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EFFECT OF FARMER GROUP MEMBERSHIP ON AGRICULTURAL TECHNOLOGY ADOPTION AND CROP PRODUCTIVITY IN UGANDA

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ABSTRACT

The deteriorating agricultural performance over the past decade that coincided with the duration of targeting farmer groups as the sole public supported extension approach in Uganda, calls for intervention on agricultural information dissemination. Uganda Census of Agriculture database of 2008 - 2009 was used to evaluate the effect of farmer group membership on agricultural technology adoption and crop productivity. This particular study aimed at providing policy; answers to whether the use of farmer' groups approach in agricultural information dissemination is resulting in increased adoption of technologies and improved yields. Descriptive statistics and results of translog production function, and propensity score matching were used to provide insights into household major characteristics and to assess the impacts of group membership on adoption of technology and agricultural productivity. Membership to farmer groups in Uganda is low. Only 16 percent of household heads belonged to a group. Although membership to groups resulted in increased yields for banana and cassava, negative impacts were observed for sweet potatoes, beans and maize. Group members were less likely to adopt inorganic fertilisers ($P<0.01$) and improved seed ($P<0.05$) than non-groups members. Although not significant ($P<0.05$), group members' achievement of yields of 3 and 2 t ha^{-1}, respectively, for banana and cassava than non-group members is quite high and of interest for development agencies. On the other hand, non-group members' sweet potato yields were 1.0 tonne per hectare, higher than group's members although not significant ($P>0.05$).

Key Words: Farmer groups, extension, impacts, technologies, Uganda, yields

RÉSUMÉ

La détérioration du niveau de performance agricole au cours des dix dernières années coïncide avec la duréé de la stratégie de d'utilisation des associations de producteurs comme unique approche de vulgarisation appuyée par le gouvernement en Ouganda, ce qui nécessite des interventions en ce qui concerne la diffusion de l'information agricole. Les données d'une enquête nationale en 2008-2009 sur l'Agriculture en Ouganda ont été utilisées pour évaluer l'effet d'organiser les producteurs en associations sur l'adoption des technologies et la productivité agricole. L'objectif de cette étude était de d'éclairer les politiques agricoles sur la question de savoir si l'approche d'utiliser les associations des producteurs pour diffuser l'information agricole résulte en une amélioration du niveau d'adoption des technologies et d'une augmentation de la productivité agricole. Les statistiques descriptives et les résultats de la fonction translog de production et le score de tendance correspondant étaient utilisés pour fournir d'information sur les caractéristiques principales des ménages, et évaluer les impacts de l'appartenance aux associations sur l'adoption des technologies et la productivité agricole: Le niveau d'adhésion aux associations est faible en Ouganda avec seulement 16% des chefs des ménages appartenant à une association. Bien que l'adhésion aux associations a entrainé une augmentation des rendements pour les cultures de la banane et le manioc, des impacts négatifs étaient observés pour la patate douce, le haricot et la maïs. Les membres des associations étaient les moins enclins à adopter l'utilisation des engrais minéraux ($P<0.01$) et les semences améliorées($P<0.05$) par rapport au non adhérents. Bien que pas significatif ($P<0.05$), les différences de rendement de 3 et 2 t ha^{-1} respectivement pour le bananier et le manioc obtenus par les adhérents aux associations par rapport aux non adhérents est tout à fait élevée et d'intérêt pour les agences de développement. D'autre part, les non adhérents ont des rendement de patate douce de 1.0 t ha^{-1} tout à fait plus élevé que celui obtenu par les adhérents aux associations bien que la différence n'était pas significative (P<0.05).

Mots Clés: Groupes des fermiers, vulgarisation, impacts, technologies, Ouganda, rendements

INTRODUCTION

In Uganda, farmer groups are targeted as an important means of increasing uptake of agricultural technologies to enhance agricultural productivity, commercialisation and linking farmers to markets (MAAIF, 2010a). Although the approach has attracted attention, little is known on how successful the approach is in addressing the country's agricultural transformation. Ugandan government considers transformation of agriculture as a major driver in changing the country from a peasant to a modern and prosperous economy (GoU, 2010). Despite the group approach being embraced in developing countries to addressing a plethora of rural development challenges (Loevinsohn, *et al*., 1994; Woomer *et al.,* 2004), queries still linger on how to enhance farmer groups' membership, cohesiveness, mandate, resources availability, integrity and members' managerial capacity (Mwaura *et al*., 2012). Nevertheless, well conceptualised and supported groups like in the case of tea smallholders in Kenya have been observed to successfully drive a sub-sector where they collectively own factories, dictate on market prices and are able to employ experts and set agenda for research (Mwaura *et al*., 2010).

Although the National Agricultural Advisory Services (NAADS) programme and other development agencies have used farmer organisations as a major avenue for information dissemination intended to spur agricultural productivity since 2001, little is known about the strategy's impacts on technology adoptions and yields (Bahigwa *et al*., 2005). Government commitment in agriculture has been through budgetary support to the sector, which accounted for about 5% of the 2010/2011 national allocation, with about 40% of the allocation directed to extension services through NAADS (MoFPED, 2010). More money has been allocated to agricultural research, training and rural infrastructural development in an effort to stimulate economic growth including agricultural transformation (GoU, 2010). Despite the efforts by government, wide yield gaps have been observed between research trials and farmers' fields for the major crops (MAAIF, 2010a). Research yields for maize, beans, banana, groundnuts, and coffee are above 800, 400, 100, 300 and 800 percent, respectively, more than farmers' average yields, indicating that more efforts are required to close yield gaps between research and farmers (MAAIF, 2010a).

Low agricultural productivity has had detrimental effects on economic welfare of rural populations (Ssewanyana and Okidi, 2007) and food security measured in terms of caloric intake (Ssewanyana and Kasirye, 2010). High prevalence and incidence of poverty have been observed in the country (UBOS and ILRI, 2007), with the main contributory factor being low agricultural productivity. Insufficiency in household food production has exposed farmers to severe food insecurity and high prices of food. In Uganda, only 12 percent of households are significant net sellers of food, with 66 percent being net food buyers and relying on market for more than 25% of the value of the food they consume (Benson *et al*., 2008). This implies that improved agricultural production remains an important intervention in addressing welfare and economic development in Uganda. The role of farmer group membership in achieving enhanced technology adoption and yield is yet to be evaluated.

Despite paucity of information on the impacts of farmer groups on agricultural production, their operations, organisation, capacity and sustainability, the new Agricultural Sector Development Strategy and Investment Plan (DSIP) 2010/11-2014/15) proposes to use the group approach for the more complex market oriented activities. The DISP targets farmer groups to improve produce marketing, increase access to financing, and produce value addition with an aim of initiating agricultural transformation (MAAIF, 2010a). It is important, therefore, to understand the role that farmer groups could play in facilitating the agricultural transformation.

Although decisions for targeting groups for extension have already been reached based on the "cooperative paradigm" and success of few groups (Bahigwa *et al.,* 2005; Adong *et al.,* 2013), especially the farmer field schools (FFS) that were highly supported by donors (Godtland *et al.,* 2004; Davis *et al.,* 2012), it is necessary to evaluate the approach's achievements considering the deteriorating agricultural performance (MAAIF, 2010a). This particular study aimed at providing policy answers to whether the use of farmer' groups approach in agricultural information dissemination is resulting to increased adoption of technologies and improved yields.

MATERIALS AND METHODS

A number of recent studies have addressed the evolution and shifting of paradigms on the best agricultural technology dissemination approach (Glendenning *et al*., 2010). Stoop (1988) addressed challenges associated with the "transfer-of technology" approach and the opportunities presented by "training-and-visit" system of agricultural information dissemination. The challenges associated with the "training-and-visit" systems of extension in developing countries, in light of adoption and implementation of liberalisation protocols (Pinstrup-Andersen and Pandya-Lorch, 1994) were highlighted. Pretty (1995), described the promotion impetus of participatory technology development approach which involves collaboration between researchers, extension and farmers in the analysis of agricultural problems and testing of alternative farming practices.

Akinnagbe and Ajayi (2010) highlighted the learning opportunity availed by participatory technology development and extension to researchers and extension agents through working closely with farmers. Effectiveness of the participatory approach has been associated with its ability to incorporate the socio-economic characteristics of the targeted clientele (Scoones and Thompson, 2009). Angstreich and Zinnah (2007) showed similarities between the participatory technologies development and extension approaches, and the farmers field schools (FFS). The potential and effectiveness of FFS approach as the appropriate mechanism for diffusing knowledge-intensive technologies, e.g. integrated pest management, has been described (Gotland *et al*., 2004). A synthesis of immediate and developmental impacts of FFS in various developing countries, in relation to intensive pest management technologies was published a decade ago by van den Berg (2004). Thiele *et al*. (2001) shared experience in implementation of FFS in the Andes and recommended groups quality and development of virtuous circle between participatory research and training.

Kenmore (2002) described the FFS concept as utilising participatory methods "to help farmers develop their analytical skills, critical thinking and creativity and also help them learn to make better decisions". Extension agents who are viewed as facilitators rather than instructors, conduct learning activities in the field on relevant agricultural practices. Through interactive learning and field experimentation, FFS programmes teach farmers how to experiment and solve agricultural problems independently. The cost effectiveness of FFS arising from the fact that farmers adopt the technologies to their own specific environmental and cultural needs even with limited extension budget (Vasquez-Caicedo *et al.,* 2000).

The concept of farmer groups in Uganda as the main component of technology dissemination borrows extensively from the FFS model. The Ugandan government has published guidelines on group formation among farmers and criteria for selection for technological and financial support (MAAIF, 2010b). As per the guidelines, all farmers above 18 years old are targeted to enroll in farmers groups through mobilisation by the local political leadership. By enrolling in groups, farmers were to be supported through provision of extension, technological inputs and other development capacities to achieve food security or transform to commercial farmers. The use of groups in extension is also viewed as more decentralised and demand driven, hence is expected to facilitate farmers to achieve higher agricultural yields. Considering that for farmers to access resources and gain capacity support from the National Agricultural Advisory Service (NAADS) they must be in groups. The main driver of farmers participating in groups may not be entirely agricultural. Other development partners have adopted the group approach in targeting interventions, with beneficiaries being those enrolled in groups (Adong *et al.,* 2013).

Little literature is available on the operations of farmer groups in the country whether those supported by donors or self-support in terms of membership, group dynamisms, operations, financing, growth trajectories and conflicts management. Steven and Terblanche (2004) outline the experience of establishing and working with farmer groups as they progressed through the different stages of group development and social capital formation. Critical to success of group formation processes, is the skills of the group promoter and the adherence to certain basic group dynamic principles. Thorp *et al.* (2005) queried the real motivation of group formation, members' interest, organisation, operational and performance of groups in achieving desired changes in rural development. Thorp *et al.* (2005) associated other pecuniary benefits and personal interest to override the aim of group formation.

Low levels of membership, both at individual and household levels, with marked differences in regional participation in farmers groups was reported in Uganda (Adong *et al.,* 2013). Key drivers for membership to groups included household's head education attainment, distance to extension service and quality of road infrastructure. In Kenya, acceptance of produce marketing group by farmers was evaluated (Mwaura *et al.,* 2012); it was observed that only a small proportion of farmers who had attended recruitment meetings ended up enrolling as members.

Comparison of farmers under NAADs and those in non-NAADs sub-counties in Uganda has been undertaken (Benin *et al.,* 2011). Using national representative data collected by Uganda Bureau of Statistics, Okoboi *et al.* (2013) evaluated participation of vulnerable households headed by females, youths or people living with disabilities in NAAD's supported groups. The study also evaluated groups affiliated with NAADs programme on agricultural households' access to extension services, the use of improved technologies, crop yield and share of output sold, consumption expenditures and poverty level.

A number of studies have used various yardsticks to compare performance of farmers working in groups and non-group members. Friis-Hansen and Duveskog (2012) used welfare indicators (resources including land, livestock, clothing and housing ownership, non-agricultural income, work as casual labour, food security, quality of diet, health, children education, marital status, and age of household head), to compare FFS members and controls in Kenya, Uganda and Tanzania. All positive attributes were associated with FFS membership than control. The study also showed that FFS had positive attributes on empowerment aspects (various indicators for innovation uptake, access to services, engaging with markets and collective actions/social relations) than non-FFS members. Non-FFS showed some significant positive empowerment attributes in Tanzania such as vaccination of livestock than FFS. Farmers who joined FFS had positive welfare and empowerment attributes prior to membership since most of the factors, e.g. housing standard and age of household could not been affected by being in FFS.

FFS participation significantly enhances knowledge on pests, fungicides and resistant varieties among Peruvian potato farmers (Godtland *et al.,* 2004). The robustness of the positive results of FFS participation on knowledge was demonstrated by the fact that two separate approaches used for estimating the effect of FFS, yielded the same results, a 14 percentage-point increase in knowledge score for FFS participants. This result was observed, despite the low participation rate in FFS of about 5 percent of the targeted population of 900.

Variations were observed among East African countries in effectiveness of FFS to increase farmers' yields (Davis *et al.*, 2012). In Kenya, the value of crop productivity per hectare for farmers participating in FFSs increased by about 80%; however, no significant impact was observed in Uganda. Over the East African countries, the impact of FFS differed significantly across gender, land resource endowment and level of education. Per *capita* agricultural incomes for female-headed households increased by 187%;

while the equivalent income for male-headed did not change. Both, Godtland *et al.* (2004) and Davis *et al.* (2012) used the propensity matching score (PSM) methods of comparison.

METHODOLOGY

Data sources. Data used in this study were derived from the Uganda Census of Agriculture (UCA) of 2008/09, collected by Uganda Bureau of Statistics (UBoS), in collaboration with the Ministry of Agriculture, Animal Fisheries and Industries (MAAIF). Rainfall information was derived from the 2011 Statistical Abstract which reported amounts received for selected towns over the 2008/09 farming seasons. UCA covered 80 districts and through two stage sampling procedures. A total of 31,340 households were surveyed across the four geographical regions, namely Central, Northern, Western and Eastern. The census captured information on socio-economic characteristics, technology use, crop area, crop production, extension, information source, and credit source for the sampled households. The data were nationally representative, rich in agricultural information and covers information on farmers’ enrolment in groups. Crops popularly grown by farmers across the country were used as a test for the yield response to farmer groups’ enrolment (UBOS, 2010). These crops included maize, bean, banana, cassava and sweet potatoes.

Model specification. Two economic models were used in this study, each contributing to its strength in addressing the objective of the study.

Translog model. An unrestricted translog production function was adopted to estimate factors affecting productivity. The translog is used because it is general and flexible to allow analysis of interaction among variables. The model has been used widely on various studies relating outputs to inputs (Byiringiro and Reardon, 1996; Iraizoz *et al.,* 2003). The model has also been used to analyse technical efficiency of agricultural enterprises (Byiringiro and Readon, 1996; Amudavi *et al*., 2009). The model is generally specified as:

$$InY = \beta + \sum \beta_i InX_i + \sum \beta_i InZ_i + \sum_i \sum_i \beta_i InX_i InX_i + \sum_i \sum_i \beta_i InX_i InZ_i + \beta_K D_K \quad .... (1)$$

Where:

βs = coefficients, *Xs* = inputs, *Zs* = conditioning factors and *Ds* = dummy variables

Y = productivity of various crops, where inputs (*X*) included: landholding, years of education, distance from local inputs market, age (years of farming experience), total rainfall and the household size. Dummies (*D*) used included sex, household reports of using organic and inorganic fertiliser, improved seeds, and access to credit. Other dummies were for region namely, Central, Eastern, Northern and Western.

Propensity score matching. Both acceptance to participate in farmer groups and adoption of any other agricultural technologies have similarity in that both follow Roger’s innovation adoption curve (Lapple and van Rensburg, 2011). Economists establishing factors influencing group membership and technology adoption have used similar models mostly the logit or probit, closely related explanatory variables largely categorised as either length of exposure, technology/groups’characteristics, environmental factors or farmers’ inherent characteristics (Adesina and Zinnah, 1995; Mwaura *et al.,* 2012; Adong *et al.,* 2013).

Participation in farmer groups could be considered as an adoption of technology with probabilities of adopting any other technology following the same trajectory (Mwaura *et al.,* 2012). To avoid selection and placement bias, propensity score matching (Heckman *et al.*, 1997) has been used to compare performance of groups and non-group members in terms of agricultural knowledge, adoption and productivity (Godtland *et al.*, 2004; Davis *et al.*, 2012).

To determine whether participation in farmer groups results into transformation of agriculture through higher productivity, propensity score matching (PSM) was used. PSM is a methodology of impact evaluation that tries to match those treated (in this case those in farmer groups) to the untreated (that is those in non-farmer groups) based on observable characteristics. Otherwise, the estimate of a causal-effect obtained by comparing a treatment group with a non-experimental comparison group could be biased because of problems such as selection, placement or some systematic judgment by the researcher in selecting units to be assigned to the treatment (Dehejia and Wahba, 2002).

In this case, i is an index of enrolment to farmers group. Y_{it} is the value of the achieved crops' productivity when unit i represent a group member, and y_{i0} is the value of the same variable when the unit is non-group member. The treatment effect of the unit then becomes $P_i = Y_{i1} - Y_{i0}$.

In non experiments, the treatment effect is the expected treatment effect expressed as:

$$P|_{T=1} = E(P_i \mid T_i = 1) = E(Y_{i1} \mid T_i = 1) - E(Y_{i0} \mid T_i = 1) \quad (2)$$

Where:

$T_i = 1$ if the unit was assigned treatment and $T_i = 0$ is the unit that was assigned to the control.

We can observe $E(Y_{i1} | = T_i = 1)$ but not $E(Y_{i0} | = T_i = 1)$. In matching, we try to construct the control units based on observable characteristics and obtain $E(Y_{i0} | = T_i = 1)$, whereby it is possible to construct the treatment effect as noted above.

$$P|_{T=1} = 1/\,||N|\,(\sum_{j\in J_I} Y_i - 1/\,|J_i|\sum_{j\in J_I} Y_i)\,N|$$

(Heckman *et al*., 1997) .... (3)

N is the treatment effect, $|N|$ is the number of units in the treatment groups, and is the set of comparison units matched to the treatment unit.

The nearest neighbour matching (Dehejia and Wahba, 2002) method was adopted. In this method, each unit/case in the control group (not group member) is matched to a treated case (group member) on the closest propensity score.

RESULTS AND DISCUSSIONS

Memberships to farmer's groups. Table 1 presents characteristics of farmers who are group members and non-members in terms of socio-economic factors and agricultural productivity. Only 16 percent of household heads were group members. Considering that farmer group approach was generally the adopted model for agricultural development by both government and other donors (Bahigwa *et al.,* 2005; Adong *et al*., 2013), it implies that most farmers are not accessing the desired agricultural information. Furthermore, the efforts by government and other development agents to target the same approach for produce marketing and value additions (MAAIF, 2010a) may fail to achieve the desired outcomes. Across regions, enrolment in groups was 20, 18, 17 and 13 percent in Northern, Western, Eastern and Central regions, respectively.

The high level of membership to farmer groups in the Northern region is partially attributed to the existence of targeted government programmes and many non-governmental organisations that have been involved in rehabilitation of the area in the post conflict period (Adong *et al*., 2013). Farmers in groups were observed to be significantly ($P<0.01$) younger than non-members; had more education than their counterparts; had relatively large landholdings; had bigger families; accessed extension and credit services; and reported higher yields of maize than farmers who were non-group members. On the other hand, non-group members had significantly ($P< 0.01$) adopted the use of inorganic fertiliser and achieved better yields of sweet potatoes.

Effect of group participation on agricultural productivity. Outputs of the translog production function estimation of factors influencing crop productivity is presented in Table 2. Various crops were influenced differently by explanatory variables used in this regression. Group members had significantly higher maize and banana yields ($P<0.001$) compared to non-group members. Non-group members, however, recorded significantly ($P<0.001$) higher yields of sweet potatoes

TABLE 1. Socio-economic characteristics and agricultural productivity among NAADS groups and non-groups members in Uganda

Variable	Member[1]	Non-members	Prob>F
Age of household head (yr)	32.2	33.2	0.000
Years of education for hh head (yr)	6.12	5.48	0.000
Total household landholding (ha)	1.45	1.13	0.000
Household size	7.71	6.43	0.000
Received extension visits a year	53.41	13.97	0.000
Maize yield (t ha^{-1})	6.75	5.56	0.000
Sweet potato yield (t ha^{-1})	6.72	8.24	0.000
Cassava yield (t ha^{-1})	9.73	10.03	0.604
Bean yield (t ha^{-1})	2.74	2.47	0.122
Banana yield (t ha^{-1})	15.42	14.98	0.329
Distance to feeder road (km)	5.08	4.95	0.022
Distance to gravel road (km)	9.82	9.88	0.574
Sex (percent female)	49.46	49.53	0.344
Inorganic fertiliser use (percent)	8.68	9.74	0.000
Organic fertiliser use (percent)	28.29	27.93	0.385
Improved seed use (percent)	33.68	34.30	0.162
Access to credit (percent)	12.83	10.81	0.000
Region			
Central (percent)	13	87	
Eastern (percent)	17	83	
Northern (percent)	20	80	
Western (percent)	18	82	
National	16	84	-

[1] Household with its head as a member of a NAADS group. Source: Author summary based on UCA 2008/9

compared to group members. Yields of beans and cassava were not significantly different between group and non-group members. These mixed observations were unexpected considering that groups are meant to empower farmers to achieve higher yields (Godtland *et al.,* 2004; van der Berg, 2004). The results imply that membership to groups has no advantages in all crop management technologies and, in fact their practices may lead to inefficiency in other crop enterprises.

A few studies points to this mixed results of crop yields and interventions through collective extension. It was reported that groups supported by NAADs promoted improved seed and high yielding enterprises, but failed on soil fertility enhancing technologies (Benin *et al.,* 2011). Although farmers in groups were observed to have adopted improved crop technologies more than the non-members in Kenya, Uganda and Tanzania, non-group members showed significantly higher levels of livestock vaccination (Friis-Hansen and Duveskog, 2012). Davis *et al.* (2012) showed that group members had no significantly higher crops yields than non-members in Uganda, while in both Kenya and Tanzania, group members had recorded significant higher yields and household incomes. Higher yields of maize and banana reported among group members are consistent with results of other studies, where group extension had been associated with superior yields (Godtland *et al.,* 2004). The lower yield of sweet potatoes reported by group members raises concern on the effectiveness of groups strategies. Initially, the group approach targeted complex technologies such as integrated pest management and were observed to lead to increased adoption of technologies and consequently higher yields (Godtland *et al.,* 2004). The low productivity could be associated with shifting of resources including capital, management and labour to other crop's enterprises (MAAIF, 2010a) that

TABLE 2. Translog production function estimation of factors influencing agricultural productivity for selected crops among farmers in 2008/9

Variable	Maize	Bean	Sweet potatoes	Cassava	Banana
Sex	0.002	-0.002	-0.029	-0.035	-0.015
Age	-0.000	-0.000	0.001	0.002**	-0.000
Edyrs	0.005**	0.002	0.011***	0.014***	0.006*
farmer group	0.107***	0.008	-0.091***	-0.029	0.166***
Hhsize	0.010***	0.004*	0.021***	0.010***	0.023***
inorganic f~t	-0.026	0.026	0.042	-0.070*	0.040
improved seed	-0.025	-0.064***	-0.008	-0.023	-0.031
organicfert	-0.046**	0.005	-0.052**	-0.076**	-0.038*
Credit	0.013	-0.030	-0.010	0.050	-0.087***
logtland2	-0.334***	-0.177***	-0.401***	-0.434***	-0.821***
Inputsqrt	-0.005	-0.001	-0.009*	-0.009	-0.025***
Lgraintot	0.746***	0.278***	1.314***	1.237***	-0.816***
p1 (Central)	0.000	0.142***	0.000	0.000	-0.108***
p2 (Eastern)	0.026	0.000	0.082**	0.073*	0.000
p3 (Northern)	-0.266***	0.194***	0.123***	0.178***	-0.157
p4 (Western)	0.210***	0.341***	0.292***	0.267***	0.404***
_cons	-4.171***	-1.418***	-7.948***	-7.279***	8.014***
N	22187	14973	16936	15158	19748
r2	0.083	0.060	0.061	0.051	0.171

NB: Significance levels, * P<0.05; ** P<0.01; *** P<0.001

are of higher commercial values and maintaining the crop as a secondary food and income enterprise.

The possibility that farmers in groups could have adopted sweet potatoes' inferior technologies cannot be ignored considering that weak linkages between farmer groups, research institutions and extension systems (World Bank, 2010) raise questions on the quality and consistence of information reaching the groups and first line extension agents.

Other factors that were observed to be significant in influencing efficiency in productivity of various crops include household size (hhsize); total landownership (logtland2); total annual rainfall received (lgraintot) and regional dummies.

Agricultural productivity levels. Table 3 shows propensity matching scores for farmers in groups and non-members. Matching farmers with similar characteristics, except membership to groups, showed that group members were unlikely to adopt the use of inorganic fertilisers and improved seeds. Membership to groups had an average treatment effect of 2.83 and 1.86 tonnes per hectare for banana and cassava, respectively. Results indicate that group members are likely to achieve higher yields of banana and cassava than non-members. A reduction of productivity was observed for sweet potatoes, maize and bean with membership to groups. An average treatment effect of negative one tonne per hectare for sweet potatoes was observed with group membership.

No treatment effects were significantly different between farmers in groups and those operating individually on crops' productivity achieved. Overall, group's membership was observed to have a mixed impact on agricultural crops productivity. While banana and cassava yields showed improvement (positive average treatment effect) with groups' membership, it may be difficult to conclude that they were very effective in improving agricultural productivity considering the negative impact for some crops including bean, maize and sweet potatoes. The observed mixed results using the PMS mirror those observed using the translog model.

TABLE 3. Propensity score results of technology adoption and productivity differences between NAADS groups and non-groups in Uganda

Technology/crop	Number of treated	Number of control[1]	Average treatment effect	Std. Err.	t-value
Inorganic fertiliser	2591	13127	-0.024**	0.009	-2.64
Organic fertiliser	2591	13169	0.014	0.013	1.06
Improved seed	2603	13238	-0.036*	0.014	-2.53
Extension visits	337	1855	0.52	0.32	1.63
Maize	947	4991	-0.10	0.45	0.21
Sweet potato	787	3972	-0.97	0.89	-1.09
Cassava	702	3396	1.86	1.75	1.07
Bean	757	3356	-0.067	0.27	-0.25
Bananas	938	4730	2.83	1.56	1.81

NB: Significant *P<0.05; ** P<0.01. [1]Do not belong to farmer groups

CONCLUSION

Membership to farmer groups in Uganda is barely 16%, which is considerably low. The study concludes that membership to farmer groups does not necessarily lead to adoption of high yielding technologies (e.g. use of inorganic fertiliser) and increased productivity. In fact, membership to groups has detrimental effects on adoption of inorganic fertiliser and improved seeds. Nevertheless, membership to farmer groups was observed to lead to achievement of higher yields for banana and cassava.

The low rate of participation in groups should also concern policy makers, especially considering that the country invests in agricultural extension through groups. Adoption of groups by farmers could be considered to be at an early stage with only innovators and early adopters joining. Development agencies need to undertake a detailed audit of farmer groups formation, leadership, organisation, operation, dynamics, facilitations and sources of technology disseminated. Promoters of farmer groups should direct efforts in ensuring the efficacy of the strategy in enhancing productivity thereby improving the welfare of farmers. Failure for such intervention would result to farmers developing negative perception on the group approach of agricultural information dissemination. Negative perception on the group strategy will not only discourage more farmers from joining but also lead to decreased membership.

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