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Participation in Agricultural Extension and Labor Productivity: A Case Study of Smallholder Farmers in Ghana

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ABSTRACT

Low agricultural productivity remains one of the main factors influencing poverty and food insecurity among smallholder farmers in many developing countries. Among the key interventions assumed to influence agricultural productivity of smallholders is the provision of agricultural extension services to farmers. Access to agricultural extension however remains low in most developing countries thus slowing down agricultural productivity growth. This study therefore sought to determine the labor productivity effects of agricultural extension in northern Ghana using data from a cross-section of 300 smallholder farm households. The results of a binary probit model indicated that participation in agricultural extension increased with farming experience, farm size, access to irrigation and group membership but decreased with years of formal education and household size. Regression estimates of a labor productivity model revealed a positive and statistically significant relationship between agricultural extension and labor productivity. Also, labor productivity increased with farming experience, household income, access to irrigation, degree of specialization in production and the level of conventional inputs used per man-day of labor but decreased with participation in off-farm work. The authors recommend an increase in agricultural extension coverage to ensure that more farmers are reached with information on modern technologies to enhance their labor productivity. Furthermore, farmers need access to inputs such as seed and fertilizer to improve the productivity of labor.

***Keywords**: Labor productivity, agricultural extension, smallholder farmers, Ghana.*

1 Introduction

Improving agricultural productivity remains one of the major priorities of agricultural and rural development practitioners and policymakers in most African countries including Ghana (Diao et al., 2018). This is because smallholders depend primarily on agricultural production for their livelihoods hence low agricultural productivity implies a threat to their incomes and livelihood. In Ghana, an estimated 60% of the population derive their livelihood directly from farming, making agriculture an important sector of the economy. Despite its significant contribution to the economy, agricultural production in Ghana is still characterized by low productivity and declining farm profits (FAO, 2015; Chauvin et al., 2012; Diao, 2010). The factors contributing to low agricultural productivity in Ghana and other developing countries have been sufficiently elaborated in the extant literature. These factors include low adoption of improved production technologies, lack of access to credit, irrigation, and extension services, low application of mechanization as well as poor technical knowhow of small-scale producers (Anang et al., 2017; Chauvin et al., 2012; Diao, 2010; ISSER 2006).

Farmers can take advantage of the economic growth in their society in several ways as indicated by van Den Ban (2011). In the first place, farmers can seek to increase their farm yields. Second, farmers may switch to the cultivation of high-value crops that command high market demand. Third, farmers need to increase the labor productivity on their farms. Fourth, farmers may look to non-farm sources of income. Smallholder farmers usually do not have the requisite skills and training to find high-paying non-farm jobs. Switching to the cultivation of high-value products is not always feasible for many farmers as a result of unavailability of land and capital. Increasing farm yields and labor productivity are therefore necessary to enhance farm performance.

According to the extant literature, extension services play an essential role in agricultural development in developing countries (Omotesho et al., 2014; Anderson, 2007; Birner et al., 2006; Williams, 1998). Accordingly, many authors have called for the prioritization of agricultural extension systems as a means to ensure food security (Hu et al., 2009; Swanson, 2006). Agricultural extension entails all activities involved in the exchange of information and knowledge essential to agriculture (Fakayode et al., 2016). A well-functioning agricultural extension service is required for the transfer of agricultural innovations and knowledge on improved methods of production, access to production inputs, among others. Through training and education of farmers, agricultural extension enhances human capital and technical knowhow of producers thereby improving agricultural productivity. Smallholders usually have low levels of education and technical knowhow hence are in dire need of extension services to enhance their level of productivity. In this regard, raising agricultural productivity of smallholder farmers hinges largely on raising their technical knowhow and access to productive resources. This calls for an efficient extension service that addresses the specific needs of smallholders in order to achieve growth in farm productivity.

Egziabher et al. (2013) studied the impact of Ethiopia's Integrated Household Extension Program on household income, investment and income diversification and found a large positive impact of public extension service on household welfare. The authors observed that extension increased household income by about 10%. Using a three-period panel dataset for Ghana, Dzanku (2015) observed that household welfare increased with labor productivity. The author however added that dramatic increases in productivity were required to bring about momentous poverty reduction. Lee et al. (2017) on his part, observed a significantly positive impact of agricultural extension service on farmers' output, gross farm revenue and profit in Uganda. The authors noted that extension directly increases farmers output as well as allocative ability and therefore called for an increase in investment in public extension service.

Ragasa and Mazunda (2018) showed that producer perceptions of the relevance and usefulness of agricultural advice enhances agricultural productivity and food security. In a study to examine the interplay of input subsidy and agricultural extension, and their impact on productivity and food security in Malawi, the authors found an inconsistent impact of fertilizer and seed subsidies on productivity and food security and non-significant effect of extension advice. However, the inclusion of indicators of usefulness and farmer's satisfaction resulted in a significant effect of extension advice on agricultural productivity and food security, underscoring the need to provide farmers with useful and relevant agricultural advice to increase the possibility of achieving higher productivity and greater food security.

Despite the important role agricultural extension plays in increasing productivity of farmers, many smallholder farmers in developing countries do not receive much assistance from extension services (Emmanuel et al., 2016; Ragasa et al., 2013). Among the factors accounting for this are inadequate number of extension staff, lack of logistics for extension staff, low morale among extension staff, low remuneration and poor working conditions. These factors impact negatively on agricultural production in many developing countries including Ghana.

It is against this backdrop that identifying the drivers of agricultural productivity growth in smallholder agriculture has been deemed necessary and accordingly gained much research attention in recent times. Notwithstanding the interest to unravel the drivers of productivity growth in smallholder agriculture in developing countries, not much research has been done in the case of Ghana, particularly in the case of smallholder rice production. The quest to fill this void as well as provide empirical evidence of the effect agricultural extension services have on labor productivity of smallholder farmers led to this study.

Specifically, this study investigates the factors affecting participation of smallholder farmers in agricultural extension and the effect of participation on labor productivity. Labor productivity as used in this study refers to farm output per unit of labor measured in man-days. A man-day of labor is equivalent to six (6) hour of work by an adult worker. Labor productivity measures how productive the labor resource of smallholders is in the production of goods and services. In the context of this paper, labor productivity measures how productive the human labor resource is in the production of rice. High labor productivity is indicative of a labor force that is well-skilled in production, and vice versa.

The findings of the study will help agricultural extension agencies, policymakers, and non-governmental organizations working with farmers to prescribe appropriate measures to enhance the productivity of smallholder farmers in Ghana and other developing countries facing similar challenges.

The rest of the paper is structured as follows. The methods used in the study are presented in section 2. This includes description of the study area, data and sampling and the theoretical and empirical model specifications. In section 3, the results of the study are presented. The conclusion and recommendations arising from the study are presented in section 4.

2 Materials and methods

2.1 Study area

Northern Ghana is characterized by savannah vegetation and is regarded as the food basket of the country due to its agricultural potential and food production levels. The area is characterized by a unimodal rainfall pattern that supports the growing of many food crops such as rice, maize, groundnut, cowpea as well as cash crops like cotton and cashew. Agricultural production is the predominant occupation in northern Ghana. Most of the farmers are smallholders and produce primarily for home consumption and sell the surplus for income. Majority of the farmers rely almost exclusively on public extension services and use low-level technology in production. Agricultural production in the study area is characterized by low application of chemical fertilizers, mechanization and irrigation technology.

2.2 Data and sampling

Data for the study was obtained from a farm household survey conducted in 2014. A total of 300 farm households were sampled and interviewed using a semi-structured questionnaire. Multi-stage stratified random sampling technique was used in the data collection. First, two of the Regions making up northern Ghana were purposively sampled, viz. Northern and Upper East Regions. The selection was based on the degree of rice production in these Regions. Next, the Botanga Irrigation Scheme in Northern Region and the Tono and Vea Irrigation Schemes in Upper East Region were selected. Rice-producing households were then stratified into irrigators and non-irrigators, after which 150 irrigators and 150 non-irrigators were sampled for analysis.

2.3 Specification of the probit model of extension program participation

Agricultural extension program participation is a binary situation which requires the application of a discrete choice model such as binary logit or probit model. As a binary situation, extension program participation may be represented as $L = 1$ if a farmer participates in extension and $L = 0$ if a farmer did not participate. A binary probit model was chosen for this study where extension program participation was modeled as an index function with an unobserved continuous variable L^*. It is assumed that L^* can be specified as follows:

$$L_i^* = \gamma_0 + \sum_{n=1}^{N} \gamma_n x_{n_i} + u_i \quad (1)$$

Such that:

$$L_i = \begin{cases} 1 & if \quad L_i^* > 0 \\ 0 & otherwise \end{cases} \tag{2}$$

where x_i is a vector of independent variables affecting extension program participation, γ is a vector of parameters to be estimated and u_i is a random error term.

Empirically, the agricultural extension participation model is presented as follows:

$$\begin{aligned} Extension\ (L) = {} & \gamma_0 + \gamma_1 Sex + \gamma_2 Educ + \gamma_3 Exper + \gamma_4 Hhsize + \gamma_5 Fmsize + \gamma_6 Hhinc + \\ & \gamma_7 Pdnsys + \gamma_8 Associa + \gamma_9 Catt + \gamma_{10} Region + \gamma_{11} EducSex + u_i \end{aligned} \tag{3}$$

where *Sex* = sex of household head (1 = male, 0 otherwise), *Educ* = years of formal education, *Exper* = years of farming experience, *Hhsize* = household size, *Fmsize* = farm size (ha), *Hhinc* = household income (Ghana cedi), *Pdnsys* = production system (1 = irrigation, 0 otherwise), *Associa* = membership of farmers' group (1 = member, 0 otherwise), *Catt* = ownership of cattle (1 = ownership, 0 otherwise), *Region* = regional dummy variable (1 = Northern, 0 otherwise), *EducSex* = interaction term for years of formal education and sex of household head.

2.4 Specification of the agricultural labor productivity model

The theoretical labor productivity model is presented in equation (4) as follows.

$$Y_i = \beta_0 + \sum_{n=1}^{N} \beta_n w_{n_i} + v_i \tag{4}$$

where Y_i is labor productivity measured as output per man-days of labor, w_i is a vector of independent variables influencing labor productivity, β is a vector of parameters to be estimated and v_i is the random error term.

The empirical agricultural labor productivity model for the study is presented as follows:

$$\begin{aligned} LabProd = {} & \beta_0 + \beta_1 Sex + \beta_2 Age + \beta_3 Exper + \beta_4 Expersq + \beta_5 Hhinc + \beta_6 Catt + \\ & \beta_7 ExpLab + \beta_8 FertLab + \beta_9 LandLab + \beta_{10} SeedLab + \beta_{11} CapLab + \\ & \beta_{12} Dspec + \beta_{13} Dcrop + \beta_{14} Ext + \beta_{15} Pdnsys + \beta_{16} Offm + \beta_{17} Region + u_i \end{aligned} \tag{5}$$

where *LabProd* = labor productivity (in kg/man-days), *Sex* = sex of household head (1 = male, 0 otherwise), *Age* = age in years, *Exper* = years of farming experience, *Expersq* = squared value of years of farming experience, *Hhinc* = household income, *Region* = regional dummy variable (1 = Northern, 0 otherwise), *Pdnsys* = production system (1 = irrigation, 0 otherwise), *Ext* = access to extension (1 = extension access, 0 otherwise), *Catt* = ownership of cattle (1 = ownership, 0 otherwise), *ExpLab* = expenditure per labor (cedi/man-day), *FertLab* = fertilizer per labor (kg/man-day), *LandLab* = land per labor (hectare/man-day), *SeedLab* = seed per labor (kg/man-day), *CapLab* = capital per labor (capital/man-day), *Dcrop* = cropping intensity dummy (1= double cropping, 0 otherwise), *Dspec* = degree of specialization, *Offm* = participation in off-farm work (1 = participant, 0 otherwise).

3 Results

3.1 Characteristics of the respondents according to extension participation status

Table 1 provides a description of the variables included in the study according to extension program participation status of the respondents.

Table 1.
Descriptive statistics of the respondents according to extension participation status

Variable	Total sample (n = 300)		Participants (n = 190)		Non-Participants (n = 110)		Diff. in means
	Mean	SD	Mean	SD	Mean	SD	
Farmer characteristics							
Sex	0.783	0.413	0.742	0.439	0.855	0.354	-0.112**
Age	41.21	12.31	42.07	11.93	39.71	12.85	2.364
Years of education	3.933	5.350	3.979	5.385	3.855	5.314	0.124
Farming experience	15.41	10.81	16.73	11.12	13.15	9.914	3.581***
Household size	9.650	7.204	8.968	6.751	10.83	7.819	-1.859**
Household income	2364	2030	2371	2121	2353	1871	17.60
Herd ownership	0.337	0.473	0.384	0.488	0.255	0.438	0.130**
Farm characteristics							
Farm size in hectares	0.857	0.682	0.854	0.741	0.861	0.568	-0.007
Labor productivity	25.81	24.32	26.17	23.93	25.20	25.08	0.968
Expenditure-labor ratio	3.052	2.358	3.167	2.539	2.853	2.002	0.314
Fertilizer-labor ratio	4.874	3.828	5.154	3.947	4.391	3.579	0.764*
Land-labor ratio	0.034	0.014	0.033	0.016	0.034	0.012	-0.0003
Seed-labor ratio	2.592	1.935	2.641	2.049	2.508	1.725	0.133
Capital-labor ratio	2.495	3.202	2.775	3.801	2.010	1.642	0.765**
Cropping intensity	0.283	0.451	0.332	0.472	0.289	0.455	0.132**
Institutional factors							
Production system	0.500	0.501	0.579	0.495	0.364	0.483	0.215***
Off-farm work	0.427	0.495	0.468	0.500	0.355	0.481	0.113*
Group membership	0.660	0.475	0.774	0.420	0.464	0.501	0.310***
Location-specific factor							
Regional dummy	0.333	0.472	0.221	0.416	0.527	0.502	-0.306***

***, ** and * stand for statistical significance at the 1, 5 and 10 percent level, respectively.

Participants in agricultural extension had higher rice output compared to non-participants, which gives indication that extension is likely to improve farmers' output. Farm size, labor input, years of formal education, household income, land-labor ratio as well as seed-labor ratio did not differ between participants and non-participants in extension. Participants in extension used more fertilizer in production than non-participants while a higher proportion of participants in extension owned cattle relative to non-participants. Furthermore, participants in extension had more years of farming experience but smaller household size, and had greater access to irrigation as well as higher participation in farmer-based organizations. In addition, cropping intensity was higher among participants than non-participants. Cropping intensity measured the number of times the land was cultivated during the cropping season.

Table 2 presents the number of extension visits received by farmers during the cropping season. Close to 37% of the farmers did not receive any extension visit during the cropping season. Nearly half of the sampled farmers received 1-5 extension visits during the cropping season with 7.3% receiving more than 10 visits.

Table 2.
Number of extension contacts during the cropping season

Number of extension visits	Frequency	Percentage	Cumulative %
0	110	36.7	36.7
1-5	147	49.0	85.6
6-10	21	7.0	92.7
11-15	10	3.3	96.0
16-20	8	2.7	98.7
More than 20	4	1.3	100.0

3.2 Factors influencing participation in agricultural extension

Table 3 presents the results of the probit model for participation in agricultural extension service in northern Ghana.

Table 3.
Probit results of the factors influencing participation in agricultural extension

Variable	Coefficient	Std. Error	P > | z |	Marginal effect
Sex	– 0.516*	0.266	0.052	– 0.173
Education	– 0.090*	0.051	0.078	– 0.033
Farming experience	0.018**	0.008	0.028	0.007
Household size	– 0.025*	0.014	0.075	– 0.009
Farm size	0.281*	0.151	0.062	0.102
Household income	– 0.136	0.111	0.224	– 0.049
Production system	0.574***	0.183	0.002	0.206
Association	0.999***	0.185	0.000	0.370
Herd ownership	0.182	0.198	0.360	0.065
Regional dummy	– 0.975***	0.221	0.000	– 0.362
Education*Sex	0.122**	0.054	0.023	0.044
Intercept	– 0.073	0.272	0.787	–

***, ** and * stand for statistical significance at the 1, 5 and 10 percent level, respectively.

As revealed by the study, the likelihood of participation in agricultural extension is related to the gender of the respondent, with women having a higher likelihood of participation. The probability of participation in agricultural extension is higher by 0.17 for female-headed farm households. Women's participation in agricultural programs is usually lower than men which may be related to the patriarchal nature of most rural communities. Many organizations working with farmers have thus taken this phenomenon into consideration and now endeavor to channel extension services directly to female farmers. The results of the study further indicate that education decreases the probability of participation in agricultural extension. The probability of participation in extension decreases by 0.03 for an additional year of education. The result runs contrary to *a priori* expectation since educated farmers are expected to have access to information which is likely to enhance their participation in programs such as agricultural extension. The result is however consistent with Ndoro et al. (2014) in their study on extension participation and smallholder livestock productivity in Kwazulu-Natal, South Africa. The interaction term of gender and education indicates that educated male farmers are more likely to participate in agricultural extension compared to educated female farmers.

It was also observed that the likelihood of participation in extension increases with years of farming experience. A unit increase in respondent's years of farming experience increases the probability of participation in agricultural extension by 0.007. The result is consistent with *a priori* expectation. Experienced farmers by virtue of years of engagement in farming are able to build relationship with extension agents over time thereby enhancing their access to agricultural extension. The result of the study agrees with Do et al. (2014) in their study of tea farmers in the Northern Region of Vietnam.

The study further revealed that the likelihood of participation in agricultural extension decreases with household size. Increasing household size by one member decreases the likelihood of participation in agricultural extension by 0.009. The results indicate that larger households participate less in extension services. The result is difficult to explain. However, it is likely that larger households that are not labor-constrained may be less eager to follow up extension agents who are not in adequate supply.

Farm size is positively related to the likelihood of participation in agricultural extension. In other words, household heads with larger farm sizes are more likely to participate in agricultural extension. A unit increase in farm size increases the likelihood of participation in agricultural extension by 0.10. Farmers with larger farms are likely to be richer and more influential in society which can influence access to extension. Farmers with larger farms may also be progressive farmers who are likely to search for extension agents. The result is consistent with Do et al. (2014) in their study of tea farmers in the Northern Region of Vietnam.

The likelihood of participation in agricultural extension increases with farmer group membership. Membership in farmer-based organizations increases the likelihood of participation in agricultural extension by 0.37. The result agrees with Ndoro et al. (2014) in their study on extension participation in South Africa. The result is also consistent with Do et al. (2014) who found participation in extension to increase with membership of local mass organizations by tea farmers in Vietnam. Farmer groups have become an important conduit for dissemination of agricultural information and services to farmers in developing countries. The method of dispensing agricultural credit to farmer groups rather than individuals as a means of collateralization and the role extension agents play with farmer groups enhance extension access to members of farmer-based organizations.

The study also reveals that farmers who use irrigation are more likely to participate in agricultural extension compared to those operating under rain-fed conditions. This signifies that the likelihood of participation in agricultural extension is correlated with the production system. The probability of participation in extension is higher by 0.21 for farmers whose farms are irrigated. Rain-fed farmers are more dispersed than irrigators who are located at the same irrigation scheme. Extension agents therefore find it easier to reach irrigators which accounts for the higher participation of irrigators in agricultural extension. In addition, the likelihood of participation in extension is higher for farmers in the Northern Region, reflecting the influence of geographical factors on access to extension. The probability of participation in extension increases by 0.36 if the farm is located in the Northern Region.

3.3 Determinants of labor productivity

Access to extension is potentially endogenous. However, preliminary investigation using the Durbin-Hu-Hausman test of endogeneity indicated that the coefficient of the residual of the extension variable in the augmented regression was not statistically different from zero (*p*-value of 0.740). This suggests that ordinary least squares (OLS) is consistent for estimating the parameters of the labor productivity model. The OLS estimates of the determinants of labor productivity are presented in Table 4. The model diagnostics indicate that the variables included in the multiple regression equation explain 65.8% of the variation in labor productivity of the respondents.

The result in Table 4 reveals a positive relationship between years of farming experience and labor productivity which is significance at 5% level. However, the quadratic term is negative and significant at 5% level, indicating that labor productivity increases at a decreasing rate with years of farming experience. Beyond a certain threshold, addition to labor productivity begins to decline with an additional year of farming experience. The result is consistent with *a priori* expectation since older farmers are less energetic to carry out farm operations and hence likely to be less productive.

Labor productivity is positively related to access to irrigation and significant at 1% level. The result is consistent with *a priori* expectation and the extant literature. Irrigation enables efficient use of labor in the production process. This is because rice production relies on water supply which if available throughout the farming season facilitates productive use of the labor resource. The productivity-enhancing role of irrigation is recognized in the academic literature (Lemoalle and de Condappa 2010; You et al. 2011, 2014; Xie et al. 2014). Consequently, several authors have recommended the expansion of irrigation access to smallholder farmers as a means to increase agricultural productivity (Anang et al. 2017).

A positive and significant relationship was observed between household income and labor productivity at 1% level. A 1% increase in household income leads to 0.30% increase in labor productivity. The level of household income is critical to acquisition of productivity-enhancing inputs in production. Poorer households are less likely to afford modern tools in production, hence more likely to be less productive in production.

The variable of interest, access to extension services was positively associated with labor productivity of smallholder rice farmers in northern Ghana. The extension variable was significant at 5% level, and shows that contact with extension workers increases the labor productivity of smallholder farmers. The result is plausible because agricultural extension is expected to facilitate the transfer of knowledge and skills to farmers thereby enhancing their level of productivity. As indicated by Anderson and Feder (2003), knowledge and skill delivery are essential in improving the capacity of farmers to generate higher growth in yield. Furthermore, agricultural extension activities help farmers to form groups and link them to organizations that assist farmers to improve farm productivity (Jamison and Moock, 1984).

Table 4.
Regression estimates of the determinants of labor productivity

Variables	Coefficient	Std. Error	P > | t |
Intercept	-1.077	1.020	0.292
Individual/household characteristics			
Sex	0.106	0.100	0.290
Age	0.145	0.190	0.444
Farming experience	0.777**	0.315	0.014
Farming experience squared	-0.152**	0.065	0.020
Household income	0.303***	0.054	0.000
Herd ownership	0.090	0.084	0.282
Farm-specific characteristics			
Land-labor ratio	0.234**	0.118	0.048
Seed-labor ratio	0.185***	0.066	0.005
Expenditure-labor ratio	0.059*	0.035	0.087
Fertilizer-labor ratio	0.078***	0.029	0.008
Capital-labor ratio	0.042	0.036	0.239
Specialization	0.004**	0.002	0.010
Cropping intensity dummy	0.119	0.126	0.346
Institutional factors			
Extension contact	0.016**	0.008	0.047
Production system (irrigation)	0.603***	0.113	0.000
Off-farm employment	-0.217**	0.086	0.012
Location-specific factor			
Regional dummy	0.386***	0.104	0.000

***, ** and * stand for statistical significance at the 1, 5 and 10 percent level, respectively. Dependent variable is log of labor productivity. Prob > F = 0.000, R-squared = 65.8.

The results also indicate that participation in off-farm work has a negative and significant influence on labor productivity at 5% level. The result indicates that working off-farm decreases labor productivity of smallholders. The result suggests that off-farm work draws labor away from farming, thus reducing the effectiveness of labor.

Furthermore, the results indicated higher labor productivity for producers in the Northern Region, compared to those in the Upper East Region. The location-specific variable is significant at 1% level. Northern Region is characterized by availability of more fertile agricultural land which is likely to enhance labor productivity.

The results of the study further indicated a positive and significant relationship (at 10% level) between labor productivity and expenditure per labor. The coefficient of expenditure-labor ratio gives the elasticity of expenditure per labor with respect to labor productivity. From the results, 1% increase in expenditure-labor ratio increases labor productivity by 0.059%. A positive and significant relationship was observed between labor productivity and fertilizer per labor at 1% level. The result implies that 1% increase in fertilizer-labor ratio increases labor productivity by 0.078%. The results of the study further indicated that labor productivity increased with land per labor (land-labor ratio) at 5% significance level. Increasing land-labor ratio by 1% will increase labor productivity by 0.234%. Furthermore, labor productivity increased with seed per labor (seed-labor ratio) at 1% significance level. One percent (1%) increase in seed-labor ratio is associated with 0.185% increase in labor productivity. Thus, the level of conventional inputs per man-day of labor used in production enhances the labor productivity of producers. Increasing the level of conventional inputs in production is therefore expected to increase labor productivity in rice production in the study area. The results also mean that farmers can make productivity gains by increasing the current level of inputs, namely fertilizer, seed, land and other expenditures.

The findings further indicate that labor productivity increased with the degree of specialization in production. As farmers become more specialized in production, they gain expertise and skill in production resulting in higher efficiency of labor. The result is plausible and consistent with a priori expectation.

4 Conclusion and recommendations

The paper investigated factors influencing smallholders' participation in agricultural extension and the determinants of labor productivity. The study was based on data from a cross-section of 300 rice farmers in northern Ghana. The study revealed that participation in agricultural extension increased with farm size, years of farming experience, access to irrigation and group membership but decreased with years of formal education and household size. The results further revealed a positive and statistically significant relationship between agricultural extension and labor productivity. Also, labor productivity increased with farming experience, household income, access to irrigation, degree of specialization in production and the level of conventional inputs used per man-day of labor but decreased with participation in off-farm work.

Based on the findings of the study the authors recommend an increase in agricultural extension coverage in order to reach more farmers with information on modern production technologies to enable them to increase their labor productivity. Extension education enhances the knowledge and skills of farmers especially with regards to improved production technologies. Low access to extension services, inadequate number of extension agents, lack of logistics for extension staff and extension messages that do not meet the needs of farmers are some of the challenges confronting extension service delivery in Ghana. Despite the existing challenges, agricultural extension service still contributes positively to agricultural productivity in Ghana and many developing countries. All stakeholders involved in providing extension services to farmers in Ghana should therefore endeavor to increase investment especially in public extension system to make it more effective in order to realize the long-term goal of rural development.

The strong statistical association between labor productivity and the level of conventional inputs used per man-day of labor suggests that increasing access to such inputs as seed and fertilizer will enable farmers to improve the productivity of labor. In addition, access to irrigation exhibited a strong statistical relationship with labor productivity suggesting that increasing access to irrigation technology will have positive effect on labor productivity. The productivity-enhancing role of irrigation in smallholder rice production in Ghana has been reported by Anang et al. (2017). Access to irrigation allows intensification of land use which promotes productivity of both land and other resources including labor.

References

Anang, B. T., Bäckman, S., and Rezitis, A. (2017). Production technology and technical efficiency: irrigated and rain-fed rice farms in northern Ghana. *Eurasian Economic Review*, **7**(1): 95-113.

Anderson, J. R. (2007). Agricultural Advisory Services. Background paper for: World Development Report 2008, Agriculture for Development (p. 1–44). Washington, D.C.: World Bank. Accessed from http://siteresources.worldbank.org/INTWDR2008/Resources/2795087-1191427986785/Anderson_AdvisoryServices.pdf. Date accessed 7 June 2018.

Anderson, J. R., Feder, G. (2003). Rural Extension Services. World Bank Policy Research Working Paper 2976. Washington, DC: World Bank.

Birner, R., Davis, K., Pender, J., Nkonya, E., Anandajayasekeram, P., Ekboir, J., Mbabu, A., Spielman, D., Horna, D., and Benin, S. (2006). From best practice to best fit: A framework for analyzing agricultural advisory services worldwide. Development Strategy and Governance Division, Discussion Paper No. 39. International Food Policy Research Institute (IFPRI), Washington, DC.

Chauvin, N. D., Mulangu, F., and Porto, G. (2012). Food Production and Consumption Trends in Sub-Saharan Africa: Prospects for the Transformation of the Agricultural Sector. UNDP Regional Bureau for Africa. Working Paper WP 2012-011: February 2012.

Diao X., McMillan, M., and Wangwe, S. (2018). Agricultural Labour Productivity and Industrialisation: Lessons for Africa. *Journal of African Economies*, **27**(1): 28–65.

Diao, X. (2010). Economic Importance of Agriculture for Sustainable Development and Poverty Reduction: Findings from a Case Study of Ghana. Global Forum on Agriculture 29-30 November 2010 Policies for Agricultural Development, Poverty Reduction and Food Security OECD Headquarters, Paris.

Do, X. L., Kieu, T. T. H., and Bauer, S. (2014). Impact of access to agricultural extension services on tea household's income in the Northern Region of Vietnam. Paper prepared for the Conference on International Research on Food Security, Natural Resource Management and Rural Development organised by the Czech University of Life Sciences Prague. Tropentag 2014, Prague, Czech Republic September 17-19, 2014.

Egziabher, K. G., Mathijs, E., Deckers, J., Gebrehiwot, K., Bauer, H., and Maertens, M. (2013). The economic impact of a new rural extension approach in northern Ethiopia. University of Leuven: Geo-Institute, Dept. of Earth and Environmental Sciences, Division of Bioeconomics, working paper, 2.

Emmanuel, D., Owusu-Sekyere, E., Owusu, V., and Jordaan, H. (2016). Impact of agricultural extension service on adoption of chemical fertilizer: Implications for rice productivity and development in Ghana. *NJAS-Wageningen Journal of Life Sciences*, **79**: 41-49.

Fakayode, S. B., Adenuga, A. H., Yusuf, T., and Jegede, O. (2016). Awareness of and Demand for Private Agricultural Extension Services among Small-Scale Farmers in Nigeria. *Journal of Agribusiness and Rural Development*, **4**(42): 521–531.

FAO (2015). Country fact sheet on food and agriculture policy trends. March 2015.

Hu, R., Yang, Z., Kelly, P., and Huang, J. (2009). Agricultural Extension System Reform and agent time allocation in China. *China Economic Review*, **20**: 303–315.

ISSER (2006). The State of the Ghanaian Economy 2005. Institute of Statistical, Social and Economic Research (ISSER). Legon, Accra: University of Ghana.

Jamison, D. T., Moock, P. R. (1984). Farmer education and farm efficiency in Nepal: The role of schooling, extension services, and cognitive skills. *World Development*, **12**(1): 67-86.

Lee, Y., An, D., and Kim, T. (2017). The Effects of Agricultural Extension Service on Farm Productivity: Evidence from Mbale District in Uganda.

Lemoalle, J., de Condappa, D. (2010). Farming systems and food production in the Volta basin. *Water International*, **35**(5): 655–680.

Ndoro, J. T., Mudhara, M., and Chimonyo, M. (2014). Livestock extension programmes participation and impact on smallholder cattle productivity in KwaZulu-Natal: A propensity score matching approach. *South African Journal of Agricultural Extension*, **42**(2): 62-80.

Omotesho, K. F., Ogunlade, I., and Adenuga, A. H. (2014). An Assessment of Farmers' Ability to Determine their Agricultural Extension Needs in Kwara State, Nigeria. *Albanian Journal of Agricultural Sciences*, **13**(3), 61–67.

Ragasa, C., Dankyi, A., Acheampong, P., Nimo-Wiredu, A., Chapoto, A., Asamoah, M., and Tripp, A. (2013). Patterns of Adoption of Improved Rice Technologies in Ghana: Ghana Strategy Support Program and International Food Policy Research Institute (July, 2013), Working Paper No. 35.

Skoet, J. (2011). The role of women in agriculture. FAO-ESA Working Paper No. 11-02.

Swanson, B. E. (2006). Extension strategies for poverty alleviation: Lessons from China and India. *Journal of Agricultural Education and Extension*, **12**(4): 285-299.

van Den Ban, A. (2011). Increasing labour productivity in agriculture and its implications. *The Journal of Agricultural Education and Extension*, **17**(5): 401-409.

Williams, S. K. J. (1998). The role of Extension Services Strategies of Agricultural Development in the South West Nigeria. 6th Annual Conference at Agricultural and Rural Management Training Institute, Ilorin, Nigeria (p. 37–38).

Xie, H., You, L., Wielgosz, B., and Ringler, C. (2014). Estimating the potential for expanding smallholder irrigation in Sub-Saharan Africa. *Agricultural Water Management*, **131**: 183–193.

You, L., Ringler, C., Wood-Sichra, U., Robertson, R., Wood, S., Zhu, T., Nelson, G., Guo, Z., and Sun, Y. (2011). What is the irrigation potential for Africa? A combined biophysical and socioeconomic approach. *Food Policy*, **36**(6): 770-782.