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Collective action and rural poverty reduction: Empirical evidence from KwaZulu-Natal, South Africa

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ABSTRACT

Organising smallholder farmers into groups has become an important and preferred mechanism through which the South African government and other rural development agencies seek to address rural poverty and household food insecurity. This study investigates whether collective action through farmer groups has improved incomes among rural farming households in South Africa. The propensity score matching (PSM) method and the treatment effect approach were used to analyse a sample of 984 rural households from four districts in KwaZulu-Natal. The PSM results indicated that participation in farmer groups significantly and positively influenced household incomes. Group membership increased the average household incomes per adult equivalent by about R3000. However, the Rosenbaum bounds tests indicated that the impact estimates obtained using the PSM approach were not robust to hidden bias. The treatment effect regression model, which controls for hidden bias, was estimated, and the results supported those of PSM. The results also indicated that groups benefit more those who are educated and are males, suggesting a bias against the females and those less educated. The results suggest that organising smallholder farmers into groups can play a positive role in rural poverty reduction. For greater impact, policy makers should promote group formation and participation among smallholder farmers as well as introduce adult literacy classes to improve education levels.

KEYWORDS
collective action; farmer groups; rural poverty; KwaZulu-Natal

JEL Classification
I32; Q13

1. Introduction

The importance of smallholder farming in the fight against rural poverty and food insecurity in Sub-Saharan Africa has largely been acknowledged (World Bank, 2008; Mabuza *et al*., 2016). There is growing recognition that smallholder farming would contribute more to rural livelihoods if it breaks out of the subsistence trap and becomes more entrepreneurial and market oriented (Barrett and Swallow, 2006; Barrett, 2008; Hazell *et al*., 2010; Sinyolo and Mudhara, 2018). The lack of market access has been identified as one of the main obstacles of smallholder-led agricultural and economic growth, rural development and poverty reduction (Barham and Chitemi, 2009; Fischer and Qaim, 2012). The smallholder farmers are located in remote areas characterised by poor infrastructure, inadequate information and missing credit markets, thus face higher transaction costs, which limits their participation in the markets (Key *et al*., 2000; Hellin *et al*., 2009; Markelova *et al*., 2009; Godfray *et al*., 2010; Fischer and Qaim, 2012). The smallholder farmers are further disadvantaged by their lack of assets and limited access to government support services (e.g., extension,

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information, training, etc.), which are important in alleviating the effects of high transaction costs (Alene *et al*., 2008; Kruijssen *et al*., 2009; Abebaw and Haile, 2013).

A growing body of literature (e.g., Hellin *et al*., 2009; Kruijssen *et al*., 2009; Markelova *et al*., 2009; Fischer and Qaim, 2012; Abebaw and Haile, 2013; Fischer and Qaim, 2014) has indicated that collective action through farmer groups can be an efficient mechanism for increasing smallholder farmers' market participation, technology adoption and welfare. Accordingly, the South African government has identified farmer groups as an important part of its rural development and smallholder support strategy (Ortmann and King, 2007a; RSA, 2010; DAFF, 2012). Output 5 of Outcome 7 of the government's outcomes approach aimed to, among other targets, have at least 30 per cent of smallholder farmers organised into associations or co-operatives by 2014 (RSA, 2010). While this target was not achieved by the end of 2014, or even by the end of 2017, organising smallholder into groups remains a priority for the agricultural department (DAFF, 2017). Farmer groups are also the preferred channel through which most non-governmental organisation (NGOs) and donors reach and support the poor with their food security and poverty reduction interventions in the rural areas of South Africa (Ortmann and King, 2007b).

Several farmer groups and cooperatives have been formed in the smallholder sector in South Africa. While some of the groups focus on one purpose, such as input supply or marketing or savings, most of these groups are multi-purpose, helping the farmers access information, secure inputs or credit as well as sell their produce (DAFF, 2012). However, information about the impact of these farmer groups on farmer welfare is scarce, especially in South Africa. While literature focusing on the impact of farmer groups in the output markets (e.g., Bernard *et al*., 2008; Shiferaw *et al*., 2008; Bernard and Spielman, 2009; Narrod *et al*., 2009; Fischer and Qaim, 2012) or technology adoption (e.g., Abebaw and Haile, 2013) is available in other developing countries, few studies (e.g., Ma and Abdulai, 2016; Tilahun *et al*., 2016) have investigated the direct impact of farmer groups on household welfare. In Ethiopia, Tilahun *et al*. (2016) found that membership in cooperatives had statistically significant positive welfare impacts. Ma and Abdulai (2016) reported a positive impact of groups on apple yields, farm net returns and household income in China. Given that the success of collective action depended on a number of factors, most of which are influenced by specific local conditions (Barham and Chitemi, 2009), it is important that more empirical studies be done in different areas.

This study aimed to investigate the impact of membership in farmer groups on the incomes of the farmers in KwaZulu-Natal (KZN), South Africa. The study seeks to answer the question of whether farmer groups result in improved incomes among rural farming households, using the propensity score matching (PSM) method and the treatment effect model. To the authors' knowledge, few studies, if any, have been done in South Africa in general and KZN in particular on the subject using these techniques. PSM pairs group members and non-members who have similar observable characteristics to control for endogeneity problems that arise from observable variables. The treatment effect model, which corrects for the hidden bias that arises from unobservable factors, was also estimated for robustness. This study seeks to contribute to the literature by demonstrating the similarities with and differences from other cases already studied in other countries and regions (e.g., Ma and Abdulai, 2016; Tilahun *et al*., 2016).

Another contribution of this study is that it does not assume that group membership has homogenous effects, but goes further and investigates the heterogeneous effects of group membership on incomes. That is, the study asks the question: Who is likely to benefit more from being members of groups among farmers with different socio-economic profiles? That is, between females and males, or the educated and less educated, the rich and poor, who benefits more from being a group member? Moreover, the study investigates some of the factors associated with group membership, to highlight the enablers and barriers of farmers participating in groups. These aspects are important for evidence-based policy and better targeting of interventions meant to increase group participation and welfare among smallholder farmers. The remainder of this paper is organised into three sections. The next section presents the research methodology, in which the data collection approach, theoretical framework, and the empirical methods are discussed. The study results are interpreted and

discussed in the subsequent section, while the main conclusions and policy implications are presented in the final section.

2. Research methodology

2.1 Data

The data were collected from 984 farming households drawn from four districts of the KwaZulu-Natal (KZN) province in South Africa. The survey was conducted using a multistage sampling technique. First, four districts were purposively chosen out of the 11 districts in KZN. The districts chosen were Harry Gwala, Umzinyathi, Uthukela and Umkhanyakude. The selected districts have a significant number of households engaged in smallholder farming. Second, one local municipality was randomly selected for each district: the Ubuhlebezwe local municipality in the Harry Gwala district; the Msinga local municipality in the Umzinyathi district; the Jozini local municipality in the Umkhanyakude district; and the Imbabazane local municipality in the Uthukela district. Third, a total of 984 households were randomly selected from the four district municipalities. The lists of farmers were obtained from the extension offices. No stratification was done according to group membership (or any other variable), giving an equal chance for both group members and non-members to be included. The number of households sampled was not proportional to the population sizes of the respective local municipalities, but were proportional to the number of farming households as received from the local extension offices. It should be noted that the data are not representative of the KwaZulu-Natal province, as the districts were chosen purposively. As such, the results should not be generalised to the whole province and should be interpreted with caution even for the selected municipalities, as they only represent the farming households.

The data were collected during the months of October and November 2014 using a structured questionnaire. The questionnaire was administered by experienced enumerators who spoke the local *IsiZulu* language. These enumerators were trained before the survey. Questionnaire pre–testing, involving 15 rural households, was also done. The ambiguities or difficulties with regards to question wording were noted and remedied during questionnaire pre-testing. The questionnaire included household demographics and socio-economic characteristics; income sources and amounts; institutional support services and membership in farmer organisations.

2.2 Theoretical framework and description of variables

The study depends on the sustainable rural livelihoods framework (Scoones, 2009) and the random utility theory (McFadden, 1974). The livelihoods concept includes the capabilities, capital (natural, physical, financial, human, social and psychological) and activities required to make a living (Ellis *et al*., 2003; Scoones, 2009). Smallholder farmers in South Africa diversify their livelihoods and depend on a number of income sources, such as farming, non-farm employment, remittances, social grants, etc. (Shackleton *et al*., 2007; Aliber and Mdoda, 2015). In the rural areas where these smallholder farmers are located, welfare levels are dependent on not only access to livelihood capital/assets but also the social and institutional setup (Scoones, 2009; Tilahun *et al*., 2016). Farmer groups, as critical local institutions, can help the farmers overcome infrastructure or resource constraints prevalent in rural areas (Bauernschuster *et al*., 2010). The groups enhance information flows, informal access to finance or insurance, access to market intelligence or contract monitoring and enforcement as well as provision of friendship or other intrinsically valued services to farmers (Bauernschuster *et al.,* 2010; Chantarat and Barrett, 2012). The result would be improved production and/or productivity, market participation and household welfare.

The decision to join groups can be analysed as a choice problem within a random utility framework (McFadden 1974). The random utility theory assumes that a farmer, as a utility maximiser,

would join a group member if the expected utility from group membership (U_i^M) is greater than that of non-membership (U_i^N). That is, a farmer chooses group membership if the expected net utility, U_i^* i.e., ($U_i^M - U_i^N$) is greater than zero. The unobserved net utility can be expressed as a function of observable elements in the following latent variable model:

$$U_i^* = \alpha Z_i + u_i,\ U_i = 1 \text{if } U_i^* > 0 \tag{1}$$

where U_i is a binary indicator variable that equals 1 for farmer *i* in case of group membership and 0 otherwise, α is a vector of parameters to be estimated, Z_i is a vector of household and farm characteristics and u_i is an error term.

Total household income per adult equivalent was used as the welfare indicator, following Tilahun *et al*. (2016), Sinyolo *et al*. (2014) and other studies. The total income included income from different sources such as farming (crop or animal production), non-farm employment (temporary or permanent), remittances, social grants and micro-business. The income was accounted for the 12 months before the survey (October 2013 to September 2014).

The treatment variable was a binary indicator of whether or not a farmer is a member of a farmer group (producer association or marketing cooperative, or both). Other variables considered include personal details of the farmer and their household characteristics (age, gender, education level, employment status, etc.), wealth and asset endowment (land size, livestock size, asset values, etc.) and infrastructural and/or institutional support (extension, credit, irrigation, distance to all-weather road, location/district, etc.). Table 2 in section 3 presents the variables and their summary statistics.

2.3 Empirical methods

The propensity score matching (PSM) method was used to investigate the impact of group membership on household incomes. Since group membership is voluntary and non–random, members may systematically differ from non-members in several socio-economic observable characteristics that may have a direct effect on household welfare. If this is the case, simply computing the difference between the mean income values of the two categories gives biased impact results. PSM identifies non-members of groups whose observable characteristics are similar to those of members, and makes comparison in the region of common support (Becker and Ichino, 2002). Compared to estimates based on full samples, the impact estimates based on matched samples are less biased and more reliable (Rubin and Thomas, 2000).

The focus of this study was to evaluate the impact of group membership on those households that are group members by estimating the Average Treatment effect on the Treated (ATT) as follows:

$$\begin{aligned} ATT &= E[\Delta_i | G_i = 1] \\ &= E[Y_{1i} | G_i = 1] - E[Y_{0i} | G_i = 1] \end{aligned} \tag{2}$$

where G_i denotes group membership by farmer *i*, and takes two values: $G_i = 1$ if the household is a group member and $G_i = 0$ if the household is a non-member. Y_{1i} is the income of group member *i*, Y_{0i} is the income of group non–member *i* and $E[\Delta_i \mid G_i = 1]$ is the expected treatment effect. The ATT captures the change in the incomes realised by farmers who are group members subject to their group membership status.

The fundamental evaluation problem is that of missing data, since the treatment indicator takes either the value of one or zero, but not both (Smith and Todd, 2005). This is because the incomes for the group members, had they not been group members, cannot be observed. Similarly, the incomes of non-members, had they been group members, cannot be observed. The PSM method generates the missing data by estimating the propensity score, which is the probability that a household is a group member (Rosenbaum and Rubin, 1983). The approach can estimate the causal group membership impact as the difference between the incomes of the group members and what would have been the case if these members had not joined groups. The logit model was used to estimate the

propensity scores. The balancing property was selected in estimating the propensity scores. The use of the balancing property ensures that a comparison group is constructed with observable characteristics distributed equivalently across quintiles in both the treatment and comparison groups (Smith and Todd, 2005).

Three matching methods, the nearest K-neighbours (K = 5), kernel (bandwidth = 0.06) and radius (calliper = 0.05) matching techniques, were used to estimate the impact for robustness reasons. A matching estimator is considered good if, on the one hand, it does not eliminate too many of the original observations from the final analysis, while, on the other hand, it yields statistically equal covariate means for households in the treatment and control groups (Caliendo and Kopeinig, 2005; Abebaw and Haile, 2013). In constructing the matching estimates, the common support was imposed. The treatment observations with weak common support were dropped, since inferences can be made about causality only in the area of common support (Heckman *et al*., 1997). All the standard errors were bootstrapped with 1000 repetitions, as suggested by Smith and Todd (2005).

The sensitivity of the estimated average income effects to hidden bias was tested using the Rosenbaum bounds sensitivity test (Rosenbaum, 2002). This test indicates how strongly an unobservable variable must influence the selection process to undermine or reverse the findings based on matching on observables (Rosenbaum, 2002, 2005). Previous studies on group membership impacts such as Abebaw and Haile (2013), Cunguara and Darnhofer (2011) and Tilahun *et al*. (2016) have used the same approach to test for hidden bias in impact estimates. The Rosenbaum bounds tests indicated that the results were very sensitive to hidden bias, as only 20 per cent of bias would reverse the conclusion (Table 6). The treatment effect model, which corrects for the hidden bias that arises from unobservable factors, was therefore estimated. The model first generates the inverse Mills ratio and then adds it to the response equation (Heckman, 1979; Maddala, 1983), as follows:

$$Y_i = \beta x_i + \delta G_i + \beta_\lambda \lambda_i + \varepsilon_i \tag{3}$$

where Y_i is household income per adult equivalent, x_i is a vector of socio-economic characteristics; G_i is group membership status; λ_i is the inverse Mills ratio, ε_i is the error term; while β and δ are parameters that are to be estimated. The impact coefficient δ is unbiased due to the inclusion of the selectivity term (inverse Mills Ratio) (Heckman, 1979).

The estimation of the impact as described above assumes a homogenous treatment effect among the group members. However, as explained in previous studies (e.g., Abebaw *et al*., 2010; Ali and Abdulai 2010; Cunguara and Darnhofer, 2011; Abebaw and Haile, 2013), the treatment effects are not the same for all the different socio-economic groups within the same treatment group. To investigate the extent to which the treatment effect on incomes varies within group members, ordinary least squares (OLS) regression of the household-level treatment effect on some background characteristics of the group members was estimated.

3. Results and discussions

3.1 Descriptive statistics

Table 1 shows the income sources, amounts and relative importance on household income. The table shows a diversity of income sources, as was expected. Social grants were the main income source among the households, contributing 38 per cent to household income. Non-farm employment was the second highest contributor, followed by remittances. Farming was the fourth important income source, contributing 13 per cent to household income. The table shows that group members had significantly more total income than the non-members. The results indicate that group members derived more income from non-farm employment, farming activities and small businesses than non-members. Farming activities contributed over 56 per cent more income to group members than it does to non-members.

Table 1. Income from different sources according to group membership status

Income source	Pooled sample ($n = 984$) Absolute income (Rands)	Pooled sample ($n = 984$) Relative income (%)	Group members ($n = 414$)	Group non–members ($n = 570$)	*t*-test
Social grants	17768	0.38	17169	16164	
Employment	11689	0.25	12895	10813	***
Remittances	8416	0.18	9285	7785	
Farming	6078	0.13	8786	4931	***
Microbusiness	1870	0.04	2063	1730	***
Other	935	0.02	1032	865	
Total	**46759**	**1**	**51230**	**42288**	***

Notes: *** means significant at 1% levels.

Table 2 presents the summary statistics of the interviewed farmers according to group membership status. The table shows that 414 of the sampled farmers were group members, representing 42 per cent of the sample. The group members indicated that the groups render several services to their members; such as dissemination of price or market information, input access, output market access, credit and savings, trainings and information/ experience sharing. The main benefit, according to the farmers, is that forming groups make it easier to access government or NGO support, as these prefer to disseminate extension information, inputs and other forms of support to groups instead of individuals.

Table 2 shows that group members had more incomes, were more educated, had bigger households and were wealthier (in terms of land, livestock and assets) than the non-members. Table 2 also suggests that group members have better access to support services such as extension and credit. The groups were dominated by males, and those with more farming experience were less likely to be group members. Table 2 indicates modest welfare levels, as households had annual incomes of about R9000 per adult equivalent. This translates to over R800 per adult equivalent per month, and compares favourably with the lower-bound poverty line (NPC, 2012). Using the lower-bound

Table 2. Summary statistics of sample households according to group membership status

Variables and description	Pooled sample ($n = 984$)	Group members ($n = 414$)	Group non-members ($n = 570$)	*t*-tests (χ^2 tests)
Treatment variable				
Group membership (1 = member, 0 = non-member)	0.42	1.00	0.00	
Outcome variable				
Household income per adult equivalent (Rands)	9854.74	11255.02	8837.70	4.34***
Socio-economic characteristics				
Age (years)	56.11	56.31	55.96	0.42
Gender (1 = male, 0 = female)	0.47	0.50	0.44	4.46**
Marital status (1 = married, 0 = unmarried)	0.46	0.49	0.45	1.40
Education level (years)	4.67	4.95	4.47	1.78*
Household size (numbers)	7.04	7.70	6.56	4.98***
Household size (adult equivalents)	5.55	5.42	5.64	1.35
Land size (hectares)	1.93	2.50	1.52	3.44***
Livestock size (tropical livestock units)	3.53	4.95	2.49	2.18**
Asset values (Rands)	82105.38	88178.31	77694.52	4.20***
Credit access (1 = yes, 0 = no)	0.36	0.40	0.32	6.79***
Extension (1 = yes, 0 = no)	0.57	0.68	0.49	35.38***
Distance to nearest all-weather road (km)	17.75	17.28	18.01	−0.31
Farming experience (years)	18.70	16.25	20.47	−4.98***
Irrigation access (1 = yes, 0 = no)	0.46	0.48	0.45	0.86
Non-farm business ownership (1 = yes, 0 = no)	0.08	0.11	0.06	5.97**
Harry Gwala	0.42	0.17	0.60	181.6***
Umzinyathi	0.24	0.26	0.23	0.94
Uthukela	0.19	0.28	0.13	35.79***
Umkhanyakude	0.15	0.29	0.04	120.20***

Notes: ***, **, and * means significant at 1%, 5%, and 10% levels, respectively.

poverty line of R443 per capita per month suggested by NPC (2012) in 2011 prices, and adjusting it to the 2014 prices using the consumer prices index (CPI) (Stats SA, 2014), produces a poverty line of R544 per capita per month or R6528 per capita per year. This implies that households, on average, are not in poverty. However, the average may be because of a few households that are wealthy. The large standard deviation points to the huge variation in the households' incomes.

Table 3 shows the Foster, Greer and Thorbecke (FGT) poverty indices (Foster *et al*., 1984) according to group membership. The poverty cut–off line used was R6528 per adult equivalent per annum, the lower-bound poverty line adjusted to 2014 prices. Table 3 shows that 39 per cent of the farmers interviewed were below the poverty line.

The table also shows that poverty is more prevalent among those who are not group members. The poverty gap index, a measure of depth of poverty, shows that the current income levels of the poor households would have to increase by 14 per cent to lift them out of poverty. The poverty gap index is lower for group members compared to non-members. The poverty severity index indicates that inequality among the poor is slightly lower among group members, suggesting that farmer groups can play a role in reducing income inequality.

3.2 Determinants of group membership and estimation of the propensity scores

Table 4 presents the logit model results estimated to investigate the factors associated with membership in farmer groups and compute the propensity scores. Table 4 shows a positive relationship between age and chances of group membership. An additional year was associated with an increase of 0.5 per cent in the likelihood of group membership. Several other studies (e.g., Bernard *et al*., 2008;

Table 3. FGT poverty indices according to group status

FGT index	Pooled sample	Group members	Group non–members
Poverty headcount index	0.39	0.35	0.42
Poverty gap index	0.14	0.11	0.16
Poverty severity index	0.07	0.05	0.08

Table 4. Determinants of farmer group membership, logit model results

	Coefficients		Marginal effects	
Variables	Coefficient	Standard error	Coefficient	Standard error
Age	0.033***	0.007	0.005***	0.001
Gender	–0.270	0.189	–0.043	0.030
Marital status	0.316*	0.181	0.051*	0.029
Education level	0.056***	0.022	0.009***	0.003
Household size	0.046*	0.026	0.007*	0.004
Land size (logged)	0.463***	0.082	0.074***	0.012
Livestock size	–0.004	0.004	–0.001	0.001
Asset values (logged)	0.237**	0.119	0.038**	0.019
Credit access	0.374***	0.169	0.060***	0.027
Extension access	0.462***	0.168	0.074***	0.027
Distance to all-weather road	–0.010***	0.002	–0.002***	0.000
Farming experience	–0.028***	0.007	–0.005***	0.001
Irrigation access	0.044	0.169	0.007	0.027
Non-farm business ownership	0.764**	0.305	0.123**	0.049
Umzinyathi	2.227***	0.224	0.357***	0.030
Uthukela	1.959***	0.210	0.314***	0.029
Umkhanyakude	3.833***	0.373	0.615***	0.044
Constant	–6.687***	1.333		
Pseudo R^2	0.28			
LR χ^2	242.19***			
% predicted correctly	76			

Notes: ***, **, and * means significant at 1%, 5%, and 10% levels, respectively.

Fischer and Qaim, 2012; Abebaw and Haile, 2013) have also reported a positive relationship between age and group membership. This result implies that farmers become more inclined to join groups as they become older. A plausible reason is that older farmers would have developed more contacts, trust and social networks, and thus have more positive attitudes to group membership than younger farmers. Interestingly, farming experience was associated with decreasing chances of group membership. This suggests that experienced farmers prefer to work as individuals rather than groups. This might indicate that farmers who would have developed enough individual capacity prefer working as individuals.

A higher level of education, as a proxy of human capital development, is also positively associated with participating in groups. This is because the more educated are more likely to understand and interpret information better, which will result in them facing less transaction costs and benefiting more from the group membership. In line with studies such as Bernard and Spielman (2009) and Fischer and Qaim (2012), the results indicate that household size was positively correlated with group membership. Presumably, bigger households are more likely to participate in groups due to labour availability. Marital status was also positively associated with an increase in the chances of group membership, suggesting that the married farmers were more likely to join groups compared with the unmarried ones.

Table 4 shows that increasing land size is positively correlated with membership in farmer groups. The net benefits of farmer group membership increase with increasing farm size possibly because bigger farms signify increased agricultural production potential. Since membership costs are usually fixed, farmers who produce more are likely to benefit more from the groups. The same pattern also applies to other proxies of physical and financial capital such as asset values, credit access and ownership of non-farm micro-businesses. Several past empirical studies (e.g., Bernard *et al*., 2008; Bernard and Spielman, 2009; Francesconi and Heerink, 2011; Fischer and Qaim, 2012, 2014; Abebaw and Haile, 2013; Tilahun *et al*., 2016) have shown positive relationship between physical as well as financial capital and group membership. The reason is that gains from participation in farmer groups are larger if a household owns complementary assets that enhance successful cooperation.

Access to support services such as extension is associated with increased likelihood of group membership. Such services ease access to relevant information about the benefits of group membership. This is in line with previous literature (e.g., Abebaw and Haile, 2013; Tilahun *et al*., 2016). In South Africa, extension officers have been in the forefront of promoting group formation as the government prefers working with farmer groups. As such, extension officers are likely to influence the farmers they contact to form groups.

A counter-intuitive result in Table 4 is that distance to the nearest all-weather road was negatively correlated with group membership. One would have expected that farmers furthest from all-weather roads would be more likely to join groups to alleviate the transportation costs. A possible explanation is that farmers in isolated areas do not have access to enough information about the benefits of group membership.

The results also show location effects as district dummies, which were included to account for unobserved agro-climatic, institutional, market access and socioeconomic heterogeneities among the sample districts, significantly correlated with group membership. In summary, the logit results show that group participation was biased towards the educated, the relatively wealthier households and households with access to support services such as extension. Previous studies (e.g., Bernard and Spielman, 2009; Abebaw and Haile, 2013) have also reported that the poor and uneducated tend to be excluded from membership in farmer groups.

3.3 Impact of group membership on household income per adult equivalent

The PSM method was employed in estimating the impact of group membership on household income per adult equivalent, and the results are presented in Table 5. The impacts were estimated using the nearest five neighbours, kernel and radius matching methods to ensure robustness.

Table 5. Impact of group membership on incomes per adult equivalent, PSM results

Matching estimator	ATT	*t*-test
Nearest five neighbours	2944.60 (798.00)	3.69***
Kernel matching (bandwidth = 0.06)	2931.38 (765.91)	3.83***
Radius matching (Calliper = 0.05)	2938.11 (765.74)	3.84***

Notes: *** means significant at 1% level. Figures in parentheses are standard errors.

Table 5 shows that all the matching estimators yield similar results and show that group membership has a positive and statistically significant effect on income. The results indicate that incomes would be about R3000 less if the farmers had not participated in farmer groups. The differences among the values estimated using the three matching approaches are very small, implying that the estimates are robust.

To evaluate the reliability of the above reported estimates, the balancing tests based on the Kernel matching approach were done and the results are presented in Table 6. The table shows that, after matching, both group members and non-members have characteristics that are statistically similar. The test for equality of the two group means shows that there is no statistically significant difference between members and non-members after matching. An exception is education, which is significant at 10 per cent level. This contrasts with the unmatched sample presented in Table 2 which indicated statistically significant differences in several covariates between the two groups. The standardised differences (per cent bias) for the mean values of all the covariates between members and non-members are below 20 per cent, implying that the balancing requirement is adequately satisfied (Rosenbaum and Rubin, 1985).

The Rosenbaum bounds sensitivity analysis was done and the results are presented in Table 7.

The bounds tests show that the conclusion would change at bounds statistic (Γ) = 1.2. This implies that the results are sensitive to hidden bias since it would require only 20 per cent to reverse bias to reverse the conclusion. The treatment effect model, which corrects for the hidden bias that arises from unobservable factors, was thus estimated. The results of the second step of the model are presented in Table 8 (the first step results are similar to those presented on Table 4).

Table 6. Test of matching quality

	Mean			*t*-test	
Variables	Treated	Control	Per cent bias	*t*	$p > t$
Age	56.24	57.01	−5.8	−0.88	0.379
Gender	0.50	0.51	−1.7	−0.24	0.813
Marital status	0.48	0.49	−1.1	−0.15	0.878
Education level	4.92	4.42	12.2	1.81*	0.071
Household size	7.67	7.93	−7.4	−0.99	0.323
Land size (logged)	0.11	0.03	6.2	0.87	0.382
Livestock size	4.89	4.46	2.3	0.32	0.748
Asset values (logged)	11.25	11.25	0.3	0.05	0.961
Credit access	0.40	0.36	8.7	1.24	0.217
Extension access	0.67	0.65	5.1	0.75	0.453
Distance to all-weather road	17.29	15.67	4.1	0.62	0.537
Farming experience	16.31	16.07	1.9	0.28	0.776
Irrigation access	0.48	0.44	8.7	1.25	0.213
Non-farm business ownership	0.11	0.11	0.4	0.05	0.964
Umzinyathi	0.26	0.29	−6.4	−0.89	0.373
Uthukela	0.28	0.30	−3.3	−0.41	0.679
Umkhanyakude	0.28	0.27	5.4	0.61	0.543
Summary of the distribution of |bias|					
Min = 0.3, Max = 12.2					
Mean = 4.75, Standard deviation = 3.34					
Pseudo R^2=0.009					
LR χ^2 = 9.81, p = 0.911					

Notes: * means significant at 10% levels.

Table 7. Rosenbaum bounds test (Kernel matching, bandwidth = 0.06)

	Wilcoxon statistics	
Γ	Upper bound significance level	Lower bound significance level
1	0.001	0.001
1.1	0.008	0.000
1.2	**0.049**	**0.000**
1.3	0.168	0.000
1.4	0.374	0.000
1.5	0.608	0.000

Notes: Bold figures refer to values at the Rosenbaum critical gamma cut-off value.

Table 8. Impact of group membership on income per AE, treatment effect model results

Variables	Coefficient	Standard error
Group membership	4651.63***	835.26
Age	77.11***	19.07
Gender	1472.12***	508.92
Marital status	416.36	531.72
Education level	312.87***	81.39
Household size	−925.40***	89.13
Land size (logged)	154.15	229.40
Livestock size	−5.61	8.05
Asset values (logged)	854.73***	280.31
Credit access	−568.79	475.72
Extension access	1072.42***	513.94
Distance to all−weather road	10.10	6.19
Farming experience	25.89	16.97
Irrigation access	1596.71***	551.72
Non-farm business ownership	1705.57	1338.64
Umzinyathi	99.52	663.78
Uthukela	−406.85	786.28
Umkhanyakude	−145.19	1069.90
Constant	−2371.65	3136.72
/athrho	−0.15***	0.05
/lnsigma	8.97***	0.09
ρ	−0.15	0.05
σ	7827.52	676.93
λ	−1153.63	398.25
Wald χ^2 (18)	187.21***	
N	984	
Wald test of independent equations ($\rho = 0$), $\chi^2(1) = 9.78$*, $p = 0.002$.**		

Notes: ***, **, and * means significant at 1%, 5%, and 10% levels, respectively.

The significant and negative ρ value in Table 8 indicates evidence of hidden negative selection bias. These findings demonstrate the possible significant effect of unobservable factors on household income per adult equivalent. The results imply that those farmers who select into groups have lower welfare relative to those with average characteristics drawn at random from the population. The estimated coefficient of group membership was positive and statistically significant, supporting the conclusion that membership in farmer groups results in increased household welfare. Table 8 also shows that increasing age, education level, assets as well as access to extension and irrigation are associated with increased incomes. Also, males have higher incomes than females, while increasing household members are associated with decreasing welfare.

3.4 Impact heterogeneity

To investigate the extent to which the treatment effect on welfare differs among group members, the OLS regression model was estimated and results are presented in Table 9.

Table 9. Heterogeneous income impacts among group members

Variables	Coefficient	Standard error
Age	128.65***	34.79
Gender	1602.63*	903.47
Marital status	468.21	994.84
Education level	345.08**	162.00
Household size	−915.46***	159.06
Land size (logged)	416.07	482.61
Livestock size	−11.49	8.54
Asset values (logged)	1149.48	728.19
Credit access	43.42	875.58
Extension access	−1769.32*	1008.06
Distance to nearest all−weather road	16.36	13.49
Farming experience	20.10	35.64
Irrigation access	1862.87*	1075.52
Non-farm business ownership	2993.39	2284.06
Umzinyathi	2193.08*	1311.99
Uthukela	1018.51	1261.37
Umkhanyakude	1746.82	1647.14
Constant	−6613.80	7854.69
N	414	
R^2	0.17	
F	4.58***	

Notes: ***, **, and * means significant at 1%, 5%, and 10% levels, respectively.

The table shows that the impact of group membership is not the same among members. The results show that group membership increases household incomes more among the older farmers than among the younger farmers. This is because the older farmers would have developed enough contacts, trust and social networks to benefit more from group participation than the younger ones. The positive and significant estimated coefficient of gender suggests that it is male farmers who benefit more from farmer groups than the females. This suggest that there is gender bias in these male dominated groups (Table 2). Also, the results show that the groups benefit the more educated, those who irrigate as well as those with smaller households. The fact that groups are benefitting more if they are educated and men is unfortunate, as it suggests a bias against the illiterate women, who constitute most smallholder farmers in South Africa.

4. Conclusions and policy implications

Organising smallholder farmers into groups has become an important and preferred mechanism through which the South African government and non-governmental organisations (NGOs) seek to use as a vehicle for addressing rural poverty and household food insecurity. The study looked at whether farmer groups have resulted in improved incomes among rural farming households. The results have highlighted the complementary role of access to information and physical and financial capital in motivating the rural farmers to participate in farmer groups. Farmers should be supplied with information not only on how to form or join groups, but also about the benefits of participating in groups. The farmers who face larger transaction costs and thus would benefit more from group membership, such as those located further away from all-weather roads, become disadvantaged as they do not have easy access to information. Access to complementary physical and financial assets enhances the participation of the farmers in the groups.

The results showed that participation in farmer groups significantly and positively influences household incomes. However, the results have shown that the effect of group membership was smaller among the marginalised groups that are prioritised or targeted by policy makers. Whereas the South African government aims to organise especially youths into groups, as they are the category more affected by the prevailing high unemployment levels, the results indicate that farmer groups have higher impact among older farmers. Also, while the priority is to support women, the

groups seem to be benefitting the male farmers more. The results suggest that organising smallholder farmers into groups can play a positive role in rural poverty reduction in South Africa. For greater impact, policy makers should promote group formation and participation among the irrigators as well as introduce adult literacy classes to improve education levels. The study also highlights the importance of building the capacity of the marginalised groups to successfully participate and benefit from farmer groups. The study did not make a distinction among different types of groups to make comparisons of the effectiveness of these different group types on the welfare outcomes among farmers. This is an area that should be investigated to help inform policy makers on which group types they should prioritise for higher welfare gains.

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