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Moran GJ, Amii RN, Abrahamian FM, Talan DA (2005). Methicillinresistant Staphylococcus aureus in community-acquired skin infections. Emerg. Infect. Dis. 11: 928-930.

Pitout JDD, Church DL, Gregson DB, Chow BL, McCracken M, Mulvey M, Laupland KB (2007). Molecular epidemiology of CTXM-producing Escherichia coli in the Calgary Health Region: emergence of CTX-M-15-producing isolates. Antimicrob. Agents Chemother. 51: 1281-1286.

Pelczar JR, Harley JP, Klein DA (1993). Microbiology: Concepts and Applications. McGraw-Hill Inc., New York, pp. 591-603.

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*Full Length Research Paper*

# The effect of malaria on staple food crop production in the Ejisu-Juaben Municipality of the Ashanti Region of Ghana

**Asiamah Maxwell T.*, Patrick Dzadze and Bertha Gyasi**

Department of Agricultural Economics, Agribusiness and Extension, Kwame Nkrumah University of Science and Technology, P. M. B, Kumasi, Ashanti Region, Ghana.

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**Malaria disease is a widespread problem in tropical countries. Recent publications have pointed to a correlation between enhanced agricultural activities and increasing prevalence of the disease. This paper therefore examined the relationship between food crop production and incidence of malaria in the Ejisu-Juaben Municipality of the Ashanti Region of Ghana. Ninety-two percent of sampled respondents had reported malaria cases in the 2010 major season. Out of these reported cases, 53.3% were female farmers. Chi-square tests of independence showed statistically significant association between education and measures adopted to control malaria. Self – medication was observed among respondents in the face of malaria symptoms. During periods of malaria incapacitation, 90.2% of affected farmers refrained from farm work. This threatened household food security and resulted in reduction in farm revenue. Average seasonal losses attributable to malaria incidence was estimated at GH¢126 ($66.67). The study recommended that efforts should be focused on malaria education during the second and third quarters of the year when malaria incidence is most prevalent.**

**Key words:** Malaria, incapacitation, Kendall's coefficient, Ejisu-Juaben, Ghana.

## INTRODUCTION

Malaria is a major contributor to poor public health and a leading cause of deaths and diseases in sub-Saharan Africa. At least 300 million cases of malaria are estimated to be reported each year globally resulting in over one million deaths. About 90% of malarial deaths occur in Africa with young children especially those under the age of five suffering the most mortality (WHO, 2008). Malaria also accounts for a high number of adult morbidity in endemic areas. Ghana's Ministry of Health and the national malaria control programme reported 2.8 million cases of malaria in 2002 and attributed 44% of out-patient clinical visits to malaria disease (Adams et al., 2004). The November 5th 2005 edition of the Daily Graphic also reported an estimated 17,000 deaths per year from malaria in Ghana.

Malaria has a negative impact on annual gross national product and up to 25% reduction in household income can be attributed to malaria control and treatment (Senzanje et al., 2002). Poor health as a result of malaria disease leads to incapacitation of the economically active population, reduces the capacity of labour force to work, affects the quality and quantity of available labour and decreases overall productivity (Asenso-Okyere et al., 2009). Thus, productive time lost and income lost to disease treatment and control, constitute some of the economically important effects of morbidity due to

*Corresponding author. E-mail: Maxwell.asiamah@yahoo.com.

malaria disease.

Acquisition and diffusion of agricultural knowledge is also affected by malaria especially in cases where it leads to mortality. According to Asenso-Okyere et al., (2009), in cases of mortality, supply of labour is affected in addition to loss of farming knowledge.

Asenso-Okyere et al. (2009) further observed that risk of malaria transmission in malaria endemic areas increased with increasing levels of agricultural activities. Provision of irrigation water for agricultural activities through dams, reservoirs, bore-holes among others, creates favourable environments for mosquito activity all year long (Appawu et al., 2004; Yasuoka and Levins, 2007).

Studies in Eastern Ethiopia point to a correlation between type of crop grown and malaria incidence. Kebede et al. (2005) showed that maize pollen provides nutrition for larval mosquitoes. Dried leaves which fall and collect rain water, along with swampy areas reserved for rice cultivation have been shown to provide fertile grounds for mosquito breeding (Oladepo et al., 2010).

The correlation between agricultural activities and malaria incidence necessitated this study to identify the relationship between food crop production and malaria in the Ejisu-Juaben Municipality in the Ashanti Region. Specifically, the study sought to determine the period of the year when the prevalence rate of malaria amongst food crop farmers is highest, identify the effect of malaria incapacitation on farming activities, determine the coping strategies employed by farmers to reduce the effect of malaria and their relation with education, quantify seasonal losses attributable to malaria, and determine farm level activities most commonly affected by malaria incidence as perceived by farmers.

## Hypothesis

$H_0$: Days of incapacitation, mode of diagnosis and coping strategies adopted are independent of education.
$H_1$: Days of incapacitation, mode of diagnosis and coping strategies adopted are dependent on education.

## METHODOLOGY

### Study area

Ejisu-Juaben Municipal is one of the 27 administrative and political Districts in the Ashanti Region of Ghana. The Municipal area covers 637.2 km$^2$ constituting about 10% of the Ashanti Region with Ejisu as its capital. It lies within Latitudes 1° 15' N and 1° 45' N and Longitudes 6° 15' W and 7° 00' W. Ejisu-Juaben Municipal shares boundaries with six other Districts in the Region. To the North East and North West of the Municipal are Sekyere East and Kwabre Districts respectively, to the South are Bosomtwe-Atwima-Kwanwoma and Asante-Akim South Districts, to the East is the Asante-Akim North Municipal and to the West is the Kumasi Metropolitan area.

As is the case for most parts of the middle belt in Ghana, the municipality experiences tropical rainfall (that is, bi-modal rainfall pattern and wet semi-equatorial climate). It is characterized by double maxima rainfall lasting from March to July and again from September and normally tapers off in the latter part of November. The mean annual rainfall is 1200 mm which is ideal for both major and minor season cropping. Temperatures range between 20°C in August and 32°C in March. Relative humidity is fairly moderate but quite high during rainy seasons and early mornings. The fair distribution of temperature and rainfall patterns enhances the cultivation of many food and cash crops throughout the district.

### Types and sources of data

A multistage sampling technique was used to select 100 farmers for interviewing by purposively selecting four rural communities for ease of access to staple food crop farmers. Twenty-five farmers were then randomly selected using assigned random numbers from each of the selected communities. The towns selected were Essienimpong, Kwaso, Onwe and Besease.

### Methods of analysis

Descriptive statistics including frequency distributions, means and percentages were employed in analysing the data obtained. Means and standard deviations were used in analysing the demographics. The Kendall's Coefficient of Concordance was employed to rank certain farm level activities/factors that were affected by malaria incidence as perceived by farmers.

### Theoretical framework

Kendall's coefficient of concordance (*W*) is a measure of the level of agreement among independent Judges (*p*) assessing a given set of *n* objects. The approach of estimation employed in this study is adopted from Pierre (2005).

$$W = \frac{12S}{k^2\left(n^3 - n\right)}$$

$$S = \sum (SR)^2 - n(SR)^2$$

Where *k* = number of judges (farmers); *n* = number of problems ranked; *S* = sum of ranks; *SR* = mean of sum of ranks.

*W* ranges between 0 and 1, and indicates the strength of agreement; the closer to 1, the higher the level of agreement or concordance with *W* of zero signifying disagreement. For *n* > 30 the test of significance is achieved by computing the Friedman's chi-square $X^2$. Pierre (2005) cited Siegel and Castellan (1988: 270, 365) that $X^2 = k\ (n - 1)\ w$. He indicated that this quantity is asymptotically distributed like chi-square with (*n*−1) degrees of freedom and allows us to test *W* for statistical significance. *W* is significant if $X^2$cal > $X^2$crit at the prescribed level of significance.

The hypothesis was tested using chi-square test of independence.

## RESULTS AND DISCUSSION

This study was conducted to identify the effects of malaria on activities of food crop farmers in the study area. Tables 1 and 2 show descriptive statistics of respondent farmers in the study area. The study sampled

**Table 1.** Descriptive statistics of respondents.

| Variable | Frequency | Percentage |
|---|---|---|
| **Gender** | | |
| Male | 43 | 46.7 |
| Female | 49 | 53.3 |
| *Total* | *92* | *100* |
| **Educational level** | | |
| No formal education | 28 | 30.4 |
| Primary | 22 | 23.9 |
| Junior high school | 11 | 12 |
| Senior high school | 28 | 30.4 |
| Tertiary | 3 | 3.3 |
| *Total* | *92* | *100* |

Source: Field Survey, January 2010.

**Table 2.** Summary statistics.

| Variable | Min | Max | Mean | Std. dev. |
|---|---|---|---|---|
| Age(years) | 27 | 66 | 46.32 | 9.69997 |
| Household size | 2 | 14 | 6.51 | 2.127 |
| Farm size(Ha) | 0.4 | 10 | 5.14 | 4.23 |
| Farming experience (years) | 2 | 20 | 13.76 | 5.106 |

Source: Field Survey, January 2010 (Std. dev.= Standard deviation).

**Table 3.** Effects of Malaria.

| Variable | Frequency | Percentage |
|---|---|---|
| **Prevalence periods** | | |
| 1st quarter | 16 | 17.4 |
| 2nd quarter | 39 | 42.4 |
| 3rd quarter | 29 | 31.5 |
| 4th quarter | 8 | 8.7 |
| *Total* | *92* | *100* |
| **Mode of diagnosis** | | |
| Medical doctor | 35 | 38 |
| Traditional doctor | 2 | 2.2 |
| Self | 55 | 59.8 |
| *Total* | *92* | *100* |

Source: Field Survey, January 2010.

100 farmers of which 92 had reported malaria cases in the 2010 major farming season, whist 8 had not report any malaria case indicating a high prevalence rate among food crop farmers in the district. The study therefore focused on those respondents who had reported malaria cases. About 53.3% of the reported cases were made by female farmers whilst 46.7% were by males. About seventy (69.6) percent of the respondents had received formal education with most (30.4%) attaining senior high school level of education. Respondents were on average 46 years old with about 14 years of farming experience and had an average of 7 persons per household. Majority of malaria cases during the 2010 major farming season, were reported in the 2nd and 3rd quarters of the year with the 2nd quarter recording the highest (42.4%) cases as shown in Table 3. This indicates a concentration of malaria cases during periods of peak agricultural activities under high rainfall conditions. It was also observed that respondents were well educated on the symptoms of the malaria disease. The number of respondents who diagnosed themselves of malaria and took remedial actions were 59.8%. Unfortunately, self-diagnosis and self-medication carry the risk of farmers misdiagnosing and treating themselves for malaria when they may be suffering from diseases like typhoid fever which have similar symptoms to malaria. Thirty-eight (38) percent sought qualified medical attention when they felt unwell and only 2.2% resorted to traditional healers for healthcare. These observations indicate a shift from traditional healthcare practices to modern medication.

Out of the total respondents who had malaria related problems, 90.2% refrained from farm work during the period of illness while the remaining 9.8% still carried on

**Table 4.** Period of staying away from farm work.

| Period | Frequency | Percentage |
|---|---|---|
| 3 days | 19 | 20.7 |
| 1 week | 21 | 22.8 |
| 2 weeks | 26 | 28.3 |
| 1 month | 17 | 18.5 |
| Others | 9 | 9.8 |
| *Total* | *92* | *100.0* |

Source: Field Survey, January 2010.

**Table 5.** Effect of illness on progress of farm work.

| Effect on farm work | Frequency | Percentage |
|---|---|---|
| Ceases | 45 | 48.9 |
| Labourers work | 35 | 38.0 |
| Family works | 3 | 3.3 |
| Others | 9 | 9.8 |
| *Total* | *92* | *100.0* |

Source: Field Survey, January 2010.

with their normal activities albeit with reduced vigour. Table 4 shows the distribution of the number of days that farmers had to stay away from work when ill. Also, 53.3% had to stay home to care for members of their household who had malaria whilst the remaining 46.7% still went about their normal activities when a household member had malaria. They attributed this to the fact that they had other family members who took care of those affected.

## Effects of malaria on progress of on- farm activities

From Table 5, all but 9.8% of respondents refrained from active farm work during periods of malaria incapacitation. For most farmers (48.9%), farm work came to a total halt whilst the remaining 41.3% either used hired labour or relied on family labour for continuation of farming activities. Most of these (38%) relied on hired labour. Further Interviews revealed that each of the various alternatives had their shortfalls. Those who ceased from doing farm work altogether said they had to grapple with problems like emergence of weeds, late planting or delayed harvesting which resulted in low economic returns and household food insecurity. Those who hired labourers had to grapple with problems like labourers not working as expected and theft of farm produce. They also had to incur extra costs for labour. Those who had family labour as substitute did not have a lot of problems except that some of them did not have adequate farming knowledge. These observations confirm reports by Asenso-Okyere et al. (2009) that high rates of malaria transmission in rural farming communities usually coincided with the planting and harvesting seasons and so affect productivity.

## Coping strategies adopted by farmers to reduce the effect of malaria and its relation with education

Farmers' views were sought on the strategies they used in the prevention of malaria. Identified strategies included visiting the hospital regularly, keeping clean surroundings (clearing bushes), using insecticide treated bed nets and clearing all choked gutters. Not all respondents demonstrated adequate knowledge on the subject, with responses like eating well, taking purgatives, and taking rest from work, among others. Chi-square test of independence showed that adoption of coping strategies was dependent on education and significant at 1% ($p > 0.001$). This meant that with higher levels of education, respondents were more inclined to adopt more effective or better coping strategies. This could be due to the fact that education gives a person a fair idea as to how to prevent or control malaria.

## Losses due to malaria

Revenue losses due to incidence of malaria during the farming season ranged between GH¢0 and GH¢500 ($264.55) with the average loss being GH¢126 ($66.67) (std. dev. =52.428). Major factors contributing to farmers' losses in revenue were attributed to cost of medication, weed infestation of untended farms, delayed harvesting

**Table 6.** Perceived effect of malaria treatment on capital outlay.

| Effect | Frequency | Percentage |
|---|---|---|
| Strongly agree | 65 | 70.7 |
| Agree | 24 | 26.1 |
| Undecided | 3 | 3.3 |
| Total | 92 | 100.0 |

Source: Field Survey, January 2010.

**Table 7.** Ranking of activities mostly affected by malaria.

| Farming activity | Rank total | Position | Comment |
|---|---|---|---|
| Labour | 229 | 1 | Activity most affected during incidence of malaria |
| Workdays | 232 | 2 | |
| Income | 249 | 3 | |
| **Crop variety** | 471 | 4 | |
| Household food security | 472 | 5 | |
| Labour intensive crops | 519 | 6 | |
| Area under cultivation | 534 | 7 | |
| Farm knowledge | 607 | 8 | Activity least affected during incidence of malaria |

Source: Author's computations.

and cost of hired labour during periods of incapacitation. Despite the National Health Insurance Scheme (NHIS), farmers still incurred high medication bills because most preferred self-medication with off the counter drugs available at local pharmacies. A five point Likert scale was used to find out farmers' perception about the effect of malaria treatment on their capital. As shown in Table 6, majority (96.8%) of farmers agreed that cost of treatment affected their capital outlay adversely leading to reduction in total output for the season. None of the respondents disagreed with this statement.

## Farm level activities/factors most commonly affected by malaria incidence as perceived by farmers

During the survey, some factors were listed for farmers to be ranked in order of those most affected with regards to malaria incidence as indicated in Table 7. From the table, the factor most affected is labour with a rank total of 229 and the factor least affected is farm knowledge. This is because according to the Kendall's Coefficient of Concordance, the factor with the least rank total is taken as the factor most affected.

Labour was perceived by farmers as the factor most affected in the incidence of malaria. From Table 5 above, it can be seen that 48.9% of the farmers said their work on the farm completely ceases when they were affected by malaria. Although 38.0% said labourers worked on the farm, they were not as productive as when the farmers themselves were around to supervise. Only 3.3% had family members working when they were taken ill. Second on the rankings was number of work days which is very obvious as the farmers were not able to go to work on those days due to incapacitation. The third was income. Combining the fact that the farmer was not able to go to the farm and spending his money on hired labour and hospital bills, income was likely to decrease. Fourth in the rankings was planting other crop varieties (mixed cropping). Farmers attributed this to the fact that they lose income and as such do not get enough money to invest in the production of different crops on the same field or plot of land. Also, they said they did not have ample energy to cultivate different crops. Household food security was perceived by the farmers as the fifth in the rank. This was attributed to the fact that input decreased in the case of malaria, resulting in low yields and as such farmers were not able to meet all their subsistence needs and were also not able to sell enough to cater for other crops they did not produce. Next were the labour intensive crops which farmers had to do away with in the case of malaria since they required a lot of energy and time input. Area under cultivation also decreased because malaria is mostly prevalent at that time of the year where the farmer is preparing his land and the farmer may either divert the resources he would use in preparing the land into treatment of malaria or may not be able to cultivate his normal land size due to incapacitation.

**Table 8.** Test of hypothesis.

| Variable | Chi-square value | Degree of freedom | Significance level | Comments |
|---|---|---|---|---|
| Malaria diagnosis and education | 36.041 | 12 | 0.000 | Dependent |
| Days of incapacitation and education | 106.8 | 16 | 0.000 | Dependent |
| Coping strategies and education | 9.530 | 4 | 0.049 | Dependent |

Lastly was loss of farm knowledge which resulted from the death of an experienced farmer or an experienced farmer who is incapacitated and had to stay away from work on the farm when he was supposed to give guidance on the farm as to how to go about work.

**Assessing the degree of agreement of the farmers ranking**

In order to assess whether farmers were in agreement with the order of the ranking computed above, the Kendall's Coefficient of Concordance was computed as:

$$W = \frac{S}{\frac{1}{12}k^2\left(n^3 - n\right)};$$

$$S = \sum(SR)^2 - n\left(\overline{SR}\right)^2$$

$$S = (229)^2 + (534)^2 + (232)^2 + (471)^2 + (519)^2 +$$

*S = 1535857-1371168*

*S = 164689*

Therefore:

$$w = {}^{164689}\Big/_{\frac{1}{2} * 92^2(8^3 - 8)}.$$

$$w = \frac{164689}{355320}.$$

*W=0.46*

Therefore Kendall's coefficient of concordance is 0.46
The value of W shows that 46% of the crop farmers were in agreement with the order of ranking of these specific factors.

**Test of hypothesis of agreement**

$H_0$: *w=0* (No significance of the order of agreement by farmers).
$H_A$: 0<*w*≤*1* (Degree of agreement of the rankings by farmers is significant).
Employing the Friedman's Chi-square:

$X^2 = k\,(n - 1)\,w$
$X^2 = 92(8-1)0.46$
$X^2 = 296$

$$X^2_{crit} = 18.5$$

From the results above, the null hypothesis is rejected in favour of the alternative that the degree of agreement of the rankings by farmers is significant. From Table 8 we reject the null hypothesis which says that malaria diagnosis, days of incapacitation and coping strategies are independent of education and confirm the alternate hypothesis.

**Malaria diagnosis and education**

The results show that malaria diagnosis depends on the educational background of the farmer. Therefore, the higher the farmer's educational level, the better the methods of malaria diagnosis adopted and vice versa.

**Days of incapacitation and education**

As the more educated farmers seek better modes of diagnosis, they are likely to spend relatively short time at home to recover thus reducing the number of days they are incapacitated. An increase in education is likely to improve the standard of living of farmers and facilitate control of malaria, hence reduction in workdays lost (Awoyemi et al., 2009).

**Coping strategies and education**

The more educated farmers were the better coping strategies they were likely to adopt since they would have more knowledge on the source of illness and as such would direct strategies in that direction. Also, education is likely to improve the living standards of the individual, hence better, efficient and improved strategies were utilized.

**Conclusion**

Farming communities in the Ejisu-Juaben Municipality experienced high levels of malaria during the 2nd and 3rd quarters of the year. Out of a total of 100 respondents, 92% had been clinically diagnosed with malaria in the 2010 major season, showing that malaria is endemic in farming communities in the municipality. More females than males reported malaria cases. Respondents were on the average 46 years old, had farming experience of about 14 years with about 7 members per household and

average farm sizes of 5 ha.

Most respondents had received some level of formal education. Farmers demonstrated adequate knowledge on malaria prevention with very few showing inadequate knowledge on the subject. There was statistically significant dependence between education and malaria coping strategies adopted. It was evident that most respondents relied on their knowledge of malarial symptoms for diagnosis and self-medication.

During periods of morbidity due to malaria disease, 90.2% of respondent farmers refrained from farm work, with the few that carried on with farm work doing so with reduced vigour. Abandonment of farms during periods of incapacitation threatened household food security, encouraged weed infestation of farms, delayed harvesting and in some cases hampered timely field preparation activities.

Losses in revenue attributable to malaria ranged between GH¢0 and GH¢500 ($264.55), with GH¢126 ($66.67) being the average loss per season. Major contributors to losses in revenue were costs of medication, cost of labour and losses due to delayed harvesting. Farmers ranked labour (quality and quantity) as the factor most affected by malaria incidence.

## RECOMMENDATIONS

The study recommends intensification of malaria education during the second and third quarters of the year when malaria prevalence is at its highest. The use of insecticide-treated bed nets and insecticide sprays by farmers is also recommended.

Along with education on control and treatment of malaria, farmers should also be encouraged to promptly seek professional medical advice when they feel unwell instead of resorting to self-medication.

Farmers should be encouraged to register with the National Health Insurance Scheme to reduce costs incurred on medical treatment in times of morbidity.

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# Impact of farmer research group interventions on maize farmers in Central Rift Valley of Oromia: An empirical study

**Wole Kinati[1]*, Adam Bekele[2] and K. P. M Chinnan[3]**

[1]Adami Tulu Agricultural Research Center, P. O. Box 35, Batu, Ethiopia.
[2]Melkasa Agricultural Research Center, Ethiopia.
[3]Haramaya University, Ethiopia.

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**The project on "strengthening Technology Development, Verification, Transfer and Adoption through Farmers Research Group (FRG)" implemented in the Central Rift-Valley of Oromia from 2004 to 2009 was used to promote and institutionalize participatory research in Ethiopian agricultural research system. A group of farmers were established as maize FRG working on maize improvement in two districts. Hence, this study was initiated with the objective to provide robust evidence for policy makers, donors, farmers, and implementing actors on whether the FRG approach can contribute to household productivity and income. A Cross sectional data were collected from a 180 randomly identified participant and nonparticipants. The empirical result of impact of our estimator indicated that the program increased participant households' productivity on average by 36%. However, further analysis revealed a positive and insignificant difference for the net income generated from the intervention. Adopting interventions that follow a value chain approach is recommended in order to make the program more comprehensive in bringing significant change not only in the production but also in the subsequent livelihood outcomes.**

**Key words:** Farmer research group, central rift-valley, maize, productivity, income, propensity score matching.

## INTRODUCTION

In order for agricultural research to properly address farmers' bio-physical and socio-economic constraints and be impact oriented by addressing the needs of its clients, it has to be participatory. The Ethiopian Agricultural Research System has been trying to promote participatory research to develop and promote technologies with farmers' active involvement. Encouraging results have been observed in the process, particularly by improving interaction among stakeholders. This has brought up a need to further improve and institutionalize participatory research in the research system for quick and tangible research impacts on the client. Owing to this, the project entitled "strengthening Technology Development, Verification, Transfer and Adoption through Farmers Research Group (FRG)" was implemented in the Central Rift-Valley of Oromiya National Regional State from 2004 to 2009. This valley largely encompasses the East Shewa Zone of Oromia and has about 40 to 60 km wide and more than 1000 km length bounded by highland plateaus. The altitude ranges from 500 to 2000 m.a.s.l. and has a semi-arid type of climate. It has an erratic, unreliable and low rainfall is

*Corresponding author. E-mail: wolekinati@gmail.com.

bimodal with the long rain from June to September. The farming system is characterized by mixed crop-livestock (Abule et al., 1998).

The project operated in three Zones, namely East Shewa, Arsi, and West Arsi in Oromia Regional State. The following districts were covered: Adama, Boset, Dodota, Adami Tulu Jidokombolcha, Bora, Dugda, Arsi Negelle, and Shala. The project fully entered into operation in 2005. The aim of the project was to promote participatory agricultural research method for enabling research outputs meet farmers' needs and priorities as well as capacitate farmers to innovate so as to raise the productivity of small holders through generation, transfer and adoption of improved technologies. The project was funded by the Japan International Cooperation Agency (JICA). It was jointly implemented by the Ethiopian Institute of Agricultural Research (IARI) and Oromiya Agricultural Research Institute (OARI) for a period of five years. The two implementing centers were Melkasa Agricultural Research Center and Adami Tulu Agricultural Research Center (MARC & ATARC).

One of the goals set in the project document was to increase in the production of major commodities of the farmers around the target FRG. One of the major commodities considered by the project was maize. In Ethiopia Maize (*Zea mays*) is mainly produced for local consumption. In additional leaves are used as feed for animals and the stake is used as fuel and for construction. Millions people depend on maize as a staple food. In view of its high demand for food grains and high yield per unit area, maize has been among the leading food grains selected to achieve food self sufficiency in Ethiopia (Benti et al., 1993 cited in Chimdo, 2001). Hence maize is one of the top priority crops to which substantial resources are being allocated by the National Extension package program. Despite its importance, the national average yield of maize is around 2 ton/ha. This is really half of the world yield average of 3.7 ton/ha (Chimdo, 2001).

Several reasons were suggested for the low productivity of maize in the study are among which the major one is shortage of improved maize seed varieties. Yet while these varieties are currently being promoted through demonstration trials with smallholders throughout the Rift Valley area, widespread adoption has been tempered by difficulties in delivering improved seed to smallholders. Despite an active agricultural extension system, a sizeable state-owned seed enterprise, and the recent liberalization of seed market regulations, the availability and adoption of improved seed in the Rift Valley area remains low (Muhammad et al., 2003).

Unlike the conventional research approach where farmers are considered as the end users of technology developed at research centers, the project involves farmers (Farmers Research Group) directly into the research process. The direct involvement of farmers into research makes the technology dissemination quicker and demand driven. Interested and hard working farmers who could conduct the experiment were identified as farmer researcher for on farm trial of technologies. Each of such groups of farmer had about 15 to 20 farmers who formed FRG. Pre-extension technologies and/or completed technologies were tested by farmers in a group with a guide of researchers.

The research topics were identified by the community and facilitated by a multidisciplinary research team so that different kinds of farmers' problems were addressed. Inputs needed for the technology trial were provided by farmers and the project. The FRG approach intended to accelerate the technology dissemination process and create confidence in farmers developing their capacity to develop, modify and adopt agricultural technologies.

## METHODOLOGY

FRGs were established at different locations in the target districts. Accordingly, in two districts, Adami Tulu Jido Kombolcha (ATJK) and Boset, maize producing FRGs were established. Selection of households into the program involved local consultation (experts and administrators) and a non-random placement. In the first place, peasant associations were identified in the district based on certain criteria like their accessibility to road and availability of agricultural extension services and willingness of the farmers to participate and the opportunity and potential of the peasant associations for specific commodity of intervention. Households who have been involved in FRG since 2007/2008 were considered as participants. Each FRGs consisted of 15 to 20 farmers. Although, the whole process of FRG activities intended to develop farmers' capacity, scheduled farmer trainings occurred on regular bases. Working in groups, farmers would observe and discuss dynamics of the maize's ecosystem and the crop development. The objective of these learning processes is to develop farmer expertise in crop management that then enables them to make their own decisions.

The study was targeted at these two districts where maize FRGs was established by the project. Adami Tulu Jido Kombolcha, is locate in the southern part of Oromiya where as Boset is located in the eastern part. Adami Tulu Jido Kombolcha and Boset have 1403.3 and 1461.88 $km^2$ of land inhabited by about 141745 and 109578 people respectively of which more than 85% are living in the rural. All the farmers are subsistence, whose livelihoods depend mainly on mixed farming of crop and livestock. Acacia species and other species generally characterize the vegetation cover of the area.

Agro-ecologically, the areas are categorized under the semi arid, with altitudes ranges from 1500 to 2000 and below 1500 m.a.s.l. for Adami Tulu Jido Kombolcha and Boset respectively. The average annual rain fall ranges from 650 to 750 mm and the distribution is highly variable between and within years. The identified major type of soil is fine sandy loam with sand silt clay (Abule et al., 1998). Open woodland consists of Acacia species and other species generally characterizes the vegetation cover of the areas.

### Sample size and sampling techniques

Based on the data from the FRG project document, there were about 143 farmers involved in maize FRG in these districts. Table 1 presents the number of farmers by sex from each implementing centers.

A random total sample size of 180 was identified for the study. Seventy two participant households with sampling proportion of 50% (72 farmers out of 143) were selected randomly using

**Table 1.** Sample size by peasant associations.

| Districts | Peasant associations | No. of FRG participants | Farmers interviewed | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | FRG participants | | Non-FRG participants | | Total | |
| | | | N | % | N | % | N | % |
| ATJK | Anano shisho | 67 | 34 | 47 | - | - | 34 | 18 |
| | Desta abijata | - | - | - | 51 | 47 | 51 | 28 |
| | Sub total | *67* | *34* | *47* | *51* | *47* | *85* | *48* |
| Boset | Dongore furda | 40 | 20 | 28 | - | - | 20 | 11 |
| | Dongore tiyo | 36 | 18 | 25 | - | - | 18 | 10 |
| | Hurufa kurkufa | - | - | - | 57 | 53 | 57 | 32 |
| | Sub total | *76* | *38* | *53* | *57* | *53* | *95* | *53* |
| | Grand total | 143 | 72 | 100 | 108 | 100 | 180 | 101* |

*, Results do not add up to 100 because of rounding.

probability proportionate to sample size technique. A second random sample of 108 farmers was drawn from the population of nonparticipating maize growers living in the same district where the FRG project took place from a purposively selected *Kebeles*[1]. In doing so these *Kebeles* were purposively identified using agro-ecological criteria to provide representation of maize dominating cropping system. There were also two other reasons: there has to be a substantial difference in terms of distance so that information exchange between FRG participant (treatment group) and non-FRG participant (control group) is minimized and the selected *Kebeles* should be accessible. Then, a list of households in each *Kebeles* was drawn up and maize producers were identified. For this purpose, the survey team constructed lists of nonparticipating maize farmers for the given locality in consultation with Development Agents (DAs) of the selected peasant associations, supervisors and village elders. As the interest was in maize producers, only farmers producing maize included in the sampling frame and households were randomly sampled.

### Sources of data and methods of data collection

Cross-sectional data was collected from the sample households by administering interview schedule. The interview schedule was pretested by administering it to selected respondents which we excluded from the sample frame during sampling. On the basis of the results obtained from the pre-test, necessary modification was made on the interview schedule. Both sampled FRG and non-FRG farmers in the selected enumeration area were visited and interviewed using the same scheduled interviews and data collection done from December, 2009 to January, 2010.

### Analytical methodology

In the more general extension literature, extension impacts per se are very difficult to show, especially in terms of dealing with attribution issues and linking cause and effect quantitatively (Purcell and Anderson, 1997 cited in Davis et al., 2010). Many infrastructural variables and other factors affect agricultural performance in complex and contradictory ways, and benefits are difficult to quantify (Anderson, 2007). Impact studies basically face three interrelated challenges: (a) Establishing a viable counterfactual (the predicted outcome in the absence of the intervention, that is, what would have happened to the participants had they not participated in the FRG; (b) Attributing the impact to an intervention; and (c) Coping with long and unpredictable lag times (Alston and Pardey, 2001; Salter and Martin, 2001 quoted in Davis et al., 2010). Other issues that may confound studies include endogeneity in program placement and extension–farmer interactions, farmer-to-farmer information flow, selection bias, and policies that affect various measures. Very few studies use an experimental design, and some studies that have used control groups have run into design problems (Davis et al., 2010).

Two common sources of bias are program placement or targeting bias, in which the location or target population of the program is not random, and self-selection bias, in which households choose whether or not to participate, and thus may be different in their experiences, endowments, and abilities.

The most accepted method to address the previously mentioned biases is to use an experimental approach to construct an estimate of the counterfactual situation by randomly assigning households to treatment (participant) and control (nonparticipant) groups. Random assignment ensures that both groups are statistically similar (that is, drawn from the same distribution) in both observable and unobservable characteristics, thus avoiding program placement and self-selection biases. Such an approach is not feasible in demand-driven programs in which participants make their own decisions of whether to participate and about the kind of activities to do in the

learning process. Likewise, random assignment also conflicts with the nature of community-driven development programs like FRG.

To address the problems of showing impact, several quasi-experimental methods have been developed to net out the impacts of other factors. These include; double difference or difference-in-difference (DID), reflexive comparison and propensity score matching (PSM). A common approach is the use of PSM method. Thus, using a cross sectional household survey for this study, we isolate the causal effect of participating in FRG on the outcome variables by using PSM method.

### Propensity score matching method

Several matching methods have been developed to estimate causal treatment effects. A commonly used matching method is propensity score matching (PSM). It applies for all situations where one has a treatment, a group of treated individuals and a group of untreated individuals (Caliendo and kopeinig, 2008). The impact of FRG intervention on household's given outcome is the difference in households' mean outcome with the program and without the

[1] The smallest administrative structure next to Woreda

program. However, households participating in the program cannot be simultaneously observed in two states. A household can either be in the program or outside the program. Thus, the fundamental problem of such an impact evaluation is a missing data problem. In other words, we are interested in answering the research question "what would have been the productivity and income outcomes of participating households if FRG was not in place?" Hence, this study applies a propensity score matching technique, which is a widely applied impact evaluation instrument in the absence of baseline survey data for impact evaluation.

The preference of PSM over the other conventional regression methods lies in its unique characteristics in which it compares outcome for observations who share similar observable characteristics[2] and only compares households lay in the common support region and excluded others from the analysis.

This study attempts to estimate the average impact of treatment on treated (ATT). According to Bryson et al. (2002), ATT refers to mean impact[3] of the program on individuals who actually participated. In this study "treatment" implies participation in the program (in FRG). In employing PSM method in assessing treatment effect, according to Caliendo and Kopeinig (2008), there are procedures to be followed. These are estimation of the propensity scores, choosing a matching algorism, checking overlap/common support condition and testing the matching quality/effect estimation.

**Propensity score estimation procedure**

The first step in PSM method is to estimate the propensity scores. As described by Rosenbaum and Rubin (1983), matching can be performed conditioning on P(X) alone rather than on X, where P(X) = Prob(D=1|X) is the probability of participating in the program conditional on X. If outcomes without the intervention are independent of participation given X, then they are also independent of participation given P(X). This reduces a multidimensional matching problem to a single dimensional problem (ibid.).

A logit model was used to estimate propensity scores using a composite of pre-intervention characteristics of the sampled households (Rosenbaum and Robin, 1983) and matching was then performed using propensity scores of each observation. In estimating the logit model, the dependent variable was participation, which takes the value of 1 if a household participated in the program and 0 otherwise. The mathematical formulation of logit model is as follows:

$$P_i = \frac{e^{Z_i}}{} \quad (1)$$

Where, $P_i$ is the probability of participation.

$$Z_i = a_0 + \sum_{i=1}^{n} a_i X_i + U_i \quad (2)$$

Where, $i$ = 1, 2, 3, - --, $n$; $a_0$ = intercept; $a_i$ = regression coefficients to be estimated; $X_i$ = pre-intervention characteristics, and $U_i$ = a disturbance term, and the probability that a household belongs to non participant is:

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \quad (3)$$

According to matching theory (Rosenbaum and Robin, 1983; Jalan and Ravallion, 2003; Bryson et al., 2002), the logit model via which the propensity score is generated should include predictor variables that influence the selection procedure or participation in the program and the outcome of interest. Several factors guide selection of predictor variables. In the present study, explanatory variables of the logit model were identified using findings of previous related empirical studies, FRG targeting criteria, and own field observation. We included as many explanatory variables as possible to minimize the problem of unobservable characteristics in our evaluation of the impact of the program.

**Matching estimators**

After estimation of the propensity scores, seeking an appropriate matching estimator is the major task of a program evaluator. There are different matching estimators in theory. The most common once are NN, Caliper and Kernel matching[4].

[2] PSM technique has attracted attention of social program evaluators since the last fifteen years (see for e.g., Jalan and Ravallion, 2003; Dehejia and Wahba, 1999). The PSM technique enables us to extract from the sample of non-participating households a set of matching households that look like the participating households in all relevant pre-intervention characteristics. In other words, PSM matches each participant household with a non-participant household that has (almost) the same likelihood of participating into the program.

[3] "Impact" is meant for the change in production and income using productivity and income level as an outcome indicator. On the other hand, "control" stands for non-participant/non-treated households used for comparison.

[4] **Nearest Neighbour (NN) Matching**: according to Caliendo (2008), the most straightforward matching estimator is Nearest Neighbour. The individual from the comparison group is chosen as a matching partner for a treated individual that is closest in terms of the propensity score. NN matching can be done with or without replacement options. In the case of the NN matching with replacement, a comparison individual can be matched to more than one treatment individuals, which would result in increased quality of matches and decreased precision of estimates. On the other hand, in the case of NN matching without replacement, a comparison individual can be used only once. Matching without replacement increases bias but it could improve the precision of the estimates. In cases where the treatment and comparison units are very different, finding a satisfactory match by matching without replacement can be very problematic (Dehejia and Wahba, 2002). It means that by matching without replacement, when there are few comparison units similar to the treated units, we may be forced to match treated units to comparison units that are quite different in terms of the estimated propensity score.

**Caliper Matching**: NN matching faces the risk of bad matches if the closest neighbor is far away (Caliendo, 2008). To avoid this problem researchers use the second alternative matching algorism called caliper matching by imposing a tolerance level on the maximum propensity score distance(caliper). Caliper matching means that an individual from the comparison group is chosen as a matching partner for a treated individual that lies within a given caliper (propensity score range) and is closest in terms of propensity score (Kopeinig, 2005). If the dimension of the neighborhood is set to be very small, it is possible that some treated units are not matched because the neighborhood does not contain a control unit. On the other hand, the smaller the size of the neighborhood the better is the quality of the matches (Becker and Ichino, 2002). One possible drawback in caliper matching as Smith and Todd (2005) cited in Caliendo (2008) indicated is that it is difficult to know a *priori* what choice for the tolerance level is reasonable.

**Kernel Matching**: the matching algorisms discussed so far have in common that only a few observations from the comparison group are used to construct the counterfactual outcome of a treated individual. Kernel matching is nonparametric matching estimator that use weighted averages of (nearly) all individuals in the control group to construct the counter factual outcome. Accordingly, all treated units are matched with a weighted average of all controls with weights which are inversely proportional to the distance between the propensity scores of treated and controls (Becker and Ichino 2002; Venetoklis, 2004). Kernel weights the contribution of each comparison group member so that more importance is attached to those comparators providing a better match. The difference from caliper matching, however, is that those who are included are weighted according to their proximity with respect to the

Generally, the choice of a given matching estimator depends on the nature of the available dataset (Bryson et al., 2002). In other words, it should be clear that there is no `winner' for all situations and that the choice of a matching estimator crucially depends on the situation at hand. The choice of a specific method depends on the data in question, and in particular on the degree of overlap between the treatment and comparison groups in terms of the propensity score. When there is substantial overlap in the distribution of the propensity score between the comparison and treatment groups, most of the matching algorithms will yield similar results. In case there are only a few control observations, it makes no sense to match without replacement. On the other hand, if there are a lot of comparable untreated individuals it might be worth using more than one nearest neighbor to gain more precision in estimates (Caliendo and Kopeinig, 2005).

**Overlap and common support condition**

As ATT is only defined in the region of common support; Heckman et al. (1997) quoted in Caliendo and Kopeinig (2008) point out that a violation of the common support condition is a measure of evaluation bias as conventionally measured. Comparing the incomparable must be avoided, that is, only the subset of the comparison group that is comparable to the treatment group should be used in the analysis. Hence, an important step is to check the overlap and the region of common support between treatment and comparison group.

Imposing a common support condition ensures that any combination of characteristics observed in the treatment group can also be observed among the control group (Bryson et al., 2002). The common support region is the area which contains the minimum and maximum propensity scores of treatment and control group households, respectively. It requires deleting of all observations whose propensity scores is smaller than the minimum and larger than the maximum of treatment and control, respectively (Caliendo and Kopeinig, 2005).

**Assessing the matching quality**

According to Caliendo (2008), matching quality has to be checked if the matching procedure is able to balance the distribution of the relevant variables in both the control and treatment group, since we do not condition on all covariates but on the propensity score. To do this, several procedures used in the literature includes standard bias, t-test, joint significance and pseudo-$R^2$ and stratification test. The basic idea of all approaches is to compare the situation before and after matching and check if there any differences after conditioning on the propensity score.

The primary purpose of the PSM is that it serves as a balancing method for covariates between the two groups since differences in covariates are expected before matching and should be avoided after matching. Consequently, the idea behind balancing tests is to check whether the propensity score is adequately balanced. In other words, a balancing test seeks to examine if at each value of the propensity score, a given characteristic has the same distribution for the treatment and comparison groups. The propensity scores themselves serve only as devices to balance the observed distribution of covariates between the treated and comparison groups. The success of propensity score estimation is therefore assessed by the resultant balance rather than by the fit of the models used to create the estimated propensity scores (Lee, 2006).

Finally, using predicted probabilities of participation in the program (that is, propensity score) match pairs are constructed using alternative methods of matching estimators. Then the impact estimation is the difference between simple mean of outcome variable of interest for participant and non participant households. In our case, the mean stands for household productivity and income. The difference involvement in FRG between treatment and matched control households is then computed. The ATT is obtained by averaging these differences in FRG outcomes ($Y_i$) across the $k$ matched pairs of households as follows:

$$ATT = \sum_{j=1}^{P} \left( Y_{ij1} - \sum_{i=1}^{NP} Y_{ij0} \right) / P \quad (4)$$

Where, $ATT$ is productivity and income, $Y_{ij1}$ is the post intervention productivity and income of household $j$, $Y_{ij0}$ is the productivity and income of household of the $i^{th}$ non-participant matched to the $j^{th}$ participant, $NP$ is the total number of non-participants and $P$ is the total number of participants. A positive (negative) value of ATT suggests that households who have participated in FRG have higher (lower) of outcome variable $Y_i$ non-participants.

**Sensitivity analysis**

It should be clear that matching estimators are not robust against 'hidden biases due to un observable characteristics, selection bias. Different researchers become increasingly aware that it is important to test the robustness of results to departures from the identifying assumption. Since it is not possible to estimate the magnitude of selection bias with non-experimental data, the problem can be addressed by sensitivity analysis.

Rosenbaum and Robin (1983) proposed using Rosenbaum bounding approach in order to check the sensitivity of the estimated ATT with respect to deviation from the Conditional Independence Assumption (CIA). The basic question to be answered here is whether inference about treatment effects may be altered by unobserved factors. In other words, one wants to determine how strongly an unmeasured variable must influence the selection process in order to undermine the implications of matching analysis. Rosenbaum bounds provide evidence on the degree to which any significance results hinge on this untestable assumption. If the results turn out to be sensitive, the evaluator might have to think about the validity of his identifying assumption and consider other estimation strategies.

**Variable choice and its definitions**

***Choice and definition of explanatory variables***

There are no general rules for which variables to include in the model (Anderson et al., 2009). However, Bryson et al. *(*2002) suggest that, economic theory and knowledge about previous research and also information about the institutional settings should guide the researcher to know which observables (explanatory variables) affect both participation and the outcomes of interest[5].

propensity score. The most common approach is to use the normal distribution (with a mean of zero) as a kernel, where the weight attached to a particular comparator is proportional to the frequency of the distribution for the difference in scores observed (Bryson et al., 2002). According to Caliendo (2008), a drawback of this method is that possibly bad matches are used as the estimator includes comparator observations for all treatment observation. Hence, the proper imposition of the common support condition is of major importance for kernel matching method. A practical objection to its use is that it will often not be obvious how to set the tolerance. However, according to Mendola (2007) kernel matching with 0.25 band width is most commonly used.

[5] In the estimation of the propensity score, we are not interested in the effects of covariates on the propensity score because the purpose of our work is to

Accordingly, different socioeconomic, demographic, institutional and location factors were identified as shown in Table 2.

***Choice, indicators and measurements of the outcome variables***

Impact on crop productivity: Crop productivity is defined as the value of production per unit area (Davis et al., 2010). This is one of the outcome variables for which this study intends to measure. It is expected that FRG interventions will improves the productivity of commodity of intervention. The effect of FRG interventions on the commodity of intervention is measured in yield per unit of area (quintal/ha) increase.

**Impact on household net income**: Household net income is also one of the outcome variables as a result of the household's participation in FRG which is measured in Birr. Household net income is calculated as the difference between the total revenue generated from sale of commodity of intervention (maize) and total cost incurred by households for the production of this particular commodity of intervention (Davis et al., 2010).

Before estimating the models, it was necessary to check if multicollinearity exists among the explanatory variables. The existence of strong multicollinearity seriously affects the parameter estimates of the regression models, it is necessary to check it's occurrence among the explanatory variables. Accordingly, Variance Inflation Factor (VIF) technique was employed to detect the problem of multicollinearity for the variables (Gujarati, 2004). It was calculated as:

$$VIF(X_j) = \frac{1}{1 - R_j^2} \quad (5)$$

Where $R_j^2$ is the squared multiple correlation coefficient between and other explanatory variables. Each selected variable is regressed on all the other variables, the coefficient of determination ($R_j^2$) being constructed in each case. If a strong linear relationship exists among the explanatory variables then this would result in large VIF value. The larger value of VIF ($X_j$), the more troublesome, as a rule of thumb, if the VIF of a variable exceeds 10 (this will happen if $R_i^2$ exceeds 0.95), that variable is said to be highly collinear (Gujarati, 1995), and is used as a signal for the existence of a severe multicollinearity among explanatory variables. In the same way, for dummy variables contingency coefficient test were employed using the following formula:

$$= \sqrt{\frac{X^2}{n+X^2}} \quad (6)$$

Where, *C* is coefficient of contingency, $x^2$ is chi-square test and *n* is total sample size. For dummy variables if the value of contingency coefficients is greater than 0.75 the variable is said to be collinear. Another problem in regression analysis is the problem of heteroscedasticity in the data and this was detected by using Breusch-Pagen test (hettest) in STATA.

To analyze the data, the estimation was run by employing propensity score matching algorism with STATA 10.0 Software using the STATA code written by Leuven and Sianesi (2003).

## RESULTS AND DISCUSSION

The effects of FRG on maize crop productivity, market surplus, and agricultural income (income from maize by households) using the analytical methods explained earlier was examined here. In doing so the important steps followed to arrive at the impact of the program was also described here. It explains the estimation of propensity scores, matching methods, common support region, balancing test and treatment effect.

### Propensity scores

The results of the logistic regression model which was used to estimate propensity scores for matching program households with non-program households was presented here. The dependent variable in this model is a binary variable indicating whether the household was a participant in the program. In the estimation data from the two groups; namely, program and nonprogram households were pooled such that the dependent variable takes a value 1 if the household was participant and 0 otherwise. Before proceeding to impact estimation, Variance Inflation Factor (VIF) was applied to test for the presence of strong multicollinearity problem among the continuous explanatory variables. Moreover, by using contingence coefficients (C) multicollinerty between discrete variables were checked.

There were no explanatory variables dropped from the estimation model since no serious problem of multicollinearity was detected from the VIF results. Similarly, heteroscedasticity was tested by using Breusch-Pagen test. This test resulted in the existence of heteroscedasticity problem as it is significant at 5% probability level (p = 0.0294) suggesting the need for standard error robust. Hence, robust standard error was conducted accordingly.

Table 3 shows the estimation results of the logit model. The estimated model appears to perform well for our intended matching exercise. The pseudo-$R^2$ value is 0.3075. According to Pradhan and Rawlings (2002), a low $R^2$ value shows that the allocation of the program has been de facto random. In other words, a low $R^2$ value means that program households do not have much distinct characteristics over all and as such finding a good match between program and non-program households becomes easier. The pseudo-$R^2$ indicates how well the regressors explain the participation probability. After matching there should be no systematic differences in the distribution of covariates between both groups and therefore, the pseudo- *R*2 should be fairly low (Caliendo

assess the impact of FRG interventions on outcome variables. However, the choice of covariates to be included in the first step (propensity score estimation) is an issue. Heckman et al. (1997) and Dehejia and Wahba (1999) cited in Caliendo (2008) argue that omitting important variables can increase the bias in the resulting estimation. Only variables that influence simultaneously the participation decision and outcome variable should be included. Accordingly, variables that determine households' decision to participate in FRG could also affect the outcome variable mentioned above. Here, pre-intervention characteristics, which bring variation in outcomes of interest among program participants and non-participants, were used. In other word, variables which are not affected by being participate in the program or not or those explanatory variables which are fixed throughout are assumed to be used as explanatory variables.

**Table 2.** Type, definitions and measurement of variables.

| Variable | Types and definition | Measurements |
|---|---|---|
| **Dependent variables** | | |
| Treatment | Dummy, participation in FRG maize | 1 if yes,0 otherwise |
| **Covariates** | | |
| AGEHH | Continuous, age of the household head | in years |
| EDULHH | Dummy, education level of household head | 1 if literate, 0 otherwise |
| FAMSIZE | Continuous, total family size of the household | number of household |
| FAREXP | Continuous, farming experience of household head | in years |
| TLOWN | Continuous, total land owned | in hectare |
| TLU | Continuous, livestock holding size | tropical livestock unit |
| DISNMKT | Continuous, distance to the nearest market | in kilometers |
| DISEXTO | Continuous, distance to extension office | in kilometers |
| DPCRTO | Continuous, dependency ratio | number of dependents in the household |

Source: Own definitions.

**Table 3.** Logit estimation results of household program participation.

| Covariates | Coefficients | Robust Std. Err. | Z |
|---|---|---|---|
| AGEHH | -0.0567592 | 0.0397389 | -1.43 |
| EDULHH | -0.2737916 | 0.4495109 | -0.61 |
| FAREXP | 0.0294119 | 0.0412445 | 0.71 |
| FAMSIZE | -0.0445323 | 0.0684756 | -0.65 |
| DPCRTO | -0.1228543 | 0.3757797 | -0.33 |
| TLU | 0.0467609 | 0.0166224 | 2.81*** |
| TLDOWN | 0.6372433 | 0.1940986 | 3.28*** |
| DISEXTO | -2.300553 | 0.49666 | -4.63*** |
| DISNMKT | 0.0250949 | 0.2235155 | 0.11 |
| _cons | 1.010433 | 1.247629 | 0.81 |
| N | 178 | | |
| Wald $chi^2(9)$ | 43.21 | | |
| Prob > $chi^2$ | 0.000 | | |
| Log pseudo likelihood | -83.176653 | | |
| Pseudo R2 | 0.3075 | | |

Source: Own estimation result. ***, Significant at the 1% probability level.

and Kopeinig, 2005).

The logit estimation results, when looked into the estimated coefficients (Table 3), indicate that program participation is significantly influenced by three explanatory variables. Sizes of livestock ownership (in TLU), size of land ownership and distance from the nearest extension office are significant variables which affect the participation of the household to the program. Size of livestock ownership and land holding are found to have strong and positive relationship with household participation in the program. This means households with more size of livestock ownership and land holding are more likely to be included in the program. In the contrary, distance from the nearest extension office has strong and negative effect on the household participation suggesting that households leaving relatively far away from extension office have less likely to participate in the program.

Figure 1 portrays the distribution of the household with respect to the estimated propensity scores. In case of treatment households, most of them are found in partly the middle and partly in the right side of the distribution. On the other hand, most of the control households are partly found in the center and partly in the left side of the distribution.

## Matching program and non-program households

Three main tasks were accomplished here before

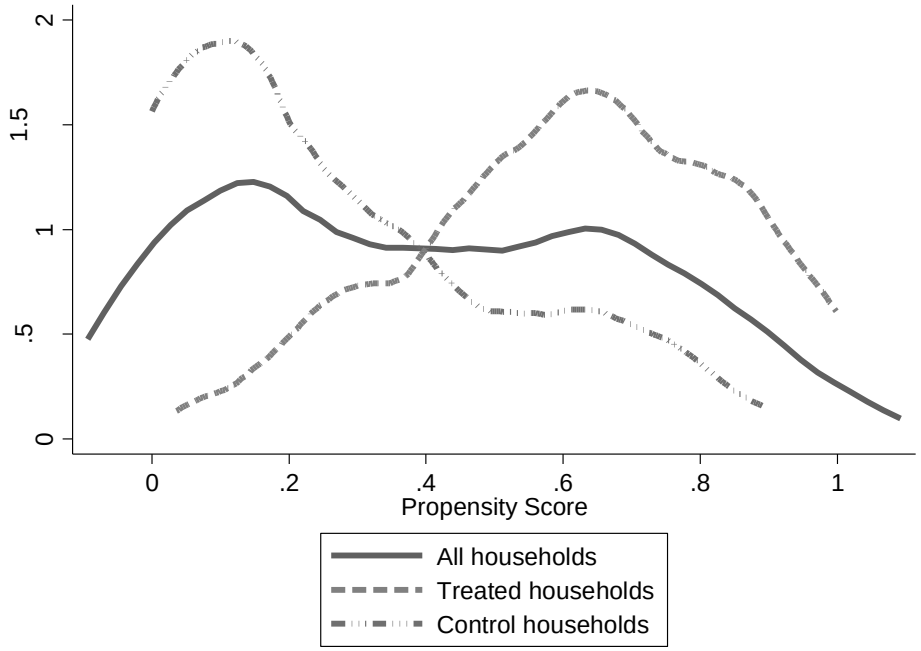


**Figure 1.** Kernel density of propensity scores

**Table 4.** Distribution of estimated propensity scores.

| Group | Obs. | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| Total households | 178 | 0.4045 | 0.2931 | 1.22e-06 | 0.9982 |
| Treated households | 72 | 0.6143 | 0.2286 | 0.0357 | 0.9982 |
| Control households | 106 | 0.2620 | 0.2426 | 1.22e-06 | 0.8899 |

Source: Own estimation result.

conducting the matching estimator. First, predicted values of program participation (propensity scores) was estimated for all households in the program and outside the program. Second, a common support condition was imposed on the propensity score distributions of household with and without the program. Then, thirdly, observations whose predicted propensity scores fall outside the range of the common support region was discarded. As shown in Table 4, the estimated propensity scores vary between 0.0357 and 0.9982 (mean = 0.6143) for program or treatment households and between 1.22E-06 and 0.8899 (mean = 0.262) for nonprogram (control) households. The common support region would then lie between 0.0357 and 0.8899. In other words, households whose estimated propensity score is less than 0.0357 and larger than 0.8899 are not considered for the matching exercise. As a result of this restriction, 31 households (10 program and 21 control households) were discarded and not used in computing the impact estimator.

As it can be observed from Figures 2 and 3, the distribution of estimated propensity scores, with and without the imposition of the common support condition, is around and less than 0.5 for program and non-program households, respectively.

## Choice of matching algorism

Alternative matching estimators were tried in matching the treatment program and control households in the common support region. The final choice of a matching estimator was guided by different criteria such as equal means test referred to as the balancing test (Dehejia and Wahba, 2002), pseudo-$R^2$ and matched sample size. Specifically, a matching estimator which balances all explanatory variables (that is, results in insignificant mean differences between the two groups), bears a low $R^2$ value and also results in large matched sample size is preferable.

Table 5 presents the estimated results of tests of matching quality based on the above mentioned

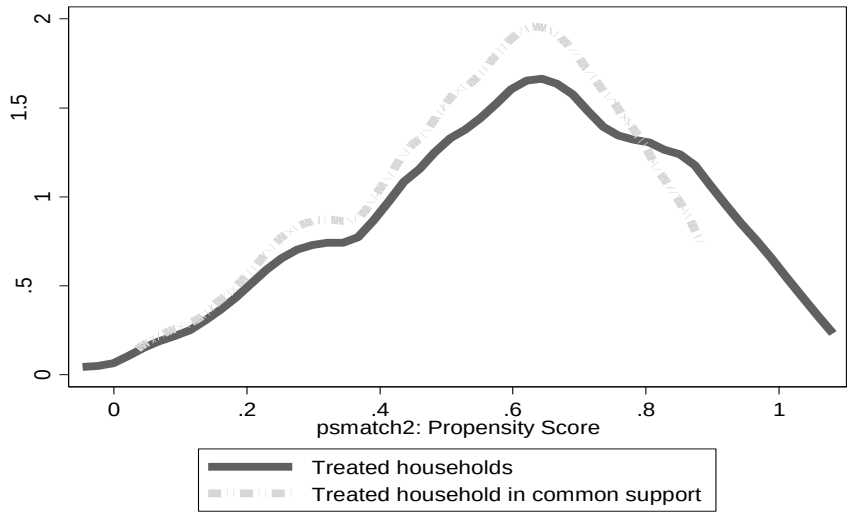


**Figure 2.** Kernel density of propensity scores of program households.

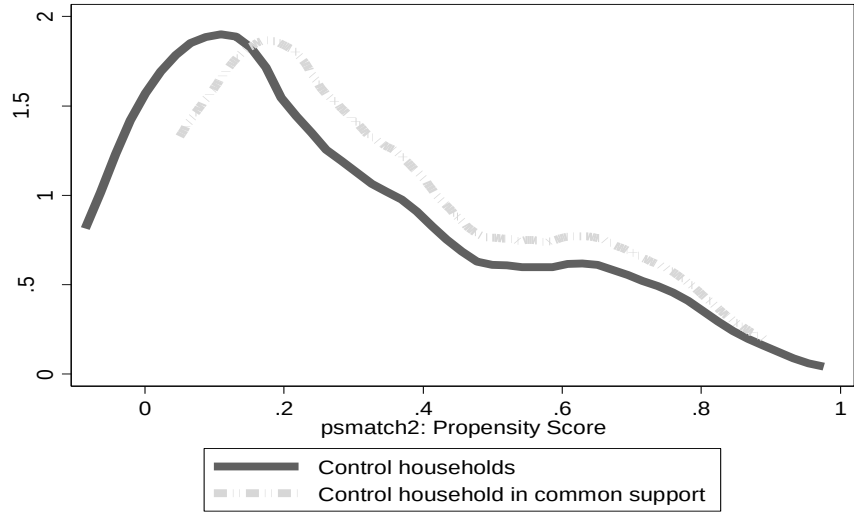


**Figure 3.** Kernel density of propensity scores of non-program households.

performance criteria. After looking into the results, it has been found that kernel matching with a band width of 0.1 is the best estimator for the data we have. As such, in what follows estimation results and discussion are the direct outcomes of the kernel matching algorithm based on a band width of 0.1.

## Testing the balance of propensity score and covariates

Table 6 shows the balancing test of covariates, before and after the matching. As the table indicates, program and non-program households were significantly different in terms of certain pre-intervention characteristics. However, these differences were removed after the matching was conducted.

The low pseudo-$R^2$ and the insignificant likelihood ratio tests support the hypothesis that both groups have the same distribution in covariates X after matching (Table 7). These results clearly show that the matching procedure is able to balance the characteristics in the treated and the matched comparison groups. We, therefore, used these results to evaluate the effect of FRG intervention among groups of households having similar observed characteristics. This allowed us to compare observed outcomes for participants with those of a comparison groups sharing a common support. The details of other Chi-square tests for joint significance for the three different matching algorithms are presented

**Table 5.** Performance of matching estimators.

| Matching estimator | Performance criteria | | |
|---|---|---|---|
| | Balancing test* | Pseudo-$R^2$ | Matched sample size |
| **NN** | | | |
| NN(1) | 9 | 0.007 | 147 |
| NN(2) | 9 | 0.007 | 147 |
| NN(3) | 9 | 0.007 | 147 |
| NN(4) | 9 | 0.007 | 147 |
| NN(5) | 9 | 0.007 | 147 |
| **Caliper** | | | |
| 0.01 | 9 | 0.033 | 85 |
| 0.25 | 9 | 0.015 | 147 |
| 0.50 | 8 | 0.099 | 147 |
| **Kernel** | | | |
| Band width of 0.1 | 9 | 0.004 | 147 |
| Band width of 0.25 | 9 | 0.009 | 147 |
| Band width of 0.5 | 9 | 0.047 | 147 |

Source: Own estimation result. *Number of explanatory variables with no statistically significant mean differences between the matched groups of program and non-program households.

**Table 6.** Propensity score and covariate balance.

| Variable | Before matching (178) | | | After matching (147) | | |
|---|---|---|---|---|---|---|
| | Treatment (N=72) | Control (N= 106) | T-value | Treatment (N=62) | Control (N=85) | T-value |
| AGEHH | 40.972 | 39.858 | 0.65 | 39.790 | 39.701 | 0.05 |
| EDULHH | 0.653 | 0.632 | 0.27 | 0.694 | 0.670 | 0.28 |
| FAREXP | 25.194 | 22.377 | 1.77* | 24.000 | 24.053 | -0.03 |
| FAMSIZE | 8.264 | 6.991 | 2.46** | 8.032 | 8.112 | -0.12 |
| DPCRTO | 0.696 | 0.724 | -0.24 | 0.736 | 0.775 | -0.22 |
| TLU | 19.678 | 12.914 | 3.32*** | 16.680 | 16.221 | 0.21 |
| TLDOWN | 2.948 | 1.939 | 5.1*** | 2.545 | 2.566 | -0.11 |
| DISEXTO | 0.416 | 1.095 | -5.9*** | 0.428 | 0.437 | -0.14 |
| DISNMKT | 0.872 | 1.553 | -4.31*** | 0.880 | 0.838 | 0.28 |

Source: Own estimation result. ***, ** and*, Significant at 1, 5 and 10% probability levels, respectively.

**Table 7.** Chi-square test for the joint significance of variables.

| Sample | Pseudo $R^2$ | LR $chi^2$ | p>$chi^2$ |
|---|---|---|---|
| Unmatched | 0.308 | 74.07 | 0.000 |
| Matched | 0.004 | 0.67 | 1.000 |

Source: Own estimation result.

under Appendix 1.

All of the above tests suggest that the matching algorithm we have chosen is relatively the best one with the data we have at hand. Therefore, we can proceed to estimate ATT for households' in order to answer the second objective of this study.

**Impacts of FRG on various outcomes**

Here, the study provides evidence as to whether or not the FRG has brought significant changes on household productivity and income from the commodity of intervention. The estimation result presented in Table 8

**Table 8.** ATT for productivity commodity of intervention.

| Outcome variable of interest | Treated | Controls | Difference | S.E. | T-value |
|---|---|---|---|---|---|
| Household maize productivity(quintal/ha) | 25.5 | 16.3 | 9.2 | 2.9 | 3.13*** |

***, Significant at 1% probability level.

**Table 9.** ATT for proportion of produce sold for commodity of intervention.

| Outcome variable of interest | Treated | Controls | Difference | S.E. | T-value |
|---|---|---|---|---|---|
| Household market surplus(qtls) | 31.55 | 19.97 | 11.58 | 6.85 | 1.69* |

*, Significant at 10% probability level.

**Table 10.** ATT for household's gross income and net income.

| Outcome variable of interest | Treated | Controls | Difference | S.E. | T-value |
|---|---|---|---|---|---|
| Households' gross income | 20015.92 | 14103.64 | 5912.28 | 3358.95 | 1.76* |
| Net income(birr) | 11883.33 | 8220.93 | 3662.40 | 2627.21 | 1.39 |

*, Significant at 10% probability level.

provides a supportive evidence of statistically significant effect of the program on household maize productivity, market surplus and gross income measured in quintals per hectare, portion of yield marketed in quintal and Birr respectively. However, the result showed that there is positive and insignificant difference between program participant and nonparticipant in terms of net income generated from the sale of increased maize produce.

After controlling for pre-intervention differences in demographic, location, institutional and asset endowment characteristics of the FRG and non-FRG households, it has been found that, on average, the program has increased maize productivity of the participating households by 9.2 quintals or by 36% (Table 8). The result is consistent with several other studies showing positive effects of similar interventions on crop productivity (Davis et al., 2010; Gockowski et al., 2006).

Our findings in Table 9 indicate that the proportion of maize sale is high for treated (31.1quintals) as compared to their counterparts (19.97quintals). In other words when the difference is tested, it is statistically significant at 10% probability level.

Similarly the result of our impact estimation proved that the project has succeeded in increasing the participant household's gross income by 5912.28 birr (Table 10). However, the empirical analysis for the net income from the sale of maize indicates that the difference between the two groups does not yield statistically significant effect (P>0.1). In other words when the total variable cost is deducted from this gross income, the result became positive but statistically insignificant. This could be attributed to the high cost of input by the program participants due to the inefficient input delivery system which involves high transaction costs and the nonexistent of concurrent market interventions for the produce in line with the commodity improvement intervention by the project that could help to achieve the ultimate objectives of the program-improved household income.

Table 11 shows the result of sensitivity of FRG intervention effects on different outcome variables in order to control for unobservable biases. The first row presents the critical level of $e^{\gamma}$, at which the causal inference of significant FRG intervention effect has to be questioned. As noted by Hujer et al. (2004), sensitivity analysis for insignificant effects is not meaningful and is therefore not considered here. Given that the estimated FRG intervention is positive for the significant outcomes, the lower bounds under the assumption that the true treatment effect has been underestimated were less interesting (Becker and Caliendo, 2007) and therefore not reported in this study. Rosenbaum bounds were calculated for FRG intervention effects that are positive and significantly different from zero. The first column of the table shows those outcome variables which bears statistical difference between treated and control households in our impact estimate above. The rest of the values which corresponds to each row of the significant outcome variables are p-critical values (or the upper bound of Wilcoxon significance level -Sig$^{+}$) at different critical value of $e^{\gamma}$.

Result show that the inference for the effect of FRG intervention is not changing though the participants and non participant households has been allowed to differ in their odds of being treated up to 200% ($e^{\gamma} = 3$) in terms of unobserved covariates. That means for all outcome

**Table 11.** The result of sensitivity of FRG intervention effects on different outcome variables.

| No. | Outcome variables | $e^{\gamma}=1$ | $e^{\gamma}=1.25$ | $e^{\gamma}=1.5$ | $e^{\gamma}=1.75$ | $e^{\gamma}=2$ | $e^{\gamma}=2.25$ | $e^{\gamma}=2.5$ | $e^{\gamma}=2.75$ | $e^{\gamma}=3$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Households' maize productivity | 0 | 0 | 0 | 0 | 1.1e-16 | 4.4e-15 | 9.4e-14 | 1.2e-12 | 9.3e-12 |
| 2 | Households' market surplus | 0 | 0 | 0 | 0 | 2.6e-15 | 8.1e-14 | 1.3e-12 | 1.3e-11 | 8.4e-11 |
| 3 | Households' gross income | 0 | 0 | 0 | 0 | 1.1e-16 | 4.4e-15 | 9. 5e-14 | 1.2e-12 | 9.4e-14 |

Source: Own estimation. $e^{\gamma}$ = (Gamma)=log odds of differential due to unobserved factors where Wilcoxon significance level for each significant outcome variable is calculated.

variables estimated, at various levels of critical value of $e^{\gamma}$, the p- critical values are significant which further indicate that we have considered important covariates that affected both participation and outcome variables. We could not get the critical value $e^{\gamma}$ where the estimated ATT is questioned even if we have set $e^{\gamma}$ largely up to 3. Thus, it can be concluded that impact estimates (ATT) of this study are insensitive to unobserved selection bias and are a pure effect of FRG intervention.

## CONCLUSIONS AND POLICY IMPLICATIONS

This study provides crucial insights into and important evidence on the impact of Farmer Research Group (FRG) implemented in the Central Rifty Valley of Oromia on the maize FRG farmers using cross sectional data collected for the same purpose. Using matching estimator (propensity score matching), the study evaluated the FRG program.

The result revealed that, as expected, participation in the program was determined by a combination of factors. Program participation is significantly influenced by three explanatory variables. Sizes of livestock ownership (in TLU), size of land ownership and distance from the nearest extension office are the significant variables which affect the participation of the household in the program. Households with more size of livestock ownership and land holding are more likely to be included in the program. By contrast, distance from the nearest extension office has strong and negative effect on the household participation suggesting that households leaving relatively far away from extension office are less likely to participate in the program[6].

After controlling for such characteristics, the empirical findings revealed that FRG had the largest impact on crop productivity. Significantly raising maize productivity of participating households in the study area. More particularly, the program increased participating households' productivity on average by 9.2 quintals per hectare. Which is in fact 36% more than what they would have produced in the absence of the program. The impact of the project on the proportion of produce sold to the market is also significant. Treated households sold significantly large proportion of their produce compared to their counterparts. However, when the gain is converted in to monetary value, after the total variable cost is deducted in order to see the net income, the estimated result revealed that the result became positive but insignificant. This could be attributed to the high cost of input due to inefficient input delivery system which involves high transaction costs and the nonexistent of concurrent market interventions for the program participants' produce in line with the commodity improvement intervention by the project that could help to achieve the ultimate objectives of the program-improved household income. In conclusion, the results of this study tell us that it is misleading looking only in to the productivity as indicators for program performance.

FRGs as participatory approaches are important research and development efforts to improve livelihoods of farmers if implemented properly. Based on the empirical findings reported in this study, the following policy recommendations are forwarded: As it can be observed from the empirical results, this study has found evidence that FRG in the study area has worked in significantly increasing household productivity. This sends an encouraging signal for program designers, implementers, and funding agencies. On the other hand, further improvement in the households' productivity and income from similar interventions could be enhanced for better

[6] Finding a reliable estimate of the program impact thus necessitates controlling for all such factors adequately. In doing so, propensity score matching has resulted in 62 program households to be matched with 85 non-program households. In other words, a matched comparison of different outcome variables of interest was performed on these households who shared similar pre-intervention characteristics except the program intervention. The resulting matches passed a variety of matching quality tests and were fit for answering the study's main objective.

livelihoods outcome by taking the following policy measures.

First, adopting interventions that follow a value chain approach is very important so that the program will be more comprehensive in bringing significant change not only in the production but also in the subsequent livelihood outcomes. Therefore, under this recommendation the following points were found crucially important but missed in the current program under study:

1. Effective and efficient input delivery mechanisms should be combined with productivity and income improvement programs. This can be possible through the use of the same approach (farmers group) so that access to input services can be enhanced. Furthermore, cost of input delivery can be minimized by linking farmers groups with input dealers.
2. On the other hand, lack of access to market has a potential in significantly reducing farmers income from their produce if market interventions are not part of the program as revealed by this study.

Second, strengthening actors involved along the value chain is recommended in order to reduce the transaction costs created in the input delivery and output marketing processes. Hence, policy makers can also increase household productivity and income for the betterment of rural livelihoods by furthering investment on those interventions giving considerable attention to the participation of target peoples in their programs.

## ACKNOWLEDGEMENTS

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## Appendix

Joint significance test (likelihood ratio test).

| Matching algorithms | Sample | Pseudo $R^2$ | LRchi$^2$ | P>chi$^2$ |
|---|---|---|---|---|
| NN(1) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.007 | 1.17 | 1.000 |
| NN(2) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.007 | 1.17 | 1.000 |
| NN(3) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.007 | 1.17 | 1.000 |
| NN(4) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.007 | 1.17 | 1.000 |
| NN(5) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.007 | 1.17 | 1.000 |
| Caliper(0.01) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.033 | 3.67 | 0.961 |
| Caliper(0.25) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.015 | 2.61 | 0.989 |
| Caliper(0.5) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.099 | 16.99 | 0.074 |
| Kernel(0.1) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.004 | 0.67 | 1.000 |
| Kernel(0.25) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.009 | 1.60 | 0.999 |
| Kernel(0.5) | Unmatched | 0.308 | 74.07 | 0.000 |
| | Matched | 0.047 | 8.09 | 0.620 |

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*Full Length Research Paper*

# Improving agricultural extension services in Moro Local Government Area of Kwara State, Nigeria

**E. O. Imoloame[1]* and A. O. Olanrewaju[2]**

[1]Kwara State University, Malete.P. M. B. 1530, Ilorin, Nigeria.
[2]Kwara State Agricultural Development Programme, Ilorin, Nigeria.

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**A survey was conducted in Moro Local Government Area of Kwara State in 2012 by administering structured questionnaire to 30 farmers each from 5 villages in the Local Government. The aim was to determine the quality of extension service in Moro Local Government Area with a view to improving it. Results show that most of the farmers (28.2%) are in the age group of 21 to 30 years. A greater percentage of the farmers (53.3%) are subsistence farmers cultivating between 1 to 2 hectares (ha) of land. Although, extension services were provided long time ago (71.1%), mainly by non-governmental organizations (NGOs) and needs assessment were not conducted first before transferring innovations (63.9%), the quality of extension service was good (51.2%) and has resulted in improved skills (89.3%) and productivity of the farmers. However, it was recommended that there is need to further improve extension service in the Local Government to ensure the achievement of the desired objectives.**

**Key words:** Moro Local Government, extension service quality, improving services.

## INTRODUCTION

Agriculture is important to the Nigerian economy as it engages 70% of the labour force and contributes over 40% of the Gross Domestic Product (GDP) (FMARD, 2000). It provides food for the teeming population and raw materials for industries. The sector is however faced with mirage of problems which militate against optimizing its potential. Some of the constraints include low productivity, poor marketing and distribution infrastructure, inadequate access to credit, weak extension services and inadequate database among others (FMARD, 2000). Extension implies informing, teaching and advising farmers about new and improved technologies and getting a feedback from them (farmers) to research. This is with a view to helping the farmers improve their productivity, earn more income and improve their standard of living (Asumugha et al., 2009). Therefore, agricultural extension brings about changes, through education and communication in farmers attitude, knowledge and skills. The roles of agricultural extension are to building capacity of farmers and help them to make informed decisions. Sinkaye (2005) equates help in extension to empowering all members of the farm house holds to ensure holistic development. In spite of the lofty role of agriculture extension, the Nigerian agricultural extension service is bedeviled by several problems as identified by Agbamu (2005), such as inadequacy and instability of funding, poor logistic support for field staff, use of poorly trained personnel at local level, ineffective agricultural research – extension linkages, insufficient and inappropriate agricultural technologies for farmers, disproportionate number extension agent to farm family ratio and lack of clientele participation in programme development. Others are poor input supply, irregular evaluation of extension programmes and policy,

*Corresponding author. E-mail: oyaimoloame@yahoo.com.

institutional and programme instabilities of National agricultural extension systems.

The problem of agricultural extension and indeed technology delivery became prominent with the expiration of the World Bank component of agricultural extension funding arrangement. Withdrawal of funding and fierce competition for resources from the national budget among different economic sections has substantially reduced the funding available for agricultural technology delivery (Chukwuone et al., 2006). Since the late 1990s, inadequate funding has led to the virtual collapse of research and extension institutions that provided services to small farmers and rural communities in Nigeria (Omotayo, 2004). Considering that improved technology delivery in Nigeria's agriculture is the veritable means of bringing about improvement in the current levels of agricultural production and resource productivity, promoting technology delivery is imperative. Several researchers (Adebayo et al., 1999; Agwu and Chukwuone, 2005; Ikpi, 2002; Ogunbameru, 2005; Omotayo, 2004) have shown that one of the major lessons learned from the past extension programmes in Nigeria is that it is not possible for government alone to support extension programme in all its ramifications, and that private sector needs to play a more active role in both funding and the physical transfer of the available improved technologies. In pursuance of more private involvement in agricultural technology delivery, some innovative mechanisms derived from the Nigerian government stance in privatization policy, are being considered. In this regard, cost sharing is seen as a tenable privatization policy option (Chukwuone et al., 2006).

Cost sharing is a system where beneficiaries of services pay user fee. It is a privatization strategy which entails paying a fee for services and advice which formerly was free of charge (Rivera and Cary, 1997). It is similar to partial commercialization, which involves the reorganization of public enterprise and the introduction of commercialization principles into the enterprise operation such as user charge, with the aim of realizing funds for the enterprise (United Nations, 1995). However, Nnaemeka et al. (2006) reported some constraints to cost – sharing arrangement as weak institutional development, uncertainties inherent in agriculture, poor cooperation from farmers and weak agricultural extension / technology delivery mechanisms. Farmers and extension agents were of the view that enacting enabling legislation for cost – sharing, building political support and disseminating information on cost-sharing of agricultural technology delivery could help facilitate cost-sharing arrangement (Nnaemeka et al., 2006). Other measures include increasing the number of extension staff or reducing the area of coverage by an extension agent and establishment of vibrant farmers cooperate to serve as avenue for collecting the charges from farmers. Since the Kwara State Government is interested in revolutionizing its agriculture, there is a great need to make the extension service in Moro Local Government Area in particular and Kwara State in general effective, which is a sine- qua- non to the achievement of its goal.

The objective of this paper is to determine the quality of extention services and the effects on the skills and productivity of farmers and suggest ways to improve them in Moro Local Government Area of Kwara State.

## METHODOLOGY

A field survey was conducted in Moro Local Government Area of Kwara State in 2012. 5 villages were selected at random within Moro Local Government for the survey. They are: Village I (Malete), Village II (Elemere), Village III (Shao), Village IV (Jehunkanu) and Village V (Omini). Structured questionnaire was used to elicit information from the farmers and were administered by extension officers on 30 farmers in each of the villages adding up to a total of 150 farmers that ware sampled. The questionnaire sought information on the method of extension delivery, effect and quality of extension services provided, etc. in Moro Local Government Area. The responses were expressed in simple percentages and determined by expressing the frequency of responses over the total population of farmers multiplied by 100.

## RESULTS AND DISCUSSION

### Socio-demographic characteristics of farmers

The socio-demographic characteristics of farmers in the five villages of Moro Local Government Area of Kwara State are presented in Table 1. It shows that a greater proportion of the farming population falls within the age range of 21 to 50 years, which constitutes 79% of the farming population. The age groups of 21 to 30 years form the highest combined percentage of the farming population. This is an evidence that majority of the farmers in this 'local government area' are youths who can be considered to be energetic for work (Kolo, 2004). A larger percentage of farmers in each of the villages sampled and the combined population are males, married and in agriculture on full-time basis (Table 1). The full-time status of most of the farmers underscores the importance of agriculture as an employer of labour and as a way out of the worsening employment problem in Nigeria. Also, the fact that majority of the farmers are married will enable them receive various forms of assistance from their wives and children both at home and on the farm. A greater percentage of the farming population has primary education (54.1%), while 26% are illiterate. Only 5% of the combine farming population have tertiary education and are present in Elemere and Shao villages of Moro Local Government Area (Table 1).

### Area cultivated, cropping system and types of livestock produced

Table 2 shows the type of crops and livestock produced,

**Table 1.** Socio-demographic characteristics of farmers in 5 villages of Moro Local Government Area of Kwara State expressed as percentage of number of respondents.

| Parameter | Villages | | | | | |
|---|---|---|---|---|---|---|
| | I % | II % | III % | IV % | V % | Combine % |
| **Age (year)** | | | | | | |
| < 20 | 6.7 | 20.7 | 23.3 | 3.3 | 6.7 | 12.1 |
| 21 - 30 | 26.7 | 31.0 | 26.7 | 3.3 | 53.3 | 28.2 |
| 31 - 40 | 50.0 | 17.2 | 20.0 | 13.3 | 20.0 | 24.1 |
| 41 - 50 | 16.6 | 3.5 | 23.3 | 73.3 | 16.7 | 26.7 |
| > 50 | - | 27.6 | 6.7 | 6.7 | 3.3 | 8.9 |
| **Marital status** | | | | | | |
| Married | 93.3 | 65.4 | 66.7 | 73.3 | 80 | 75.7 |
| Single | 6.7 | 34.6 | 33.3 | 26.7 | 20 | 24.3 |
| **Gender** | | | | | | |
| Male | 72.4 | 64.3 | 70.0 | 50.0 | 55.6 | 62.5 |
| Female | 27.6 | 35.7 | 30.0 | 50.0 | 44.4 | 37.5 |
| **Farming status** | | | | | | |
| Full - time | 79.3 | 57.1 | 53.6 | 66.7 | 48.3 | 61.0 |
| Part - time | 20.7 | 42.9 | 46.4 | 33.3 | 51.7 | 39.0 |
| **Educational status** | | | | | | |
| Illiterate | 33.3 | 32.1 | 7.7 | 30.0 | 26.7 | 26.0 |
| Primary | 53.3 | 35.7 | 61.5 | 56.7 | 63.3 | 54.1 |
| Secondary | 13.3 | 21.5 | 23.1 | 13.3 | 3.3 | 14.9 |
| Tertiary | - | 10.7 | 7.7 | - | 6.7 | 5.0 |

cropping system and size of land cultivated by farmers. Most of the farmers are subsistence farmers as they cultivate between 1 to 2 ha of land with major crops like legumes, root and tuber and cereal crops and most of the farmers adopted monocropping. Also, most of the farmers (65.4%) are engaged in poultry production, while pigs and ducks are not produced probably due to the predominance of Muslims in Kwara State who forbid pork meat.

## Extension activities in Moro Local Government Area

The response of farmers on extension activities in Moro Local Government Area is presented in Table 3. Most of the farmers in the villages sampled and the combined farming population accepted that extension service was provided for them a long time ago and that non-governmental organizations (NGO) provided most of the extension service. Only a small percentage (17.5%) of the farming population claims that government agencies provided them with extension service. Also, most farmers are aware of the plan to implement extension programme in their villages by NGOs. The Kwara State governments do not seem to be meeting its obligation of providing adequate extension services to this local government area, as it has abandon the provision of extension services to the private sector. This situation could be as a result of poor funding of Agricultural Development Programme which is the state organ responsible for providing extension services. This agrees with the report of Agbamu (2005) that Nigeria extension service is bedeviled by several problems which include inadequacy and instability of funding and poor logistic support for field staff. According to Anderson and Feder (2003), withdrawal of funding with the expiration of the World Bank of the agricultural extension funding arrangement and fierce competition for resources from the national budget among different economic sectors has substantially reduced the funding available for agricultural technology delivery in Nigeria. Omotayo (2004) reported that since the late 1990's, inadequate funding has led to the virtual collapse of research and extension institutions that provided services to small farmers and rural communities in Nigeria.

Table 4 shows the response of the farmers on the perceived reason extension service was provided a long time ago and why some innovations were not adopted by

**Table 2.** Response of farmers in Moro Local Government Area on farming system, area of land cultivated and types of crops and livestock reared.

| Parameter | Villages | | | | | |
|---|---|---|---|---|---|---|
| | I % | II % | III % | IV % | V % | Combine % |
| **Type of crops cultivated** | | | | | | |
| Cereals | 20.0 | 33.3 | 14.3 | 10.0 | 20.0 | 19.4 |
| Legumes | 60.0 | 33.3 | 53.6 | 46.7 | 73.3 | 53.4 |
| Tuber and root | 20.0 | 23.3 | 21.4 | 40.0 | 6.7 | 22.3 |
| Oil crop | - | 3.3 | 3.6 | - | - | 1.4 |
| Vegetable | - | 6.7 | - | - | - | 1.4 |
| Fruits | - | - | 7.1 | 3.3 | - | 2.1 |
| **Cropping system practiced** | | | | | | |
| Mono cropping | 79.3 | 72.4 | 58.3 | 20.0 | 89.7 | 64 |
| Mixed cropping | 20.7 | 20.7 | 29.2 | 73.3 | 3.4 | 29.4 |
| Mixed farming | - | 6.7 | 12.5 | 6.7 | 6.9 | 6.6 |
| **Area of land cultivated (ha)** | | | | | | |
| <1 | 20.0 | 20.7 | 14.8 | - | 6.7 | 12.4 |
| 1 - 2 | 60.0 | 44.8 | 51.9 | 33.3 | 76.7 | 53.3 |
| 3 - 4 | 20.0 | 17.2 | 25.9 | 63.3 | 10.0 | 27.3 |
| 5 - 6 | - | 3.4 | 3.7 | 3.3 | 3.3 | 2.7 |
| >6 | - | 13.8 | 3.7 | - | 3.3 | 4.2 |
| **Types of livestock** | | | | | | |
| Poultry | 73.3 | 56.7 | 53.6 | 46.7 | 96.7 | 65.4 |
| Sheep | 10.0 | 6.7 | 7.1 | 23.3 | 3.3 | 10.1 |
| Goat | 16.7 | 3.3 | 14.3 | 26.7 | - | 12.2 |
| Pig | - | - | - | - | - | - |
| Fish | - | 20.0 | 17.9 | - | - | 7.6 |
| Duck | - | - | - | - | - | - |
| Others | - | 13.3 | 7.1 | 3.3 | - | 4.7 |

them. Most of the farmers (75.4%) attributed the delay in the provision of extension service to lack of funds. Similarly, most farmers (57.1%) did not adopt some of the innovations due to the fact that they do not only lacked relative economic advantage over the old practices, they are also expensive to adopt. This result agrees with Oni et al. (2008) that the more economically beneficial an innovation is, the greater the rate of adoption. Table 5 presents the response of farmers on teaching methods used to inform and transfer new technology to them. Most farmers said extension meetings and result demonstration were used to transfer technology to them. However, most of the farmers in each of the villages and combined farming population admitted that farmers' needs are not assessed before a new technology is provided for them. The use of only extension meetings and result demonstrations may be grossly inadequate to effectively transfer innovation to farmers. Pretty and Volouche (1997) mentioned the extension methods that extension staff should draw from to address specific needs. They includes: (a) Individual farm and home visit for follow up, (b) Group method: demonstrations to farmers groups, field days, (c) Mass method to create awareness and reach large population at a time, (d) farmers trainings and (e) participatory methods in which extension staff work with farmers to analyze current situations and problems and determine appropriate action for self-reliance. An example is farmer field schools (FFS). Also, the failure of extension service to start with needs assessment, might have resulted in the rejection of some of the innovations by farmers. Failure to carry out needs assessment was wrong because for a successful extension activity, it is necessary that extension worker must collect the relevant data about an area and that it will enable him to identify areas of constraints that need extension attention (Ani, 2007).

## Response of farmers on the effect of extension services on their skills and productivity

Response of farmers on effect of extension service on

**Table 3.** Response of farmers on the extension activities in Moro Local Government Area of Kwara State, 2012.

| Parameter | Villages | | | | | |
|---|---|---|---|---|---|---|
| | I % | II % | III % | IV % | V % | Combine % |
| **Last time extension service was provided** | | | | | | |
| Few days ago | - | 13.8 | 6.7 | - | - | 4.1 |
| Recently | 3.3 | 17.2 | 3.3 | 46.7 | - | 14.1 |
| Long time ago | 90.0 | 51.7 | 66.7 | 50.0 | 100.0 | 71.7 |
| Never | 6.7 | 17.2 | 23.3 | 3.3 | - | 10.1 |
| **Which agency provided you with agric extension service** | | | | | | |
| Government agency | 6.7 | 23.3 | 21.4 | 26.7 | 10.0 | 17.6 |
| Non-governmental organization | 93.3 | 60.0 | 67.9 | 63.3 | 86.7 | 74.2 |
| Fate based organized | - | 6.7 | 10.7 | - | 3.3 | 4.1 |
| Others - specify | - | 10.0 | - | 10.0 | - | 4 |
| **Are you aware of any plan for an extension service in future** | | | | | | |
| Yes | 89.7 | 20.7 | 50 | 73.3 | 93.3 | 65.4 |
| No | 10.3 | 79.3 | 50 | 26.7 | 6.7 | 34.6 |
| **Which organisation wants to execute plan** | | | | | | |
| Government agency | 20.7 | 28.6 | 42.5 | 53.8 | 18.5 | 32.8 |
| Non governmental organization | 75.9 | 61.9 | 53.8 | 46.2 | 70.4 | 61.6 |
| Fate based | 3.4 | 9.5 | 3.3 | - | 11.1 | 5.5 |

**Table 4.** Response of farmers on the perceived reason extension service was provided long time ago and for not adopting some of the innovations extended to them.

| Parameter | Villages | | | | | |
|---|---|---|---|---|---|---|
| | I % | II % | III % | IV % | V % | Combine % |
| **Reason for providing extension service long time ago** | | | | | | |
| Lack of fund | 83.3 | 67.9 | 59.3 | 76.7 | 90.0 | 75.4 |
| Lack of adequate extension officer | - | 10.9 | 11.1 | 3.3 | - | 5.1 |
| Village not accessible | 13.3 | 17.9 | 25.9 | 16.7 | 10.0 | 16.8 |
| Village do not want extension service | 3.3 | 3.5 | 3.7 | 3.2 | - | 2.7 |
| **Reasons for not adopting some innovation** | | | | | | |
| Complex in nature | - | 10.0 | 10.0 | 3.3 | - | 4.7 |
| No relative advantage | 80.0 | 36.7 | 33.3 | 6.7 | 76.7 | 57.1 |
| Not related to previous experience | - | 10.0 | 6.7 | 3.3 | 6.7 | 5.4 |
| Expensive to adopt | 10.0 | 33.3 | 33.3 | 26.7 | 10.0 | 22.8 |
| Not meeting need | 10.0 | 10.0 | 16.7 | 10 | 6.7 | 10.7 |
| Others specify | | | | | | |

their skills and productivity is presented in Table 6. It shows that most of the farmers in the 5 villages and the combined population are of the opinion that extension service provided has improved their skills and productivity and it is of good quality, although extension service was provided to the farmer a long time ago. Table 7 shows the response of farmers on the principles of sharing cost of extension delivery with the farmers. Overwhelming percentage of farmers in the 5 villages sampled and their combined population agree that they will share the cost of providing extension service. This could be due to the realization on the part of the farmers that there is need to cooperate with the government to improve the mechanism of extension delivery system in Nigeria. This supports the findings of several researchers (Adebayo et al., 1999; Agwu and Chukwuone, 2005; Ikpi, 2002;

**Table 5.** Response of farmers on teaching methods used to inform and transfer of innovations.

| Parameter | Villages | | | | | |
|---|---|---|---|---|---|---|
| | I % | II % | III % | IV% | V % | Combine % |
| **Extension methods used for communication** | | | | | | |
| Extension meetings | 63.3 | 55.2 | 27.6 | 31.0 | 76.7 | 50.8 |
| Result demonstration | 33.3 | 27.6 | 51.7 | 55.2 | 16.7 | 36.9 |
| Method demonstration | - | 3.4 | 3.4 | - | 3.3 | 2.0 |
| Mass media | 3.3 | 13.8 | 17.2 | 13.8 | 3.3 | 10.3 |
| Others specify | - | - | - | - | - | - |
| **Are needs of farmers assessed first before the transfer of technology** | | | | | | |
| Yes | 46.7 | 24 | 23.3 | 50 | 36.7 | 36.1 |
| No | 53.3 | 76 | 76.7 | 50 | 63.3 | 63.9 |

**Table 6.** Response of the farmers on the effect of extension service on their skills, productivity.

| Parameter | Villages | | | | | |
|---|---|---|---|---|---|---|
| | I % | II % | III % | IV % | V % | Combine % |
| **Has extension service improved your skills** | | | | | | |
| Yes | 96.6 | 100.0 | 96.6 | 60.0 | 93.3 | 89.3 |
| No | 3.3 | 0.0 | 3.3 | 40.0 | 6.7 | 10.7 |
| **Has it increased your productivity** | | | | | | |
| Yes | 93.3 | 28.6 | 43.3 | 56.7 | 93.1 | 63.0 |
| No | 6.7 | 71.4 | 56.7 | 43.3 | 6.9 | 37.0 |
| **Quality of extension service** | | | | | | |
| Excellent | 6.7 | 6.7 | 3.3 | 3.3 | 0.0 | 4.0 |
| Very good | 40.0 | 40.0 | 30.0 | 23.3 | 10.3 | 28.7 |
| Good | 40.0 | 50.0 | 46.7 | 33.3 | 86.2 | 51.2 |
| Poor | 13.3 | 3.3 | 20.0 | 40.0 | 3.4 | 16 |

**Table 7.** Response of farmers on the principles of sharing cost of providing extension service with the extension service provider.

| Parameters | Villages | | | | | |
|---|---|---|---|---|---|---|
| | I % | II % | III % | IV % | V % | Combine % |
| **Cost sharing** | | | | | | |
| Yes | 100.0 | 100.0 | 96.1 | 77.7 | 100.0 | 94.8 |
| No | 0.0 | 0.0 | 3.9 | 22.3 | 0.0 | 5.2 |

Ogunbameru, 2005; Omotayo, 2004) that one of the major lessons learned from the past extension programmes in Nigeria is that it is not possible for government alone to support extension programme and that private sector needs to play a more active role in both funding and the physical transfer of the available improved technologies and that some innovative mechanisms such as cost sharing with the farmers should be considered in pursuance of more private involvement in agricultural delivery.

## CONCLUSION AND RECOMMENDATIONS

It can be concluded that though extension services provided in Moro Local Government Area has led to improvement of the skills and productivity of farmers, there is still need to do more to improve the extension delivery system in order to make it more effective. Some of the improvements to be made are:

a) State government should be more active and take a

leading position in providing extension services to farmers on a more regular basis.

b) State government should coordinate the activities of other extension delivery systems like the non-governmental organizations and make them compliment the efforts of the state agricultural development programme for effectiveness of the system and enhanced service delivery to farmers.

c) In order to improve the quality of extension service, needs assessment should be conducted and involvement of farmers in programme development should be encouraged.

d) State government should increase the funding to Kwara State Agricultural Development Agency through better budgetary allocations and cost-sharing by the 3 tiers of government, support from development partners, the private sector, NGOs and farmers' organizations.

e) Government should explore ways of privatizing or partially commercializing the state's extension delivery system since farmers have agreed to share the cost of providing effective extension services with other stake holders.

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*Short Communication*

# Knowledge and adoption of cabbage management practices by farmers

**R. S. Suman**

IARI Regional Station, Katrain (Kullu Valley) H.P., India.

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**Vegetables are the most important diet for human's health, because they possess high nutritive value and are rich sources of carbohydrates, proteins, vitamins and minerals. Kullu Valley of Himachal Pradesh was selected as the research area because it has temperate and good conditions for vegetable production. The area is suitable for production of different types of vegetation and their breeding. Himachal Pradesh has 12 districts. Out of the 12 districts, Kullu District was selected purposely. It covers five community development blocks namely Manali, Kullu, Banjar, Ani and Nirmand. Out of these five Blocks, two blocks (Kullu and Manali) were selected. Out of these two blocks, 10 villages were selected randomly in each block with the help of random number table. From the comprehensive list of farmers according to Gram Panchayts from 20 villages, 30 vegetable growing farmers (Small, Medium and Large) from each village were selected randomly. Thus, 600 farmers were included in this study. Data were collected with the help of developed and pre-tested questionnaire. Suitable statistical tools were applied for analysis of primary data to get the final results. All the cabbage growers had complete knowledge about the selection of soil, preparation of soil, spacing and harvesting. Majority of the respondents had complete knowledge about irrigation method (97.33%). Majority of the respondents had completely adopted inter-cultural operation (67.00%) and transplanting (63.00%). All the respondents suggested that the prices of improved varieties seeds be made available at reasonable rates in the open market.**

**Key words:** Knowledge, adoption, cabbage management practice, constraints.

## INTRODUCTION

Vegetables are the most important diet for human's health. The research was done in Kullu Valley of Himachal Pradesh. The area has summer season, which is mild and therefore suitable for many sub-tropical important vegetables. Still in this area, vegetable production is low, because the rate of adoption of improved vegetable production technology by the farmers at their own field is low (Suman, 2008). Even if they produce, they face marketing problems. Therefore, this research programme aims to find out the adoption behavior of farmers towards vegetable production technology.

## METHODOLOGY

The present study was conducted in Kullu district of H.P. Himachal Pradesh has 12 districts. Out of 12 districts, Kullu district was selected purposely. It covers five Community Development Blocks namely Manali, Kullu, Banjar, Ani and Nirmand. Out of these five Blocks, two blocks (Kullu and Manali) were selected. Out of these two blocks, 10 villages were selected randomly in each block with the help of random number table. From the comprehensive list of

*Corresponding author. E-mail: rssuman@hotmail.com., sumanrs@iari.res.in.

**Table 1.** Knowledge and adoption of cabbage management practices.

| S/N | Improved production technology | Knowledge (N = 600) | | | Adoption (N = 600) | | |
|---|---|---|---|---|---|---|---|
| | | Complete | Partial | No | Complete | Partial | No |
| 1 | Selection of soil | 600 (100.00) | - | - | 600 (100.00) | - | - |
| 2 | Preparation of soil | 600 (100.00) | - | - | 600 (100.00) | - | - |
| 3 | Selection of seed | 354 (59.00) | 204 (34.00) | 42 (7.00) | 54 (9.00) | - | 546 (91.00) |
| 4 | Varieties | 404 (67.33) | 150 (25.00) | 46 (7.67) | 87 (14.50) | 342 (57.00) | 171 (28.50) |
| 5 | Nursery management | 384 (64.00) | 210 (35.00) | 6 (1.00) | 48 (8.00) | 158 (26.33) | 394 (65.67) |
| 6 | Planting method | 504 (84.00) | 96 (16.00) | - | 245 (40.83) | 203 (33.83) | 152 (25.33) |
| 7 | Spacing | 600 (100.00) | - | - | 108 (18.00) | 187 (31.17) | 305 (50.83) |
| 8 | Fertilizer management | 364 (60.67) | 198 (33.00) | 38 (6.33) | 165 (27.50) | 202 (33.67) | 233 (38.83) |
| 9 | Transplanting | 570 (95.00) | 30 (5.00) | - | 378 (63.00) | 100 (16.67) | 122 (20.33) |
| 10 | Inter-cultural operations | 542 (90.33) | 58 (8.67) | - | 402 (67.00) | 101 (16.83) | 97 (16.17) |
| 11 | Irrigation management | 584 (97.33) | 16 (2.67) | - | 352 (58.67) | 197 (32.83) | 51 (8.50) |
| 12 | Plant protection | 498 (83.00) | 102 (17.00) | - | 68 (11.33) | 201 (33.50) | 341 (56.83) |
| 13 | Harvesting | 600 (100.00) | - | - | 258 (43.00) | 231 (38.50) | 111 (18.50) |

*Figures in parenthesis are percentage.

farmers according to Gram Panchayts from 20 villages, 30 vegetable growing farmers (Small, Medium and Large) from each village were selected randomly. Thus, 600 farmers were included in this study. Data were collected with help of developed and pre-tested questionnaire.

## RESULTS AND DISCUSSION

The findings obtained from the present study are presented below: Knowledge and adoption of cabbage management practices. The data regarding the knowledge and adoption of cabbage management practices are presented in Table 1 and the results obtained have been interpreted.

### Knowledge

The data from Table 1 revealed that all the cabbage growers had complete knowledge about the selection of soil, preparation of soil, spacing and harvesting. Majority of the respondents had complete knowledge about irrigation method (97.33%), transplanting (95.00%), inter-cultural operations (90.33%), planting method (84.00%), plant protection (83.00%), varieties (67.33), nursery management (64.00%), fertilizer management (60.67%) and selection of seed (59.00%).

### Adoption

The data from Table 1 revealed that all the cabbage growers had completely adopted the selection and preparation of soil. Majority of the respondents had completely adopted inter-cultural operation (67.00%), transplanting (63.00%), irrigation management (58.67%), harvesting (43.00%) and planting method (40.83%). The results in line with Sasane et al. (2009).

### Constraints faced by the respondents

The data regarding the constraints faced by the respondents are presented in Table 2. It is found in the table that all the respondents suffer from higher price of improved seed materials. Large communities of the respondents were facing the following constraints viz., insect-pests and diseases problems (96.33%), costly fertilizers (84.33%), transportation facility (77.83), lack of market rates (76.50%) and lack of improved varieties seed on time (70.16%). Only 33.67% respondents faced the problem of less recommended spacing which occurs at the time of harvesting of the crop (Vaidya et al., 2005).

### Suggestions made by the respondents

The data regarding the suggestions made by the respondents are presented in Table 3. It is revealed from the table that all the respondents suggested that reasonable prices of improved varieties seeds be made available in the open market. Majority of the respondents (96.67%) suggested that resistant varieties should be developed and 90.00 per cent respondents suggested that the price of fertilizers should be reduced at reasonable rates.

### Conclusion

The study revealed that all the cabbage growers had complete knowledge about the selection of soil, preparation of soil, spacing and harvesting. Majority of

**Table 2.** Constraints faced by the respondents.

| S/N | Particulars | No. of respondents (N=600) | Percentage | Rank |
|---|---|---|---|---|
| 1 | Higher price of improved seed | 600 | 100.00 | I |
| 2 | Insect-pests and diseases problems | 578 | 96.33 | II |
| 3 | Costly fertilizers | 506 | 84.33 | III |
| 4 | Transportation facility | 467 | 77.83 | IV |
| 5 | Lack of market rates | 459 | 76.50 | V |
| 6 | Lack of improved varieties seed at time | 421 | 70.16 | VI |
| 7 | Less recommended spacing which creates the problems at the time of harvesting the crop | 202 | 33.67 | VII |

**Table 3.** Suggestions made by the respondents.

| S/N | Particulars | No. of respondents (N = 600) | Percentage |
|---|---|---|---|
| 1 | There should be reasonable price of improved varieties seed | 600 | 100.00 |
| 2 | Need of resistant varieties against insect-pests and diseases | 580 | 96.67 |
| 3 | Need of reasonable price of fertilizers | 540 | 90.00 |

the respondents had complete knowledge about irrigation method (97.33%). All the cabbage growers had completely adopted the selection and preparation of soil. Majority of the respondents had completely adopted inter-cultural operation (67.00%) and transplanting (63.00%). The respondents suffer from higher price of improved seed materials. All the respondents suggested that the prices of improved varieties seeds be made available at reasonable rates in the open market.

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