Agricultural cooperatives and irrigation in Ghana: Implications on household welfare

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To cite this article: Owusu, B.Z. (2021) *Agricultural cooperatives and irrigation in Ghana: Implications on household welfare* The Saharan Journal, issue 1 (2), 297-323; National Institute for African Studies (NIAS)

Published online: June 2021

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BEATRICE ZACHIA OWUSU*

Abstract

Sustainable agricultural production systems such as irrigation are well echoed in the UN's Sustainable Development Goals. Agricultural cooperatives are viewed as valuable tools with the potential for engaging in these systems. This study identifies the drivers of household participation in agricultural cooperatives and irrigation. Also, it studies the impact of cooperatives and irrigation on their welfare. Using secondary data from the Ghana Statistical Service [Ghana Living Standards Survey Round 7 (GLSS7)], I employed parametric modelling to identify the drivers and the impact on welfare. The results showed that the age of the household head, livestock rearing, agricultural extension, and household size had a positive influence on participating in agricultural cooperatives and engagement in irrigation. Similarly, households with larger farm sizes and male-headed households had a higher probability of participation in agricultural cooperatives and irrigation. Both agricultural cooperatives and irrigation participation was found to have a positive and significant impact on household welfare at about GH₵265.64 (£32.40) and GH₵534.05 (£65.12), respectively. Ultimately, the study recommends that irrigation policies such as the current One Village, One Dam policy, and agricultural cooperatives should positively impact farmers' welfare.

Keywords: Agricultural cooperatives, Ghana, irrigation, parametric modelling, welfare;

Introduction

The second pillar of the Sustainable Development Goals (SDGs) has the singular objective to end hunger, achieve food security, improve nutrition and promote sustainable agricultural development (UNDP, 2015). Among other factors, achieving these objectives requires putting in measures to ensure all-year-round production through irrigation schemes. According to Ansah, Lambongang and Donkoh, (2020: 162), even though Ghana met the Millennium Development Goal One (MDG1) by halving poverty and hunger by the end of 2015, over a quarter of the population remains below the poverty line of US$ 1.25/day (£0.89). In the Northern region of Ghana, the situation is even worse. However,

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eradicating poverty, achieving food security, and improving nutrition requires the achievement of SDG2 (Lambongang et al., 2019: 3).

Irrigation infrastructure has long been considered pertinent to the economic development in rural areas, especially for regions that rely heavily on agriculture for income and livelihoods, since changes that result in erratic rainfalls can affect their production (Nguyen 2016: 3). In these regions, raising farm productivity and creating livelihoods is essential for poverty alleviation, and irrigation acts as a catalyst in agrarian communities for economic development. Since the 1950s, countries have tried to expand the coverage of irrigation infrastructure, with the most significant achievement witnessed in South and East Asia (Frenken, 2012: 212). The rapid expansion of irrigation schemes has contributed to the increased farm yields in most situations in Ghana (Mendes et al. 2014: 4). To further emphasise the importance of irrigation, research has shown that the practice of irrigation comes with numerous benefits. The direct benefits are improvements in household income due to increases in farm yields, expanded cultivation area, crop diversification, enhanced crop intensity and the use of high yielding varieties, amongst others (Rebelo et al. 2014: 79). A recent study by Kemeze (2020: 1) on the economic evaluation of small-scale irrigation through water harvesting techniques in Cote d'Ivoire revealed that irrigation helps smallholder farmers overcome the risk of spells and engineers investment in agriculture. They thus recommended that rainwater harvesting in rainfed agriculture should form a cornerstone of any country's strategy for adapting to drought, especially in Sub-Saharan Africa, which is vital in achieving food security.

However, the role cooperatives play in helping members out of abject poverty is worth our attention. A cooperative is a voluntary association of people who come together to improve the economic welfare of members through the establishment of a business entity that is managed democratically (Kolleh, 2016: 12). Studies have indicated that farmers participate in agricultural cooperatives to overcome barriers such as poverty, markets failure, missing services in the production process, decreased income, increased transaction costs, as well as participation in irrigation activities (Karli et al. 2006: 116; Fisher and Qaim, 2014, p. 1). This means that cooperatives play an enormous role in economic growth and subsequent development. Therefore, to help its members, the cooperatives need to accelerate their performance. Siziba, et al. (2011: 181) further stated that smallholder agriculture is too important to employment, human welfare, and political stability

in Sub-Sahara Africa to be ignored or treated just as another small sector of the market economy. Another study by Lecoutere (2017: 1) in Uganda indicated that participation in agricultural cooperatives has a positive and statistically significant impact on economic well-being, knowledge, and adoption of agronomic practices, especially among women. Farmers typically pool their limited resources to improve agricultural output and enhance socio-economic activities through cooperatives in rural areas.

Furthermore, the participation of farmers in marketing cooperatives is an important determinant of well-being and development (Poole, 2017: 4). Agricultural cooperatives are also valuable for disseminating information about modern practices and participation in irrigation activities in agricultural production, which contributes to farmers' output and overall farm income and welfare. Additionally, Michael et al. (2018: 784) suggested that the analysis of the relationship between factors that influence farmers' participation in agricultural cooperatives reveals information that is crucial to increasing the participation of farmers in cooperative organisations, thus resulting in the increase in agricultural output and the eradication of rural poverty. Participation of farmers in cooperatives has always been an essential issue because cooperative societies are key to national development. Governments in most developing and developed countries use agricultural cooperatives as channels to reach rural farmers (Chen and Scott, 2014: 2; Luo et al. 2020: 2). All in all, cooperative organisations reduce the cost for governments and support organisations in meeting farmers' needs.

Notwithstanding the numerous benefits deriving through cooperation and irrigation in the agricultural sector, irrigation in Africa is not fully exploiting its potential, especially for smallholder farming. Within the Dakar Declaration, African heads of states declared in 2013 that irrigation's potential contribution to agricultural and rural economies of the region only covers 2 per cent of cultivated land, with less than 20 per cent of its potential being exploited (Ker Rault et al. 2020: 7**)**. Therefore, to reverse the current underdeveloped nature of irrigated agriculture in Sub-Saharan Africa, there is a strong need for empirical argument for expanding small-scale irrigation schemes. This is also to increase agricultural production to ensure improvement in the welfare of most Ghanaians engaged in the agricultural production sector. It is equally necessary to determine how farmers welfare can be improved when they effectively participate in irrigation activities through agricultural cooperatives.

In rural Ghana, the agricultural sector employs close to 75 per cent of the active labour force and provides revenue for government businesses (Osei-Boateng and Ampratwum, 2011: 5; Lambongang et al., 2019: 86). However, the researchers further noted that though the sector's contribution has been enormous in the past, recent growth and performance indicators have not matched up to expectations. This is attributed to the low agricultural productivity, which is also a threat to livelihoods and natural resources.

Etwire et al. (2013: 42) indicated that farmers' participation in agricultural interventions relates directly to the environment, their nutrition and poverty levels, and agricultural sector and macroeconomic performance. Since the planting for food and jobs (PFJ) programme was implemented in 2017 in Ghana, the government has had a strong aim to provide irrigation infrastructure in rural communities to enhance the year-round production of agricultural commodities.

Ensuring that the government's initiative is achieved requires considering how agricultural cooperatives can enhance participation in irrigation activities. The knowledge of drivers of the involvement in cooperatives and irrigation activities is necessary to ensure the effectiveness of the government's One Village One Dum Initiative. Furthermore, this is necessary to advise and guide policy implementation in subsequent years. Since it is a long-term programme, the desire to generate such necessary knowledge drives this study. Therefore, the objective of the current study is to find out the drivers of participation in agricultural cooperatives and irrigation in northern Ghana and to estimate the impact of agricultural cooperatives and irrigation on household welfare. This paper is important as it will help us understand how the One Village One Dum Initiative will likely perform in Ghana. Hence, valuable lessons from the paper could be utilised by policymakers. In this light, we consider looking at the drivers of participation in cooperatives as necessary and valuable. The rest of the paper is organised into three sections as follows. Section 2 outlines the review of agricultural cooperatives and irrigation in Ghana. Section 3 looks at the methodological approach. In section 4, the results from the data analysis are presented and discussed, while section 5 presents a conclusion and policy implications.

Review of agricultural cooperatives and irrigation in Ghana

Water is one of the most important inputs in agricultural production in Ghana. More importantly, almost all agricultural production depends on natural rainfall.

Because of this situation, crop yields are invariably poor when rains come too early or too late since there is no control over this critical input pertinent to survival for a developing country. The timeliness of rains is another issue that seriously affects agricultural production in Ghana. For example, the northern sector typified by the rainfall pattern shows a unimodal rainfall of rather a short duration and excessive evapotranspiration rates. The dry season duration in these areas tends to be distinct and long, of nearly 7-8 months per annum. The implication is that under agriculture that solely depends on natural rainfall, farming is possible for 4-5 months, and the cultivation of crops with a longer duration is impossible or at least risky without irrigation (Kyei-Baffour et al., 2006: 143).

Although there is a different categorisation of irrigation projects in Ghana, generally, projects jointly owned and managed by the state through Ghana irrigation development authority (GIDA) and farmers could be regarded as a medium. Historical accounts trace irrigated agriculture in Ghana to a little over a century ago (Kyei-Baffour et al., 2006: 142), but the practice on a small scale dates back to as early as 1880 in Keta (Adzraku, 2017: 3). This form of agriculture had to be adopted in Keta because natural conditions did not permit shifting cultivation as practised elsewhere in the country; thus, intensive cultivation methods by irrigation, manuring and crop rotation had to be used (Kyei-Baffour *et al.*, 2006: 145). Their findings also showed that the first scheme that the government conceived was in 1920 as part of the then Winneba Water Supply Project. According to Namara et al*.* (2011: 4), some forms of shallow tubewell irrigation could also be identified in South-Eastern Ghana in the 1930s. The 1950s and early 1960s saw the development of water schemes in the Guinea, Sudan and Coastal Savannah belts which accounted for about 240 earth dams and dug-outs in the north and about 66 in the Ho-Keta plains of the south purposely to provide water for domestic use, livestock and for dry season irrigated farming (Agodzo et al. 2014: 2). After independence in 1959, the first national irrigation project, Dawhenya, was started, but available records indicate that Asutsuare Irrigation Project was the first to be completed in 1967 (Adzraku, 2017: 8). Even though the records date irrigation in the country to about a century ago, it is clear that severe irrigation is a more recent phenomenon.

Nyadzi et al. (2018: 51) also noted that the northern zone has unimodal rainfall, and in the absence of irrigation, farmers are limited to one crop a year. This is partly why the government has made it a point to provide dams in villages in

northern Ghana, which is to enhance all year production to achieve the first sustainable development goal of ending poverty in all its forms.

It is currently estimated that of Ghana's 55 irrigation projects, 32 are in the Northern Savannah Ecological Zone (NSEZ). However, only 13 of the 34 irrigation projects are in good condition and functioning correctly; the rest are either still under construction, broken down, or under repairs. In fact, the total irrigable area serving the projects is 2,629.22ha (UNDP, 2018: 114).

The government's One Village, One Dam Initiative provides opportunities for developing local water resources and networks and may be useful in this regard. However, it would do well to be complemented by more extensive sustainable irrigation facilities and support to and water conservation. As irrigation infrastructure can be very costly, efficient use of water and cost recovery is critical for the sustainability of the projects. Water Use Associations (WUA) are now common on formal irrigation projects. They are primarily charged with day-to-day management (operation and maintenance). Their functions include collecting water users' fees and participation in water distribution, repairing broken canals, embankment, and catchment area protection.

Nevertheless, in many instances, maintenance is found to be challenging. The reasons include high costs, the reluctance of some farmers to pay levies, poor coordination among WUAs and poor participation by farmers who are the direct beneficiaries of the schemes in maintenance activities. The Ghana Irrigation Development Authority also aims to increase private participation in the management of various irrigation facilities. The private entities are expected to adopt a more commercial approach to identify markets, produce crops as a nucleus farm, and support farmers with inputs and services in out-grower schemes (UNDP, 2018: 123).

However, to better understand the significant role of cooperatives in the agricultural sector, and for that matter, irrigation in Ghana, it is important to accurately identify the factors influencing farmers' behaviour and willingness to participate in local agricultural cooperatives. Factors that likely determine participation in cooperatives to participate in irrigation schemes are essential because cooperatives help develop rural areas by reducing poverty through increases in their level of income (Kolleh, 2016: 5). Previous studies showed a significant influence on farmers' participation in agricultural cooperatives. The outcomes of past research suggest that the following factors have significant

effects on farmers' participation in agricultural cooperatives: age, land size, access to extension services, household size, and household labour availability (Karli et al., 2006: 17; Kehinde et al., 2018: 99). Kolleh (2016: 16) further indicated that agricultural producers perceive cooperatives as a positive means of improving their economic welfare. This means that farmers participate in cooperatives because they view it as an institution that can help them to reduce production and marketing risks and ultimately enhance their chances of expanding their business operations and increase their income level (Ortmann & King, 2007: 221).

Methodology

Study Area and Data

The Ghana Living Standards Survey (GLSS) is a nationally representative household survey that provides relatively accurate, reliable, disaggregated and internationally comparable welfare and living conditions statistics in Ghana. It is an important tool in the welfare monitoring system. Together with other surveys such as the Core Welfare Indicators Questionnaire (CWIQ) and the Ghana Demographic and Health Survey (GDHS), it has provided the necessary information for understanding living conditions in Ghana.

The study used the 2016/2017 data reported in the Seventh Round of the Ghana Living Standards Survey (GLSS 7) conducted by the Ghana Statistical Service (GSS) with technical assistance from other sister organisations. A nationally representative sample of 15,000 households in 1,000 Enumeration Areas (EAs), consisting of 561 (56.1%) rural EAs and 439 (43.9%) urban EAs. The EAs were first stratified into 10 regions of the country and further into a rural or urban place of residence. Ecological zones (i.e. Coastal, forest and northern Savannah) were also considered in the classification. The previous rounds of GLSS have always had a specific focus. In the 5th Round, for instance, the Non-Farm Household Enterprises Module was put to focus, and additional sections covering Tourism and Migrants & Remittances were introduced. The GLSS6 focused on Labour Force, and the GLSS7 had Agriculture Module. The survey spread over 12 months to ensure a continuous recording of household consumption and expenditures and changes occurring.

Furthermore, detailed information on household income and expenditure makes the data vital for a welfare study like this one. For GLSS 7, a household is

defined as one group of persons who live together in the same dwelling, share the same housekeeping arrangements, and cater to one unit. Therefore, household total food expenditure and binary variable participation in cooperatives were used as the dependent variable in the estimations. The variable includes a summation of all items purchased directly by the household or indirectly (such as output from own production activities, batter exchange, transfer/remittances etc.).

Analytical framework

The theoretical framework of the study is from the utility maximisation framework. According to this theory, a rational household will evaluate the utility for engaging in irrigation and participation in agricultural cooperatives against the utility if they do not participate. Hence, a household will decide to engage in irrigation or agricultural cooperatives if the perceived utility or net benefits are significantly greater.

Assuming V1 and V0 are the satisfaction or utility for participating or not participating in irrigation or cooperatives respectfully.

The linear random model for the utility (V1) of participating in irrigation or cooperatives is expressed as a function of explanatory variables X1:

$$v_{11}x_{11} \quad (1)$$

Likewise, v_0 the utility for not participating is given below:

$$v_{00}x_{10} \quad (2)$$

x_1 is the explanatory or independent variable, β_1 and β_0 are the parameters to be estimated, ε_1 and ε_0 are the error terms for participants and non-participants of irrigation and cooperatives respectively. Before a farmer will participate in irrigation or cooperative, the expected output of participants should be greater than that of the non-participants. Therefore; E(V1) > E(V0)

The probability for participating in irrigation or cooperatives is given by:

$$P(V = 1 \mid X) = P[(\beta_1^* X_1 + \varepsilon_1) > (\beta_0^* X_1 + \varepsilon_0)] \quad (3)$$

$$P(V=1 \mid X) = P[(\beta_1^* X_1 + \varepsilon_1) > (\beta_0^* X_1 + \varepsilon_0) > 0 \mid X] \quad (4)$$

$P\ (V=1|\ X) = P\ [X_1\ (\beta_1^{*} - \beta_0^{*}) + (\varepsilon_1 + \varepsilon_0) > 0|\ X]$ (5)

$P(V = 1|\ X) = P[(\beta_1^{*} X_1 + \varepsilon^{*}) > 0\ |\ X]$ (6)

$P(V = 1|X) = F(\beta_0 + \beta_1 X_1 + \beta_2\ X_2 + \beta_3 X_3 + \cdots + \beta_n X_n)$ (7)

P is the probability function, (3)

$\varepsilon^{*} = \varepsilon_1 + \varepsilon_0$ is a random term,
$\beta^{*} = \beta_1 - \beta_0$ is a vector of unknown parameters and F depending on the distribution of the error.

Bivariate Probit model

The bivariate probit model was used to achieve the first objective: the drivers of participation in agricultural cooperatives and irrigation in northern Ghana. The bivariate probit model is used to analyse participation in either cooperatives or irrigation activities empirically. Farmers can decide to participate in both irrigation and cooperatives or any of them. Let Y_1 be the participation variable in agricultural cooperatives activities and y_2 be the participation variable in irrigation activities. These are binary variables taking on the value 1 if the farmer engages in cooperative or irrigation activities and 0 otherwise.

$Y_1^{*} = X_{ik} b_1 + e_1$ Where $y_1 = 1\ if\ y_1^{*} > 0,\ 0\ if\ otherwise$
$Y_2^{*} = X_{ik} b_2 + e_2$ $y_2 = 1\ if\ y_2^{*} > 0,\ 0\ if\ otherwise$

Thus, the two participation variables according to the bivariate probit can be set up as follows;

$$y_{i1} = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + \cdots \ldots \ldots \ldots + b_n X_n + e_1$$
$$y_{i2} = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + \cdots \ldots \ldots \ldots + b_n X_n + e_2$$

Where X_i is a vector of explanatory variables, b_1 and b_2 are vectors of parameters; e_1 and e_2 are the error terms.
Distribution of the error terms and the variance-covariance matrix

$\begin{pmatrix} e_1 \\ e_2 \end{pmatrix} \Big| x_1, x_2 \ldots \ldots \ldots x_n \approx N \begin{bmatrix} 0 \\ 0 \end{bmatrix} \begin{bmatrix} 1 & \rho_{12} \\ \rho_{21} & 1 \end{bmatrix}$ ρ is the coefficient of correlation.

Y_1 and Y_2 are two dummy variables equal to 1 if a farmer i participate in either cooperative or irrigation activities.

The Inverse Probability Weighted Regression Adjustment (IPWRA) Model

The effect of the various CA practices on soil health was estimated using the Inverse Probability Weighted Regression Adjustment (IPWRA). This is because IPWRA can account for potentially biased estimates (ATT) that might emanate from propensity score models in the presence of misspecification (Wooldridge, 2007: 1288). Hence, IPWRA can ensure consistent results as it permits the treatment and the outcome model to account for misspecification due to its double-robust property. Here, soil health has been defined as 1 if the household agricultural soil is healthy (i.e. If their soils are not susceptible to erosion) and 0 if otherwise. Imbens and Wooldridge (2007: 1292) stated that estimating the average treatment effect on the treated (ATT) involves a two-step process. Hence given the outcome equation

$$Y_i = \alpha_i + \beta_i x_i + e_i \quad (4)$$

The propensity score is first generated from the selection equation as $Ps = P(x;\gamma)$ and in the second step, linear regression is employed to estimate the propensity scores as $P(\alpha_0;\beta_0)$ and $P(\alpha_1;\beta_1)$ using inverse probability least squares on the binary outcome. The inverse probability least squares are expressed as

$$\underset{\alpha_0,\,\beta_0}{Min}\sum_{i}^{N}(Y_i - \alpha_0 - \beta_0 x_i)/\,p(x;\gamma) \quad (5)$$

if soil health is 0 for the ith household and

$$\underset{\alpha_1,\,\beta_1}{Min}\sum_{i}^{N}(Y_i - \alpha_1 - \beta_1 x_i)/\,p(x;\gamma) \quad (6)$$

if soil health is 1 for the i[th] household.

Hence the ATT is then computed as the difference between equation 5 and 6, expressed as

$$ATT = \frac{1}{N_w}\sum_{i}^{N_w}\left[(\hat{\alpha}_1 - \hat{\alpha}_0) - (\hat{\beta}_1 - \hat{\beta}_0)x_i\right] \quad (7)$$

where $(\hat{\alpha}_1 - \hat{\alpha}_0)$, are the estimated inverse probability -weighted estimates for the treated group of the i[th] household and $(\hat{\beta}_1 - \hat{\beta}_0)$ are the estimated inverse probability weighted estimates for the control group. Finally, N_w is the total number of treated households.

Table 1: Definition of variables, measurement and A Priori expectations

		A priori Expectation	
Variable	**Measurement**	**Agric Cooperatives**	**Irrigation**
Gender of household head	Dummy (1=male)	+/-	+
Age of household head	Years	+/-	-
Marital status of household head	Dummy (1=married)	+	+
Extension service	Dummy(1=yes)	+	+
Livestock Rearing	Dummy (1=Yes)	+	+
Savings	Dummy(1=Yes)	+	+
Credit accessibility	Dummy(1=Yes)	+	+
Household size	Dummy(1=Yes)	+	+
Total farm size	Dummy(1=Yes)	+	+

Results and discussions

Socio-economic characteristics of households in Ghana

Results on the socio-economic characteristics of households used in the study are presented in table 2. The results showed that most household heads were males, about 68.8 per cent, while females headed 31.17 per cent. The average age of a household was about 46 years, while each household head differs from the average at about 15 years. About 68.8 per cent of the household's heads were married. Extension coverage was relatively high at about 55 per cent. This suggests that the extension delivery in the country is improving. About 28.9 per cent of the households reared livestock, while about 30.7 per cent had savings.

Table 2 presents results on the socio-economic characteristics of households in Ghana.

Variable	Mean	Std. Deviation
Continuous Variables		
Age of household head	46.2	15.3
Household size	5.27	8.925
Total farm size	5.47	139.85
Categorical variables	***Frequency***	***Per centage (%)***
Marital status of household head		
Married	7,719	55.10
Not married	6,290	44.90
Gender of household head		
Male	9,643	68.83
Female	4,366	31.17
Extension service		
Yes	3,991	28.49
No	10,018	71.51
Livestock Rearing		
Yes	4,056	28.95
No	9,953	71.05
Savings		
Yes	4,301	30.7
No	9708	69.29
Credit accessibility		
Yes	1,509	10.77
No	12,500	89.23

The rate at which households accessed loans were found to be relatively low at about 10.7 per cent. The average household size was about 9 members per household with a standard deviation of 5 members. The results suggest a relatively high number of individuals for most households in the country. The total farm size

considered for the study was about 5.47 acres with a very high standard deviation of approximately 139.85 acres. The variation in farm size indicates the differences in farm holding among different households in the country. The vast deviation could also emanate from households in the Southern part of the country where a household can farm on over 100 acres of just cocoa farm, unlike the northern region where the land tenure system results in fragmentation of farmlands.

Drivers of participation in agricultural cooperatives and irrigation in Ghana

Empirical results from the bivariate probit model on the drivers of household participation in agricultural cooperatives and irrigation are shown in table 3. Out of nine (9) explanatory variables considered for the study, seven (7) significantly influenced agricultural cooperatives and irrigation in Ghana. The likelihood ratio test for rho was highly significant, suggesting that households belonging to agricultural cooperatives are more likely to engage in irrigation and vice versa.

Table 3: Drivers of participation in Agricultural cooperatives and irrigation in Ghana

	Agricultural Cooperatives	Irrigation	
Variable	Coef. (Std.error)	Coef. (St. Error)	Marginal effects
Gender of household head	0.126(0.046)***	0.018(0.048)	0.002
Age of household head	0.002(0.001)	0.006(0.001)***	0.000***
Marital status of household head	0.191(0.046)***	0.200(0.047)***	0.008**
Extension service	2.892(0.050)***	2.18(0.054)***	0.309
Livestock Rearing	0.059(0.044)	.384(0.045)***	0.012**
Membership of savings group	-0.100(0.056)*	0.062(0.057)	0.000***
Credit accessibility	0.208(0.060)***	0.001(0.062)	0.002***
Household size	-0.021(0.009)**	-	-0.001***

		0.033(0.009)***	
Total farm size	0.241(0.012)***	-0.005(0.014)	-0.000***
Constant	-2.511(0.088)	-2.801	

Likelihood-ratio test of rho=0: chi2(1) = 1316.38 Prob > chi2 = 0.0000
Number of Observations= 14,009 Wald chi2(12) = 478.52 Prob (Chi2) =0.000

Notes: ***,**, and * indicate significance at 1%, 5% and 10% respectively.

After the bivariate probit model, the marginal effects were also shown to identify the probability of a household being likely to participate.

Gender was highly positively correlated with participation in agricultural cooperatives such as cocoa farmers cooperatives and tractor service cooperatives. However, gender was insignificant in explaining their participation in irrigation. The marginal effects showed that the probability of male-headed households participating in agricultural cooperatives and irrigation was to be 0.2 per cent.

The age of the household head was found to have a positive effect on irrigation but do not significantly influence participation in agricultural cooperatives. This was expected because elderly farmers are more likely to be more experienced and better appreciate the importance of irrigation, especially for areas that experience bi-modal rainfall patterns.

Household heads who are married had a positive and significant correlation with their decision to participate in agricultural cooperatives and irrigation. This was expected because such households will have more labour to engage in agricultural cooperatives to boost their production and marketing activities. They can also engage in irrigation since both and perhaps their children can collectively plan to engage in irrigation. The probability that married household heads will participate in agricultural cooperatives and irrigation was about 0.8 per cent holding all other factors constant.

The study included household accessibility to agricultural extension services to envisage how it influences their decisions to participate in agricultural cooperatives and their engagement in irrigation. Access to extension services significantly positively influenced both their decision to participate in agricultural

cooperatives and irrigation. The marginal effects showed that households with access to agricultural extension service were about 1.2 per cent more likely to irrigate and participate in the agricultural cooperative.

Household size was found to harm both participation in agricultural cooperatives as well as irrigation. This contradicts the *a priori* expectation that households with more significant numbers would have more labour for irrigation in addition to agricultural cooperatives. The negative effect could emanate from the relatively smaller household size, as seen from the descriptive statistics with an average of 5 members. Also, the relatively larger household may imply more dependent and not necessarily family labour, which could hurt their decision to participate in a cooperative or irrigate their farms.

Finally, households with larger farm sizes had a higher probability of participating in agricultural cooperatives but lessor probability of engaging in irrigation as depicted by the positive and negative signs of the covariates for agricultural cooperatives and irrigation, respectively. Though the influence of farm size on irrigation was not significant, the probability that a household with a larger farm size will participate in agricultural cooperatives and irrigate was significant.

Impact of agricultural cooperatives and irrigation on household welfare

Results on the impact of household participation in agricultural cooperatives and irrigation are presented in table 4 below. The results reveal a positive sign and statistically significant impact of agricultural cooperatives and irrigation on household welfare by increasing their consumption expenditure.

The results showed that households that participate in agricultural cooperatives realise a GH₵265.64 increase in welfare than non-participants. This result confirms the FAO (2012) report, which indicated that agricultural cooperatives play an important role in improving household welfare for most developing countries by creating economically and socially sustainable agribusiness models.

Also, the results on irrigation reveal that households that engage in irrigation will improve their welfare by approximately GH₵534.05 (£65.11). This is expected because such households will earn additional income through the sale of these irrigated commodities. Also, it serves as a means of employment during the dry

season in areas like northern Ghana, where bimodal rainfall is experienced.

Table 4: Impact of agricultural cooperatives and irrigation on household welfare

Outcome Variable	TE	Agricultural Cooperatives	Irrigation
Welfare	ATT	265.64(128.61) [b]	534.05(133.94) [a]
	POM	4407.37(104.22) [a]	4394.72(75.73) [a]

Hagos et al. (2009: 37) also found irrigation to result in about 219.7per cent higher incomes in Ethiopia when compared to farming systems that depend on natural rainfall. The positive impact of participation in agricultural cooperatives and irrigation on household welfare suggests a potential for agricultural development.

Conclusion and Recommendations

The purpose of the study was to identify the drivers of household participation in agricultural cooperatives and irrigation and the impact of cooperatives and irrigation on their welfare. I used secondary data from the Ghana Statistical Service (Ghana Living Standards Survey Round 7, GLSS7) collected in 2017 over 14,009 households while employing a parametric modelling approach to identify the drivers and the impact of these on welfare. Specifically, the bivariate probit model was first used to identify the drivers of participation in agricultural cooperatives and irrigation. At the same time, the Inverse Probability Weighted Regression Adjustment (IPWRA) was used to estimate the impact of agricultural cooperatives and irrigation on household welfare. The results showed that the age of the household head, livestock rearing, agricultural extension, and household size had a positive influence on the probability of participating in agricultural cooperatives in addition to engagement in irrigation. Also, households with larger farm sizes and male-headed households had a higher probability of participation in agricultural cooperatives and irrigation. Both agricultural cooperatives and irrigation participation positively and significantly impact household welfare at about GH₵265.64 (£32.38) and GH₵534.05 (£65.11), respectively.

Thus, the study recommends that the current *One Village, One Dam* policy is in the right direction but should be improved to ensure an all-year-round water supply to stimulate irrigation. Also, agricultural cooperatives should be encouraged

and used to implement agricultural innovations, which will also help maintain sustenance and improve household welfare.

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