season irrigation farming. The low involvement of the youth in dry season irrigation farming has serious implications for the sustainability of the projects and consequences for high emigration and poverty.

Table 6: The table shows Personal characteristics and participation in dry season irrigation farming.

Variable	Do not participate in dry season farming		Participate in dry season farming		Chi-square
	Freq.	%	Freq.	%	
Gender					
Female	53	46.5	61	53.5	χ^2 = 0.905
Male	89	47.8	97	52.2	p = .014
Age					
Youth (<30)	69	63.9	39	36.1	χ^2 = 0.059
Adults (30 - 59)	92	49.5	94	50.5	p = .073
Aged (60+)	5	83.3	1	16.7	
Education status					
Educated	69	47.3	77	52.7	χ^2 =0.854
Uneducated	81	52.6	73	47.4	p = .001
Wealth status					
Poor (<US$360)	76	49.0	79	51.0	χ^2 =0.120
Rich (≥US$360)	74	51.0	71	49.0	p = .035

3.7 Quantity, input and output related cost of dry season irrigation farming

Table 7 presents the results on quantity, input and output related cost of dry season irrigation farming. The findings show that there is profitability (mean = GHS7,452.9) in dry season irrigation farming. The findings suggest that dry season irrigation farming is far less risky compared to rain fed agriculture where crop cultivation is dependent on the amount and distribution of rainfall. The study results show that the average amount of water levy is GHS450 for the whole farming season. Farmers' willingness to pay water levy is high because they have ready access to water any time of the day and at any quantity for crop use. The study recognized that water levy is calculated based on the farm size of the farmer. The larger the farm size the higher the water levy and the smaller the farm size, the lesser the water levy.

The results also indicate that the quantity and input use for dry season irrigation farming do not vary as mean (8 liters) quantity of agro-chemicals (insecticides, pesticides, herbicides) used are the same. Furthermore, the findings of the study indicate that farmers use more of fertilizer (mean of 7 bags) compared to manure (mean of 3 bags). The reason is that it is time consuming for farmers to gather animal droppings and crop residue to prepare compost. This is because livestock farmers practice free range system of animal rearing. The significant use of fertilizer and agro-chemicals suggest that crop production can be boosted by making these inputs readily available and accessible to farmers.

Table 7: The table shows input and output cost related to last year dry season irrigation farming.

Variables	Minimum	Maximum	Mean	Standard deviation
Farm size (acres)	4	25	12.8	0.92
Seeds (Sachets)	6	22	12	0.13
Watering can (number)	1	4	2	0.73
Snap sack sprayer (number)	1	3	2	1.66
Land rent (GHS/season)	200	600	250	5.21
Membership dues (GHS/season)	20	20	20	0.01
Fertilizer (bag)	4	13	7	3.35
Manure (bag)	1	8	3	1.78
Insecticide (litres)	4	24	8	1.42
Pesticides (litres)	4	21	8	1.42
Herbicides (litres)	4	21	8	1.42
Water levy (GHS/season)	100	1,000	450	2.63
Land preparation (GHS/labour)	30	500	150	1.51
Ploughing (GHS/tractor)	60	1,500	768	2.28
Nursery (GHS/labour)	16	400	200	1.06
Planting (GHS/labour)	16	400	200	1.09
Weeding (GHS/labour)	40	1,000	500	1.15
Harvesting (GHS/labour)	20	500	250	1.08
Transportation (GHS)	120	1,125	620	1.21
Tax (GHS)	24	110	78	0.31
Sales' commission (GHS/labour)	100	300	155	1.02
Value of yield (GHS)	3,489.8	87,245.4	21,811.3	304.74
Net return (GHS)	1,192.5	29,811.4	7,452.9	87.92

GHS – Ghana cedis (US$1 = GHS3.6)

3.8 Contribution of dry season irrigation farming to farmers' livelihoods

The contribution of dry season irrigation farming was evaluated on four main/major indicators namely welfare, wellbeing, income and food security (Table 8). The findings show that the contribution of dry season irrigation farming to welfare is very high (average score is 4.50). Majority (93%) of the farmers have through dry season irrigation farming bought motorbikes and multi-TV decoders for private and commercial use as additional sources of household income. This finding is consistent with Adam et al. (2016) that irrigators use proceeds from dry season irrigation to purchase bicycles and motorbikes so as to reduce travelling time to farm and social gathering [8]. The results also indicate that the contribution of dry season irrigation farming to wellbeing and income is high (average scores is 3.75). The results show that farmers use proceeds of dry season irrigation farming to purchase livestock, poultry, pay for water and sanitation facilities, pay health bills and meet the educational needs of children.

Table 8: The table shows contributions of dry season irrigation farming to livelihood.

Welfare indicators	Scores	Income indicators	Scores

Bicycle	5	Able to invest in livestock and poultry	5
Motorbike (motor king)	5	Able to pay health bills	3
Multi TV decoder	4	Able to meet education needs of children	5
Furniture	4	Pay water and sanitation, and other social activities dues	2
Average welfare	**4.50**	**Average income**	**3.75**
Wellbeing indicators		**Food security indicators**	
New roof	2	The family is food secured throughout the year	4
Fixed/improved existing roof, floor and walls	3	The family is food secured for 9 months	5
House expansion (new room, shed and fence)	5	The family is food secured for 6 months	2
Lighting of house	5	The family is food secured for 3 months	1
Average wellbeing	**3.75**	**Average food security**	**3.00**

4. DISCUSSION

The results point out that the farmers in Tono and Vea irrigation schemes face myriads of barriers, which affect the sustainability of the schemes. The analysis indicates that barriers related to institutional, technical and economic are co-related and serve to lock-in participation in dry season irrigation farming. These barriers affect women, poor and uneducated farmers (generally referred to as economically disadvantaged people) more than the affect men, rich and educated farmers. The specific barriers affecting entry and participation in dry season farming include lack of access to credit, lack of access to regular extension services, high cost of agricultural inputs, among others. The lack of funds and access to credit facilities reduce women's ability to increase productivity. The inability to access credit are largely due to the lack of collateral security and unfavourable credit conditions (e.g., belonging to groups, high interest rates, short repayment period, etc.) imposed by financial institutions. These findings collaborates with Adam (2009) that gari processors in the West Gonja district lack collateral assets beyond cooking utensils to access credit from financial institutions [6]. The inability to access credit coupled with the lack of government's subsidies on key agricultural inputs directly affect farmers' ability to purchase fertilizer, seeds and agro-chemicals such as insecticides, pesticides and weedicides. This often compels farmers to purchase these inputs at full cost and in small quantities resulting in crowding out of agro-chemical input retailers/dealers in most rural communities. In-depth interviews with extension officers indicate the lack of effective control measures to guard retailers from purchasing government subsidized fertilizers. The free access to government subsidized fertilizers by retailers lead to the development of a thriving black market and smuggling of the product to neighbouring countries such as Togo, Burkina Faso, Benin, et cetera and thus, reducing poor farmers' access to such inputs.

The study findings also indicate that farmers in Tono and Vea irrigation schemes lack access to regular extension services. This is because the Department of Agriculture has few extension officers. This problem is compounded by the freeze or ban on employment of new extension officers by the central government. The effects of government's freeze on employment have worsened the farmer-to-extension officer ratio especially in the region. Even the introduction of private extension services has not helped in any meaningful way to reduce the high incidence of farmer-to-extension officer ratio. Furthermore, the results of the study show that lack of storage and processing facilities is a major barrier facing farmers in the schemes leading to post-harvest loss. The non-operation of the Pwalugu Tomatoes Processing Company in the Upper East region of Ghana in the last four years due to technical challenges and inefficient management, has constrained farmers to sell their perishable produces at cheaper prices to consumers directly. This finding confirm Adam et al. (2016) that the shutdown of the Pwalugu Tomatoes Processing Company has negative consequences for vegetable farmers in the Bolgatanga Municipal [8].

Despite the aforementioned barriers facing farmers, the study found that participation in dry season irrigation farming is a positive development tool for empowering poor farmers and emancipating them through increased profits/income. The evidence gathered from the study shows positive net returns, which has improved the welfare and wellbeing of farm families. Therefore, any development intervention that seeks to improve welfare and wellbeing of people should be extolled because they are critical indicators of poverty reduction and sustainable development goals. Beneath the economic theory of firms, a positive net return is used to judge how well an enterprise performs and survives on the market. The high net returns from dry season irrigation farming should therefore be a tool for advocacy by development organizations to encourage the youth to embrace the Youth in Agriculture module of Youth

Entrepreneurial Agency of the Government of Ghana to participate in dry season irrigation farming. This will not only reduce the rate of emigration and crime rates in cites, but will propel economic growth and development. This finding agrees with previous conclusions reached by Alhassan (2009) that the net return from non-traditional vegetable production in the northern region of Ghana should be of great importance to the Government of Ghana especially for targeting the youth for employment under the vegetable industry [9].

This study however encountered one major limitation, which is the non-availability of critical historical data on farm records. This is largely attributed to lack of education on the need to keep proper and accurate data by farmers. As a result, the study relied on last farming session records to analyse input and output cost related to dry season irrigation farming.

5. CONCLUSION

The major findings of the study indicate that farmers face varied, complex and intertwined barriers ranging from economic, socio-cultural, and institutional to technical. These surmountable barriers squarely results in few farmers around the project site participating in dry season irrigation farming, hence the under-utilization of the schemes. The study evidence show that dry season irrigation farming is profitable and contributes very high to welfare and wellbeing of farm families. In order to help address all forms of entry and participation barriers in dry season irrigation farming to ensure project sustainability, it is recommended that the schemes be run on a public-private-partnership basis. This is because the central government alone cannot effectively and efficiently manage the barriers farmers face in all the irrigation schemes across the country.

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Cite this article: James Natia Adam, Dersiderious Awedam Wekem, and Emmanuel Zumabakuro Dassah. ENTRY AND PARTICIPATION BARRIERS IN DRY SEASON IRRIGATION FARMING: EVIDENCE FROM TONO AND VEA IRRIGATION SCHEMES. *American Journal of Innovative Research and Applied Sciences. 2016; 3(2): 462-469.*