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Determinants of Rural Youth Participation in Non-Farm Income Generating Activities: the Case of East Gojjam Zone, Ethiopia

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Abstract

Rural youths are forced to look for non-farm income generating activities to sustain and secure their livelihoods as well as to supplement their agricultural activities. However, their participation in nonfarm activities is influenced by various and yet empirically unidentified factors in East Gojjam Zone. Thus, the aim of the study was to identify factors that determine the participation of rural youths in non-farm income generating activities in the study area. The study drew a sample of 360 rural youths through systematic random sampling technique from three woredas of East Gojjam Zone. Data were collected using interview schedule, focus group discussions and key informant interviews. Descriptive statistics were applied to characterize the sample households' demographic, economic and institutional factors. The finding of the survey indicated that participation in non-farm income generating activities is significantly influenced by eight variables. These variables are family size of the household, marital status, education level, land ownership, credit usage, market distance, mass media exposure and frequency of the household received extension service in a year. Among these variables market distance, land ownership and extension contact have negatively affected participation of youth in non-farm income generating activities. Agricultural extension service was skewed towards rural youth who engaged in agricultural activities at the expense of those who engaged in non-farm income generating activities. Market distance was also found to have a negative nexus with participation in non-farm income generating activities. Among several challenges which hinder rural youths from participating in non-farm income generating activities, lack of working capital and lack of working place were the major ones. This study concludes that rural youths in the study area faced different challenges to engage in non-farm income generating activities. Among those major challenges lack of working capital was the first bottleneck to start non-farm business in the study area. Thus, rural development strategy should give emphasis on promoting non-farm activities in rural areas to improve overall wellbeing of the rural youths.

Key words: *rural youth, non-farm income generating activities, employment*

1. Introduction

Rural youth in developing countries make up a very large and vulnerable group that is seriously affected by international economic crisis. Globally, three-quarters of the poor live in rural areas, and about one-half of the population is young. Climate change and the growing food crisis are also expected to have a disproportionately high impact on rural youth (Paul B. 2010). The Food and Agriculture Organization of the United Nations (FAO) estimates that nearly half a billion rural youth "do not get the chance to realize their full potential" (FAO, 2009).

Rapid population growth which brought about reduction of cultivable land, erosion, loss of soil fertility and biodiversity have resulted in decreasing agricultural productivity and negative effect on people's income as well as accelerated rural poverty (Sheheli, 2012). According to IFAD (2001), poverty remains predominantly a rural phenomenon despite rapid urbanization observed in most developing and transition countries. There are over one billion youth (aged 15-24) in the world, 85 percent of these youth live in the developing countries and about 50 percent of youth population in developing countries live in rural areas (United Nations, 2007). They constitute a reasonable force propelling rural economy, nonetheless, poverty is still pervasive among rural youth who face numerous challenges in order to achieve and maintain their livelihoods. ILO (2004) reported that youth have difficulties in accessing livelihood opportunities globally.

In societies governed by elders and where control of resources is in the hands of older people, young people have little opportunities to express their interests and needs. This explains why youth issues have not received much needed attention in development policies. Despite the fact that burning problems at present day relates to rural youth globally, not much have been done to collect information about them in many countries and knowledge about their livelihoods remain fragmented among service providers (Waldie, 2004). Living standard of the rural poor would only be uplifted when they receive income from economic activities (Ahmed et al., 2007; Al-amin, 2008; and Ahmed, 2009). Undoubtedly, the plight of rural youth would be alleviated through their involvement in income generating activities. Understanding income generating activities pursued by rural youth is highly imperative in developing policies and services aimed at reducing rural poverty.

Land is an important determinant of livelihood in rural areas. As population increases and land scarcity becomes critical, non-farm activity and migration may become the only way out of poverty for land poor farmers as well as primary source of livelihood for the new generation of rural resident. It has

been argued that the de-linking of rural livelihood from farming has been on the rise for the past few decades in Africa (Bryceson, 1996, 2002; Rigg, 2006). If land-scarce farm households participated in the non-farm sector to diversify income and cope with shocks in the past, non-farm employment may now become the only source of employment for the children from such farm households. This situation is further reinforced by changes in youth aspirations fueled by increased information and improved access to roads, which reduces transaction costs (Sosina and Stein, 2014). Although rural areas of Africa have been typically associated with agriculture, the non-farm sector is an important source of employment and income. When considering national employment statistics, it does not seem very significant because national statistics report only primary employment. On average, rural non-farm employment accounts for 10% of full-time employment in Africa (Haggblade *et.al.* 2007).

The majority of the youth in Ethiopia live in rural areas where farming has been traditionally the main livelihood of the people. As the state owns all land in Ethiopia, rural residents have been guaranteed access to land through a law that grants them a right to obtain agricultural land for free. However, it has become increasingly more difficult to fulfill this right for the young generation. Ethiopia currently faces severe land scarcity in parts of the highlands where population densities have become very high and farm sizes have become very small. As a result, land as a safety-net is eroding and landlessness is emerging among the youth who are unable to stay on their parents' land (Sosina and Stein 2014).

Agriculture remains the main source of income for rural areas of East Gojjam Zone. The farming system of the area is mixed which is crop and livestock production. As the sector depends on land, most landless groups of the population can't get resource to engage in the sector. As a result, these rural landless youth are suffering from unemployment. In the Zone, a total of 157,467 youths live in rural Kebele Administrations.

According to CSA (2016), 157,467 youths are found in rural kebele administrations of East Gojjam zone. East Gojjam Zone Agricultural Office reported that 24,150 youths are involved in agricultural activities, 28,181 youths are involved in nonfarm activities and 52,320 are involved in neither in agriculture nor in non-farm activities. The Zone described that 52,320 youths are not involved in agricultural sector due to lack of access to land and other unidentified problems. However, the reason why these youths are not involved in non-farm activities is not yet studied. Although similar studies have been conducted in Ethiopia on participation in non-farm income generating activities, the problem is context specific and needs further attention. Thus, identifying those factors that affect the

non-farm participation of rural youths in this specific zone is necessary if there is a need to participate rural youths in non-farm income generating activities.

2. Materials and methods

2.1 Description of the study area

The study was conducted in East *Gojjam zone*. It is 298 km from Addis Ababa and 265 km from regional capital city. It is bordered in the South by *Oromia Region*, in the West by W*est Gojjam*, in the North by *South Gondar*, and in the East by South Wollo; the bend of the Abay River defines the Zone's northern, eastern and southern boundaries. Its highest point is Mount *Chokie* (also known as Mount *Birhan*) which is found at 4,100 metres (13,451 ft). Towns and cities in East *Gojjam* include *Bichena*, *Debre-Markos*, *Debre Werk*, and *Mota*.

Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this Zone has a total population of 2,153,937 of whom 1,066,716 are men and 1,087,221 are women; with an area of 14,004.47 square kilometers, *East Gojjam* has a population density of 153.80. The average rural household has 1.1 hectare of land (compared to the national average of 1.01 hectare of land and an average of 0.75 for the Amhara Region) and the equivalent of 0.6 heads of livestock. 11.4% of the population is in non-farm related jobs. In the zone there are about 18 woredas which are classified into three agro-ecological zones i.e. two woredas are *Dega*, four woredas are *kola* and the rest are *Weyena Dega*.

2.2 Study Population

Rural youths of *East Gojjam* zone with an age range of 15 to 29 were the study population of this study. About 157, 467 rural youths in the zone are considered for this very study (EGZAO, 2009 E.C)

2.3 Sampling Techniques

East *Gojjam Zone* was selected purposively based on the severity of the problem and nearness to Debre Markos University. Then three sample woredas were selected randomly from the total of 18 woredas which are found in the zone. The selected woredas were Dejen, Sinan and Gozamen Wereda. From these woredas, a total of 6 kebeles (two from each woreda) were also selected randomly. Proportional to sample size sampling techniques was applied to determine number of youths from each Kebeles as well as to determine the number of participants and non participant youths in non-farm income generating activities. To consider gender issue from both groups, male and female respondents were also included proportionally. Finally, a total of 398 sample respondents were selected from both groups through systematic random sampling method. However, due to budget shortage and other related problems the total sample size was

minimized to 360 sample respondents. Among the total of 360 sample respondents, 195 and 165 youths were participants and non-participant in non-farm income generating activities respectively.

Since this study was conducted to represent the zone, the sample size was drawn from the total youths living in the zone The total number of sample respondents were determined by using the simplified formula provided by Yamane (1967) cited in Udayakumara *et al*. (2010) at 95% level of confidence interval, with 0.05 level of precision. $n = \frac{N}{1+N(e^2)}$, where, N- total population/ sampling frame of the study, n- sample size, e – level of precision at 0.05. The total number of youths in the zone is 157467.

$$n = \frac{N}{1+N(e)^2} = \frac{157467}{1+157467(0.05)^2} = 398$$

2.4 Type of Data, Sources and Methods of Data Collection

Both qualitative and quantitative data were collected from primary and secondary sources. Primary data were collected through interview schedule and focus group discussion. Interview schedule was used to collect data from 398 sample respondents. Focus group discussion and key informant interview were conducted with group of elders, extension workers and Woreda agricultural office workers. Five discussants of elders from each woreda were involved in focus group discussion to describe the overall condition of youth participation in non-farm activities and the observed determinants. Key informant interview was conducted with extension workers and woreda agricultural office workers. Secondary data were collected from reports of different concerned organizations, published and unpublished reports, articles, and journals which are related to this study.

2.5 Methods of Data Analysis

Both qualitative and quantitative data which were collected from primary and secondary sources were analyzed by using different methods of data analysis. The qualitative data were analyzed through narration, whereas, the quantitative data was analyzed using simple descriptive statistics such as frequency, mean, standard deviation, and inferential statistics such as t-test and chi-square test. The basic data analysis tools which were used for this were Statistical Package for Social Science (SPSS) and STATA software. The qualitative data obtained from focus group discussions and key informant interviews were stated in narrative form. Econometric model (binary logistic regression) was employed to analyse major determinants of rural youth participations in non-farm income generating activities.

2.6 Variables and their definitions

2.6.1 Dependent variable

The dependent variable of the study was participation in non-farm income gener-

ating activity which takes the value 1 for those youths who participated in nonfarm income and zero for those who did not participate. Non-farm income was used to identify the level of participation.

2.6.2 Independent variables

Sex: is a dummy variable representing the respondent's sex. Men and women have different access to resources and opportunities. Women are subject to discrimination in labor, credit and a variety of other markets and they own less property compared to men. Women have long been constrained in the activities in which they are permitted or able to participate, by tradition, religion, or other social mores. Both Ellis (1998) and Newman and Canagarajah (1999) point out the activities in which women are involved are more circumscribed than those for men.

Therefore, it is expected that sex and involvement in non-farm income generating activities are negatively related in female youth groups.

Marital status-It is a categorical variable. Married youths are expected to involve in different income generating activities than unmarried ones because they do have different responsibilities for their families. There is a significant positive effect of marital status on rural youth involvement in non-agricultural income generating activities. This implies that married rural youth were more involved in non-agricultural income generating activities than unmarried rural youth. Greater responsibilities associated with marriage could be the possible explanation for the finding (Victor 2014).

Educational level of respondent: educational level refers to the schooling level of the respondent in years. Education determines the capability of finding a job (Warren, 2002). Better-educated members of rural populations have better access to any non-farm employment on offer, and are also more likely to establish their own non-farm businesses. This variable is expected to have a positive effect on youth participation in non-farm income generating activities.

Family size: Family size refers to the size of household members in Adult Equivalent. Family size either determines the availability of family labor or, large family size demands large amount of production to feed its members. In the context of limited income generating opportunities, having more productive household members facilitates diversification into multiple activities, thereby dissipating risk (Gala, 2006). This variable will affect participation positively or negatively.

Land ownership: -The majority of young people in rural Ethiopia do not have their own farmland. So that, for those youth who do not have land will participate in non-farm income generating activities. Therefore, land owner-

ship and non-farm participation are negatively related.

Size of land owned: Land size refers to the size of land owned by the respondent in hectare (10,000m^2). This variable is a basic asset for majority of the rural livelihoods. More land size holding means more cultivation and more possibility of production which in turn increases farm income (Tesfaye, 2003).Therefore, land size and non-farm participation are negatively related. Diminishing farm sizes and a decline in return to labor in farming under population pressure may encourage rural households to diversify their employment and sources of income (Tesfaye, 2003).

Livestock holding: - livestock holding is the number of livestock owned by the respondent. It is measured by Tropical Livestock Unit (TLU). Livestock benefit much and perceived as the accumulation of wealth status, use for draft power, manure, income from sale of milk, butter and sale of live in times of risk to buy necessities. The household having larger size of livestock can have better chance to have better income from livestock. The more livestock owned by the household will be the less possibility of the households to participate in non-farm activities. On the other hand, poor households who owe no or less livestock are likely to relay on sources of income other than livestock. Therefore, it is expected that livestock holding is negatively related to non-farm participation.

Credit service and usage: - refers access to credit service. One of the principal problems for rural households and individuals wishing to start a business, whether in the farm or non-farm sector, is access to capital or credit. Without start-up funds, or with only little cash available for investment, households are limited to a small number of activities which yield poor returns, partly because of the proliferation of similar low entry barrier enterprise. Youths who have access and able to afford to credit will be able to engage in to non-farm income generating activities. In the case of access most households may have access to credit but if they did not use the credit service access only may not affect the decision to participate in non-farm income generating activities. Hence, it is expected that, youths having access to and used credit service are believed to participate in non-farm income generating activities therefore, it is expected that access to credit services and participation of youths are positively related.

Distance from market center: - Distance from market center refers to the nearness or farness of the youth's residence from the "nearest" market place in walking hours. It is measured by walking hour. Access to market and other public infrastructure may create opportunities of more income by providing in diversifying livelihood strategies through non-farm employment, easy access to input and transport facilities; youths nearer to market center have better chance to engage in non-farm

activities. For this reason the variable is expected to be related negatively with participation.

Farm income: - refers to youth's income from his/her farm. As the farm income increases the interest to engage in to non-farm income generating activities will decrease. So that, farm income and youth's participation in non-farm income generating activities is negatively related

Rural life preference: - Rural life preference has a significant positive effect on involvement in non-agricultural income generating activities. This implies that rural youth who have higher rural life preferences also are increasingly involved in non-agricultural income generating activities. Due to improved social amenities in the rural areas as well as improved linkages to urban centers, rural youth who desire to work in non-agricultural sectors would prefer to live in rural areas all things being equal. According to Winters et al. (2009), greater access to infrastructures is hypothesized to be positively linked to non-agricultural activities and negatively related to participation in agricultural activities. De Janvry et al. (2005) found that proximity to county capital influenced participation in rural non-agricultural.

Social Networks: - Individuals and households with better social networks have greater opportunities in the non-farm sector. Once again, this discriminates against the poorest, who suffer from a lack of (useful) social networks and are, therefore, unable to capitalize on informal opportunities and remain excluded from formal support systems (Smith, 2000). Those youths you do have better social networks will have a great chance to engage in non-farm income generating activities.

Mass media exposure: - As mass media exposure of rural youth increased there is a significant positive influence on their involvement in non-agricultural income generating activities (Victor 2014). This could be the result of improved access to information on available income generating opportunities. Young job seekers usually get information on available job vacancies through advertisement on mass media. This variable will positively affect youths participation in non- farm income generating activities

Extension contact: extension contact is negatively related to involvement of rural youth in non-agricultural income generating activities. Increased extension contact resulted in decreased involvement in non-agricultural income generating activities. The skills and knowledge imparted by extension agents were irrelevant to non-agricultural income generating activities.

3. Result and Discussion

3.1 Existing Non-Farm Income Generating Activities

Like other parts of rural areas in the country, in East Gojjam zone both farm and non-farm income generating activities are available. In the zone, the following non-farm income generating activities are currently undertaken by youth, these are;-petty trade, handcraft, fuel wood selling, cobble stone construction, metal work, wood work, daily laborer and mining are non-farm income generating activities which are currently available in the zone. Among the above mentioned non-farm income generating activities available in the study area daily laborer was the first mostly rural youths involved in even though it was not sustainable and enough for their lives.

The second mostly engaged in nonfarm activity is petty trading/merchandizing activity. Some people in the rural area trade different items. The main items that were brought to the market were charcoal, timber, fire wood, and those items for home consumption, crop, livestock and others. These items are mostly merchandised by males. Females are mainly engaged in petty trade and alcohol (*Tella* and *Arekie*) trade. Preparing and selling of Food is also done in the area laterally with Alcohol marketing.

Stone quarrying is the other activity rural youths were participating in the area to generate income. The main resources available in the area are stone and sand which are used for the construction purpose. It is done mostly by organized groups who have got permission from Woreda mineral office and KAs. Stone quarrying is the program forwarded by the government to those youths who are jobless living in the rural kebeles. Handicraft activities like waving, pottery and metal work are among nonfarm activities done in the area. During FGD held with selected persons some part of the community do these activities as their major sources of income.

3.2 Status of rural youth participation in non-farm activities

Based on the survey result shown in figure 1 below, among the total 360 sample respondents 45.96 % rural youths did not participant in non-farm income generating activities. This indicated that most of rural youths face different challenges to engage in non-farm business.

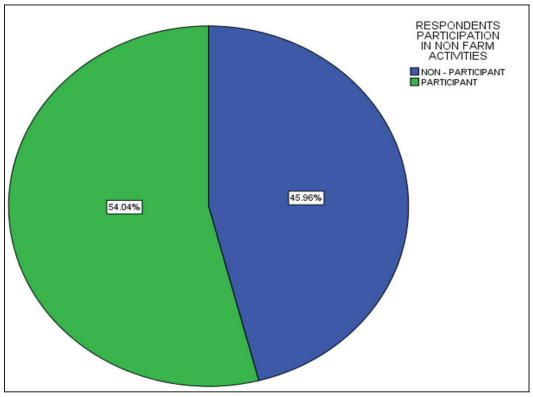

Figure 1: *Status of rural youth participation in non-farm income generating activities*

3.3 Determinant of rural youth participation in non-farm income generating activities

The pseudo R^2 is one of the most commonly used measure of model goodness of fit. The lower values of the pseudo R^2 indicates how well the dependent variable is explained by the explanatory variables included in the model. The logit result of this study turned out to be fairly low (pseudo $R^2 = 0.0828$). This clearly implies that the dependent variable of this study (participation in non – farm income generating activities) is well explained by the explanatory variables included in this study. Caliendo & Keopeinig (2005) had also explained that the pseudo R^2 indicates how well the model explain the participation probability of rural youth on non – farm income generating activities. A low R^2 value means participated youth do not have much distinct characteristics overall and as such finding a good match between participated and not participated youth becomes easier (Yibeltal, 2008).

The logistic regression result showed that participation in non-farm income generating activities is significantly influenced by eight variables. These variables are family size of the household, marital status, education level of the respondent, land ownership, credit usage, market distance, mass media exposure and number of times the household received extension service in a year. Among these variables market distance, land ownership and extension contact negatively affect participation of youth in non-farm income generating activities. In the case of extension contact, extension workers most of the time only give extension service for those youth who are engaged in agricultural activities and in the case of market distance those youths who are far from the market may be discouraged to engage in different activities.

The result showed that youth who had better schooling have high likelihood to participate in non-farm income generating activities. Marital status of youths affected participation positively. Youths who are married participated in non-farm income generating activities because they have responsibilities to feed their family. In respect to land ownership, it affected participation negatively because those youth who do have land prefer to engage in farming than to engage in non- farm activities.

Having credit access does not mean that youth can get and utilize credit in this study. Credit usage highly affected the participation than access as it was discussed in the descriptive part. Most of youth had access to credit but those who used credit were very low in number and percentage. Credit usage affected the participation of youth in non-farm income generating activities positively and significantly. The result from FGD clearly indicated that the basic reason of youth to not participate in non-farm income generating activities is lack of initial capital. Therefore, if youth get credit, they can involve in the non-farm activities and that is way credit usage affect participation positively.

Market distance is another factor which affected youth participation in non-farm income generating activities. According to the result of this study market distance negatively affected the involvement of youth in non-farm income generating activities. This might be because if youth live very far from the main market, they may not get transport to sell their products and they may not get enough information about different activities in the market. It discouraged them not to engage in non-farm income generating activities. Mass media exposure of rural youth had a significant positive influence on their involvement in non-agricultural income generating activities. This might be the result of having access to information on available income generating opportunities. Young job seekers usually get information on available job vacancies through advertisement on mass media.

The result of this study was supported by similar study which were conducted in India by Victor C. 2014 on his study he found that the involvement of rural youth in non-farm income generating activities was affected by marital status, education level, mass media exposure and extension contact.

Table 1: Determinants of Rural Youth Participation in Non – farm Income Generating Activities.

Logistic regression Number of obs = 354
LR chi2(11) = 40.48
Prob> chi2 = 0.0000
Log likelihood = -224.18065 Pseudo R^2 = 0.0828

Independent Variables	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
GENDER	.0011579	.2909159	0.00	0.997	-.5690267	.5713425
FAMSIZE	-.3850806	.2010836	-1.92	0.055*	-.7791972	.0090359
MARISTAT	.6365144	.2715798	2.34	0.019**	.1042279	1.168801
EDULEVL	.1424731	.0877691	1.62	0.105	-.0295512	.3144973
LANDONW	.5704568	.3006081	1.90	0.058*	-.0187243	1.159638
CREDITUSE	-.5780954	.2847142	-2.03	0.042**	-1.136125	-.0200659
MARKTDIS	.0553286	.0365482	1.51	0.130	-.0163045	.1269617
MASSMEXP	-.5902206	.2529899	-2.33	0.020**	-1.086072	-.0943694
EXTENCONT	-.7125571	.2530347	-2.82	0.005***	-1.208496	-.2166181
RULIFEPR	-.1876584	.2402359	-0.78	0.435	-.6585121	.2831954
_cons	3.951165	1.610709	2.45	0.014**	.7942331	7.108097

*Note: ***, **,* Significant at <1%, 5% and 10% probability level respectively*

One of the chief objectives of this study was to find out the major determinants of rural youth participation in non – farm income generating activities. Binary logistic regression is the best econometric model often used for such empirical investigations. Thus, this study run the model and the output of the model is presented in Table 1 above. The predicted model output indicated the fact that participation in non – farm income generating activities is significantly influenced by the following independent variables.

Credit Use: Credit use was expected to have a positive impact on rural youth participation in non – farm income generating activities. However, the model result was turned out against this expectation. As can be seen in Table 1 above, participation in non – farm income generating activities has reduced by .578 units for users than non – users. This may be explained by the fact that credit use has promoted rural youth capability to purchase land and other productive augmenting resources

and technologies to stay in the agricultural business.

Land Ownership was found to be the most important determinant of participation in non – farm activities. This variable has negatively influenced the dependent variable of this study. The predicted model indicated that landownership causes a 0.57 units decrease in participation in non – farm income generating activities. This might be having land will encourage the youth to engage in farm activities than in non-farm activities.

Extension contact affected participation in non – farm income generating activities negatively. The model result revealed that access to extension service didn't encourage farmers' participation in non – farm income generating activities. The model result above made clear that the probability of participation in non – farm income generating activities decreases by .71 units for respondents with extension contact as compared to those without extension contact. In other words, increased extension contact resulted in decreased involvement in non-agricultural income generating activities. The basic reason of this was extension workers only give advice as well as other services for those youth who participate in farming activities.

Marital Status: This variable has significantly influenced participation in non – farm activities at 10% significant level. As can be learnt from the predicted model the probability of participation in non – farm activities rises by 0.64 units for married respondents. This may be explained by farm land shortage which urged them to participate in non-farm activities to fulfill the basic needs of their family. This econometric result was also supported by focus group discussants. They described that married youths are more involved in non-farm activities compared to single once.

Mass Media Contact: Contact with mass media was expected to improve rural youth participation in non – farm income generating activities. However, the model result turned up against the expectation. From the model it is apparent that a unit increases in mass media contact decreases participation in non – farm income generating activities by .59 units. The negative impact of mass media on participation in non – farm income generating activities may have some explanation. First, it may be due to lack of access to mass media. Second, it may be due to the fact that the media isn't working in areas related to rural employment creation and non – farm income generating activities.

Market Distance: The estimated logit model indicated that a unit increase in distance reduces participation in non – farm income generating activities by .055 units.

3.4 Challenges Rural Youths Facing to Participate in Non-Farm Income Generating Activities

From the HH survey in different KAs can understand all of the respondents want to participate in one or more nonfarm income generating activities. But all of the respondents mentioned different challenges they faced to enter in to nonfarm business. Among them the following reasons are found and summarized below

Table 2: Respondents Challenge to participate in Non-farm Activities

Challenges	Frequency	Percent
lack of working capital	120	47.4
absence of working place	66	26.1
waiting for better job	24	9.5
lack of commitment	17	6.7
lack of interest	18	7.1
lack of training	2	.8
lack of skill	6	2.4

According to the household survey and the discussion held with focal groups and key informants the major challenge to start nonfarm business is lack of working capital. From the descriptive statics of HH survey as shown in the above table 47.7% of the respondent's problem was lack of starting capital. The only supplier of the credit in the area is Amhara Credit and Saving Institute (ACSI). ACSI gives the credit mainly for agricultural input purchase purpose; however, it can also give credit for nonfarm business. Collateral is necessary to get the credit. Lack of collateral or guarantee makes the rural youths unable to get the credit access. Lack of working place, unavailability or poor performance is the second main problem of the area. As shown in the table 8; 26.1% of the respondents' thought it as a major problem that restricted them from participation in nonfarm income generating activities. From the discussion held with focal groups and key informants there is not any enabling environment to run nonfarm activities for rural youths. In addition to these, waiting for better job, lack of commitment & interest from rural youths, lack of training and skill and knowledge gap were the major challenges that enforced rural youths to preserve from nonfarm income generating activities.

4. Conclusion

This study is aimed at identifying factors that determine rural youth participation in non-farm income generating activities in East Gojjam zone. Qualitative & quantitative techniques were employed to get a better understanding regarding these issues. The household survey was the tool for collecting data about currently existing and emerging non-farm income generating activities, determinate factors of rural youths to participation in non-farm income generating activities, the challenges and opportunities of rural youths in relation to their participation in non-farm income generating activities. FGD & KII were also employed to get deep knowledge in the study topic.

The logistic regression result showed that participation in non-farm income generating activities was significantly influenced by eight variables. These variables are family size of the household, marital status, education level of the respondent, land ownership, credit usage, market distance, mass media exposure and number of times the household received extension service in a year. Among these variables market distance, land ownership and extension contact negatively affected participation of youth in non-farm income generating activities. In the case of extension contact, extension workers most of the time give extension service only for those youth who are engaged in agricultural activities. Market distance affected those youths who were far from the market and may be discouraged them not to engage in different activities.

Among factors studied in this paper extension contact of rural youth found as one of the determinant factors under individual characteristics. Extension contact was negatively related with participation in non – farm income generating activities in a significant way. Access to extension service didn't encourage farmers' participation in non – farm income generating activities. The basic reason of this was extension workers only give advice as well as other services for those youth who participate in farming activities.

Rural youths in the study area face different challenges to engage in non-farm income generating activities. Among those, the major challenge to start nonfarm business was lack of working capital. Working place unavailability or poor performance is the second main problem of the study area. Respondents thought these two major problems restrict them from participation in nonfarm income generating activities. From the discussion held with focal groups and key informants there was not any enabling environment to run nonfarm activities for rural youths. Therefore, it is possible to conclude that rural youths are not participating enough in nonfarm income generating activities in the study area. This means that rural youth unemployment is the major problem in the study area.

5. Acknowledgement

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Conflicts of Interest

The authors declare that they have no competing interests

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Talking Plants: Communication and Signaling via Volatiles

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Abstract

There is an urgent need for new sustainable solutions to support plants in facing current environmental challenges. In particular, strengthening of productivity and food security needs sustainable exploitation of natural resources and metabolites. In this review, we fetch the attention to the agronomic potential of volatile organic compounds (VOCs) emitted from plants, as a natural and eco-friendly solution to defend from stresses and to enhance crop production. Plants defense by emitting volatile organic compounds communicate with herbivore-attacked neighbors to activate defenses before being attacked. Many volatile compounds especially, transcriptome and signal cascade analyses of VOC-exposed plants indicates that plants snoop to prime direct and indirect defenses and to hone competitive abilities. A diversity of emission responses have been observed from stressed plants. Although, the similarities have been seen in bearing environmental stress, it is also established fact that an emission of VOCs can be induced at any time from leaves of all plant species following abiotic and abiotic stress.The present challenges regarding changing environment which may hamper the use of VOCs in open field are analyzed by several scientist and solutions for a better exploitation of VOCs in future sustainable agriculture are envisioned.

Keywords: Biotic and Abiotic stress, Plant defense, , Talking plants, VOCs, Signaling,

1. Introduction

Plants eavesdrop on their neighbors through the detection of volatile organic compounds (VOCs). These compounds can, as mentioned, be emitted from the root system, but can also be found airborne and floral as well. The ability to detect and respond to VOCs of most competitive neighbors is an important strategy for individual plants since it enables them to adjust their physiological status and growth pattern accordingly, especially in the early stages of their life (Stephen and Harry 2006).

As it is well established fact that plants produce many volatile metabolites and a small subset of these compounds is identified by animals and humans, and the volatile profiles are defining elements of the distinct flavors of individual foods. Flavor volatiles are derived from an array of nutrients, including amino acids, fatty acids, and carotenoids. In tomato, almost all of the important flavor-related volatiles are derived from essential nutrients (Baldwin, 2010). The predominance of volatiles derived from essential nutrients and health-promoting compounds suggest that these volatiles provide important information about the nutritional makeup of foods (Stephen and Harry 2006).

Contrary to the long-held idea that plants are uncommunicative, recent research has made it clear that many species conduct lively and informative conversations with one another. Scientists have revealed that plants communicate through the air, by releasing odorous chemicals called volatile organic compounds (VOCs), and through the soil, by secreting soluble chemicals into the rhizosphere and transporting them along thread-like networks formed by soil fungi. In addition, this is more than mere gossip: these signals warn neighbors of the many dangers facing plants (Baldwin, 2010).

Volatile organic compounds (VOCs), first theorized by plant scientists Jack Schultz and Ian Baldwin in the early 1980s, are now a well-known form of plant communication. Maple tree (**Acer**) saplings (ramp up their own defenses in the presence of herbivore-damaged neighbors.

In late 1990, however, a drop of more carefully designed experiments began to yield convincing evidence to the contrary. In 2000, Karban showed that wild tobacco plants grown in close proximity to sagebrush plants whose leaves had been clipped became resistant to herbivores, ostensibly in response to VOCs released by the sagebrush. Other researchers soon reported similar VOC-induced defense responses, both intra and interspecies in several other plants, including lima bean, broad bean, barley, and corn. Moreover, in 2006, Karban showed that VOCs released by damaged sagebrush induce herbivore resistance in plants growing at distances

of up to 60 cm, well within the range of sagebrush neighbors in nature. By now, the wonder of VOC-based plant communication is well established. Different researches demonstrated that volatile cues increase fitness in receiver plants. In one experiment, lima bean plants exposed to herbivore-induced VOCs lost less leaf mass to herbivores and produced more new leaves than controls (Kost and Heil, 2006). But very little information available that demonstrates volatile signaling between neighboring plants can benefit the emitting plant, prompting some researchers to suggest that "eavesdropping" is a more accurate description of what has been observed than "intentional" communication.

2. Impact of Environment on Volatile Compound Emission

A variety of emission responses are observed from stressed plants. Although all environmental stresses bear similarities, e.g. any stress typically leads to reductions in leaf photosynthesis rates, different stresses differently affect volatile emission rates, and the responses can be different for constitutive and induced emissions. In addition, for any stress, the effects depend on stress severity and duration. Mild stress characteristically first results in physiological responses those are quickly reversible upon a return to non-stressed conditions. Such physiological responses typically result from changes in substrate availability for all stresses and from changes in enzyme activity for temperature stresses. Thus, the effects can be positive, e.g. due to enhanced substrate availability for isoprene emission upon mild drought stress or due to enhanced substrate availability and enzyme activity upon mild heat stress. For other mild stresses, the effects can be negative or occasionally no effects can be observed. Mild stress seldom elicits release of stress volatiles, or if it does, the elicitation is minor. More severe stress typically leads to major reductions in constitutive emissions and release of characteristic stress volatiles. The available evidence demonstrates that the release of stress volatiles is stress dose dependent (Baldwin and Schultz, 1983; Rhoades, 1983; Heil and Silva Bueno, 2007; Heil and Karban 2010).

3. Impact on Biotic and Abiotic stress

Emission of VOCs can be induced at any time from leaves of all plant species following abiotic (Loreto *et al.,* 2006; Loreto and Schnitzler, 2010) or biotic stresses (Dicke and Baldwin, 2010). Results from many studies have demonstrated that emission of isoprenoids, the most abundant group of VOCs (Guenther *et al.,* 2006), is stimulated by abiotic stresses and improves plant resistance either by direct quenching of reactive oxygen species (ROS) (Loreto and Velikova, 2001), or indirectly by stabilizing cell membranes (Velikova *et al.,* 2011). However,

protection of cell membranes to avoid toxic accumulation of ROS is only one among the many roles of VOCs that may be exploited in agriculture.

Grapevines are generally well-adapted to arid and semi-arid climates, and they appear to primarily rely on drought avoidance mechanisms in water stress situations. In terms of the response of the grapevine to drought conditions, rootstock can have an impact on the gas exchange and water status. The mechanism of drought tolerance, rootstock anatomy, stomatal regulation, physical and chemical responses are the main contributing factors during grapevine drought stress responses (Tsegay*et al.,* 2014; Lovisolo*et al.,* 2016).

Plant volatiles are the metabolites that plants release into the air. Plants are champion synthetic chemists; they take advantage of their anabolic ability to produce volatiles, which they use to defend themselves against biotic and abiotic stresses and to deliver information- and potentially disinformation- to mutualists and competitors alike. Volatiles have provided plants with solutions to the challenges associated with being rooted in the ground and immobile (Baldwin *et al.,* 2006; Baldwin, 2010; Dudareva *et al.,* 2006; Kessler *et al.,* 2008; Kostand Heil, 2006).

Plant volatile blends are dominated by four biosynthetic classes: terpenoids, compounds with aromatic rings, the fatty acid derivatives and volatiles derived from amino acids. Terpenoids play a central role in generating the chemical diversity of plant volatiles and appear to have been under strong diversifying selection. Methanol and ethylene are two the most commonly emitted plant volatiles (Baldwin, 2010; Maffei, 2010; Blande*et al.,* 2007).

Most plant volatiles help in communication to the outside world, providing information to other organisms about a plant's physiology (e.g., its sexual receptivity, fruit maturity, insect damage, oviposition, and competitive status). They can also transmit information within a plant and potentially between plants. Green leaf volatiles, ethylene and perhaps other plant volatiles transmit information within plants, affecting transcript abundance or directly activating defense responses in distal branches that are not well connected by the private communication channels of the vascular system. Plants are known to change their metabolism in response to other long-distance signals. This change in resource allocation priorities likely reflects the more severe consequences of resource competition than of attack from herbivores and pathogens for a plant's fitness (Baldwin, 2010; Dudareva*et al.,* 2006; Lovisolo*et al.,* 2016; Choudhary*et al.,* 2008).

When plants are attacked, they attract predators and parasitoids of the attacking herbivores with volatile blends that provide information about the location, activity and perhaps even develop-

mental stage of the attacking herbivore. The more information about attacking herbivores a plant can encode into its volatile emissions, the more effectively a carnivore will be able to respond to a plant's 'cry for help' and the more likely the carnivore will benefit the plant by disposing of its attackers (Baldwin *et al.,* 2006; Baldwin, 2010; Dicke and Baldwin 2010; Engelberth*et al.,* 2014).

The floral bouquets also contain potent repellants to the unbidden guests of flowers: nectar robbers and florivores. These repellants likely signal the presence of high concentrations of less volatile toxins and other deterrents in the flower. The blends released from ripe fruits are highly attractive to potential seed dispersers, and since many fruit volatiles are derived from amino and fatty-acids, the blend likely represents the true nutritional value of the fruit to a potential disperser (Baldwin *et al.,* 2006; Baldwin, 2010).

4. Impact on Agriculture

Plants can detect their neighbors by stimuli sensed either through their leaves or by root exudates. The researcher also found that a brief and light touch to the leaf has an impact on above and below ground communication, affecting the pattern of biomass allocation and reducing their attractiveness for herbivore insects. The chemical composition of the soil is a key factor in the lifespan of any plant as conveys signals not only about the presence of surrounding neighbours but also their physiological status. Intriguingly, some reports demonstrated that brief touch stimuli perceived by the leaves can affect belowground plant interactions. The recent study demonstrated the extraordinary capacity of maize roots to discriminate between belowground signals and then to respond differentially according to the stress status of their neighbours (Rhoades, 1983).

Whether they are studying volatiles drifting on the breeze or phytochemicals zipping through subterranean fungi, researchers are now bent on elucidating the relevant receptors and deciphering the molecular lingua franca of plant communication. They could then begin to clarify the ecological significance of the phenomenon and, potentially, help farmers grow hardier crops (Kost and Heil 2006).

Understanding how plants perceive airborne volatile signals, for instance, could inform the genetic engineering of crops that are hypersensitive to cues from sacrificial "beacon" plants that are deliberately damaged to emit signals that trigger neighboring plants to activate their antipredator and/or antipathogen defenses. And if researchers could pinpoint the compounds that act as vectors for stress cues passed between roots, they could potentially "train" crop seedlings to better cope with drought and other stresses. Plants maintain memory of any stress event they have

experienced (Crisp *et al.,* 2016; Hilker *et al.,* 2016), and this memory is able to influence the response to forthcoming stressful situations. Factors able to shape the plant's stress memory are referred to as "priming stimuli", among which plant VOCs play a crucial role because, due to their volatility, they can quickly reach distant plant parts (Heil and Kost, 2006; Mauch-Mani *et al.*, 2017). A "primed" plant shows an earlier, stronger, and faster response upon further stress occurrence, thereby resulting in increased resistance and/or tolerance (Conrath *et al.*, 2015; Mauch-Mani *et al.,* 2017). VOCs have been extensively demonstrated to prime defenses against herbivorous insects (Kim and Felton, 2013), pathogens (Ameye *et al.,* 2015), and environmental stresses (Cofer *et al.,* 2018). Defense priming against pathogens has also been considered as a sort of "green vaccination" (Luna-Diez, 2016). Green leaf volatiles (GLVs) such as Z-3-hexenyl acetate, ubiquitously and rapidly released after mechanical damage of leaf tissues (Brilli *et al.,* 2011), have been reported to prime resistance of wheat plants to the fungal pathogen *F. graminearum* (Ameye *et al.,* 2015) and to reduce the damage occurring to maize plants during cold stress (Cofer *et al.,* 2018). Other VOCs such as methyl salicylate (MeSA) and monoterpenes (i.e., camphene and pinene) (Riedlmeier *et al.,* 2017) have been found to actively participate in the mechanisms leading to systemic acquired resistance (SAR) (Dempsey and Klessig, 2012). Low concentrations of methyl jasmonate (MeJA) have been demonstrated to prime plant defenses by modifying the epigenetic status of wound-inducible genes in rice, thereby enhancing responsiveness to wounding (Bertini *et al.,* 2018). Even methanol, ubiquitously emitted from plant leaves during cell division and cell wall expansion (Nemecek-Marshall *et al.,* 1995), seems to act as a priming stimulus when released from damaged tobacco leaves by enhancing resistance to the pathogenic bacterium *Ralstoniasolanacearum* (Dorokhov *et al.*, 2012). In addition, antibacterial defenses have also been reported to be primed by VOCs such as nonanal in lima bean plants treated with benzothiadiazole (BTH), a synthetic salicylic acid analog (Yi *et al.,* 2009). Compared to the direct induction of defenses in plants, priming does not incur in an energetically costly activation of metabolic pathways (van Hulten *et al.,* 2006; Martinez-Medina *et al.,* 2016) and therefore represents a sustainable method to develop novel crop protection strategies.

It can be a successful strategy but for that more research should be carried out in this area. Nowadays, the availability of new analytical technologies such as high-resolution Proton Transfer Reaction "Time-of-Flight', mass spectrometry (PTR-TOF-MS) make possible instantaneous and highly sensitive detection of the whole spectra of VOCs with high resolving power (Graus *et al.*, 2010). This can provide *in vivo* a complete and high-throughput measurement of the

entire blend of VOCs (the "volatome") emitted from plant leaves. Phenotyping the volatome could allow non-invasive screening of plant VOC profiles, assisting breeders in the selection of cultivars that successfully perform under changing environmental conditions and associated biotic stressors (Araus and Cairns, 2014). PTR-TOF-MS analysis could also enable a real-time diagnosis of the crop health status (Niederbacher *et al.,* 2015), by monitoring in air the occurrence of specific VOC emissions (i.e., MeSA, sesquiterpenes) as stress biomarkers triggered by abiotic and biotic constraints (Karl *et al.,* 2008; Chalal *et al.,* 2015). Moreover, variations of VOC emission patterns over time can be used for precision agriculture purposes to monitor plant growth and development in the field. Likewise genomics and high throughput platforms for imaging and remote-sensing, real-time highly resolved VOC detection generate massive amount of data (Gandomi and Haider, 2015). This production of 'big data' requires computational analysis to extract patters and identify features useful for phenotyping (Singh *et al.,* 2016). Implementation of machine learning tools to process information on VOC emissions along with environmental parameters collected in the field by multiple sensors will allow exploration of big data in order to measure plant performance and recognize early symptoms of stress.

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