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White Mango Scale Distribution and Its Impact: A case of Guto Gida and Diga Districts of East Wollega, Ethiopia

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Abstract

Mango is one of the tree crops cultivated in Ethiopia particularly in the southwestern part of the country; it is the primary fruit crop. A survey was made in Guto Gida and Diga districts of East Wollega Zone during 2016 cropping season to assess the current status, effect, and implication of white mango scale infestation on the target beneficiaries and mango value chain project implementation in the two districts. The discussants in Guto Gida district disclosed that they observed the infestation of their mango trees for the first time in 2008 and those in Diga observed it in 2010. They also said that they had never ever seen such kind of problem in their mango farm and considered it as a new phenomenon for the people in both districts. For this reason, they did not know whether the problem was caused by pest or disease. They commonly called it "Cholera" because of its transmission ability and deadly disease to mango trees. The participants described the effect of the pest on mango production and productivity, though they observed it in mango orchards since 2010, it did not affect the production level immediately, but through time starting from the year 2012 the pest was causing them a drastic reduction in production and productivity. In the year 2014, there was a total failure in mango production and also the harvested one was no market value because of infestation. The effect of the pest in mango grower farmers was so devastating as the mango sell proceeding was used to cover various household expenses like children schooling, purchase of oxen, fertilizer, seed and etc., were done with income derived from. The income earned from mango is, therefore, constituted some 10 -12 percent of the annual income of the households. A total loss of this amount of income most likely caused a great disruption in annual outgoings of households. The impact of the pest in the household livelihoods will be more prominent due to its cumulative effects through time and causing disruption in the normal functioning integrated household economy which one depended on another. The other impact was due to this pest attack, the growers cut mango tree and substitute by other crops. This would cause deforestation, biodiversity loss, causing soil erosion, depletion of surface and underground water and wildfire in the area at large. From the current survey, white mango scale has become a stumbling block to realize the objectives of mango value chain project in both districts.

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Introduction

The production of mango firstly ranked in the world is India. India produces 65% of the world's mango crop 10,800 (70% of its fruit-growing area). Following India

in the volume of production China 3673, Thailand 1800, Mexico 1679, Pakistan 1674, Indonesia 1478, Brazil 1000 and Philippines 985 and all are in 1,000MT (Edward A. Evans, 2005). Nigeria is first from Africa it produce 730000 MT and Egypt is the second 380000MT

of mango produced per year (Edward A. Evans, 2005). Mango is an important fruit crop grown in the southwest part of Ethiopia and ranking first in production. (Edossa *et al.*, 2006). The area of mango production in the different regions of Ethiopia is about 3789.47 ha in Oromia, 3375.89 ha in SNNPR, 652.56 ha in Benishangul Gumz, 246.85 ha in Amahara, 180.41 ha in Gambella, 44.5 ha in Dire Dawa, 33.52 ha in Somali, 118.20 in Tigray and 367.24 ha in Harari. The total area allotted for mango is about 8,808.64 ha and the country annual production of mango from all mango grower regions is about 697,507 quintals (CSA, 2012/2013).

Mango trees in most parts of Ethiopia are developed from seedlings and are inferior in productivity and in fruit quality. To alleviate these problems improved varieties named Kent, Kit and Tommy Atkins were introduced from Israel in 1983 and are being commercially produced by the Upper Awash Agro Industry Enterprise (UAAIE). These varieties are widely distributed to different parts of Ethiopia by UAAIE. In 2008/2009, a private farm called Green Focus Ethiopia Limited introduced a new mango cultivar called Alphanso from India and planted in its farm at Loko in Guto Gida district of East Wollega zone of Oromia, western Ethiopia. Many farmers are growing mango trees used as a source of income and for shading purpose (Mohammed *et al.*, 2011).

The mango tree is attacked by different insects and diseases such as Anthracnose, Bacterial Black spot, Fruit fly, mango gall flies, Mango leaf coating, Mites, Mango seed weevil, Mealybug, Powdery mildew, Scale, Spider mites, Mango tip borer, Stem-end rot, Termite, Thrips, and Whiteflies. The major insect pest of mango is the white mango scale insect, *Aulacaspis tubercularis* (Hemiptera: Diaspididae). It has been recorded mainly from plants belonging to four families: Palmae, Lauraceae, Rutaceae and Anacardiaceae (Borchsenius, 1966).

This insect is a serious pest in mango especially on the late cultivars (Daneel & Dreyer, 1998). Mango scale insect is among those first reported incidences of the mango scale, *Aulacaspis tubercularis* Newstead in South Africa was in 1947 (De Villiers, 2001). For many years this scale insect was regarded as a sporadic pest on mangoes and of little economic importance (Annecke and Moran, 1982). More recently, the pest status of this scale insect became apparent. Severe infestation of this scale insect can result in leaf drop and even dieback of stems, especially in young trees (De Villiers and

Viljoen, 1988). Not only has the seriousness of this pest intensified over time, but the scale insect has also extended its distribution range and is now present in all major mango producing areas of South Africa (Daneel and Dreyer, 1998).

White mango scale insect is a serious pest that injures mangoes by feeding on the plant sap through leaves, branches and fruits, causing defoliation, drying up of young twigs, poor blossoming and so affecting the commercial value of fruits and their export potential especially to late cultivars where it causes conspicuous pink blemishes around the feeding sites of the scales. In nurseries, severe early stage infestation retards growth. Young trees are particularly vulnerable to excessive leaf loss and death of twigs, during hot dry weather. The heavily infested premature fruits dropping and the mature fruits became small in size with lacking juice. *A. tubercularis* is a tropical species that may have Abo-Shanab, A.S.H. originated in Asia. It has been recorded mainly from hosts belonging to four plant families: Palmae, Lauraceae, Rutaceae, Anacardiaceae, particularly on mangoes and cinnamon (Borchsenius, 1966).

The insect was identified as *Aulacaspis tubercularis* Newstead (white mango scale) in Ambo Plant protection research center with the collaboration of Gillian Watson senior insect biosystem analyst in plant pest diagnostic center, USA in February 2011 as Hemiptera: Diaspididae: *Aulacaspis tubercularis* Newstead. Its common name is white mango scale and it is the first record in Ethiopia. This insect pest also affects the expansion and the production of mango in Ethiopia.

According to the information obtained from farmers, they use to harvest up to 10 qt of fruits per tree before the occurrence of this new insect pest. But the current condition of the trees suggests that fruit yield of 2-3 qt per tree may not be obtained due to the heavy infestation of white mango scale. In Ethiopia, white mango scale is first recorded in 2010 in Western Ethiopia East Wollega Zone of Oromia region in Green focus Ethiopia private farm at loko places in Guto Gida district (Mohammed *et al.*, 2011).

The percentage of infestation was of white mango scale in Gida Ayana 43%, Sasiga 29%, Guto Gida 39%, Limu 16%, and Diga 33%. On average 33% mango area is infested by white mango scale (Mohammed *et al.*, 2011). At the moment the infestation has spread to all mango producing areas.

The main objectives of this study includes, to understand the current status of the pest in terms of its distribution and assess the existing capacities to mitigate its effects, to assess the effects of the pest in the grower farmers' economy and livelihoods in particular and the area in general. To gain some insights from the data gathered and analyzed at the grassroots/community level so as to stimulate discussions among concerned agencies to influence the management decisions at higher levels and also assess the various stakeholder's perceptions and understanding about the pest and the control measures.

Materials and Methods

Team members from Ethiopian Institute of Agricultural Research, Ambo Plant Protection Research Center, Plan International Ethiopia Oromia Programme Area, Wollega Zone Agricultural Development and Wollega University, Shambu Campus were involved on the assessment of white mango scale infestation in Guto Gida and Diga districts of East Wellega Zone of Ethiopia during 2016 cropping season. Key stakeholders and key actors who should be part of the work were identified.

The field data were collected by combing both qualitative and quantitative data collection methods and also primary and secondary data collection method was used.

The secondary data review was made on the relevant secondary information sources including the collection and review of the already existing data from various agencies and relevant previous research findings on the topics.

The other method of data collection used during the field visit was included field level physical observation on mango farms, focus group discussion (FGDs) with men, women, children (boys and girls), and key informant interview (KIIs) with relevant government officials and staff and other knowledge rich individuals. Accordingly, a total of 6 FGDs, involving 93 participants (48 males and 24 females), 12 children (5 boys and 7 girls) and 14 participants of key informant interview in both woreda.

For laboratory observation, a total of 20 mango growing farmers' fields were randomly selected and 5 leaves per trees; (10 leaves from two trees) with a total of 200 sample leaves were collected and brought to Ambo Plant Protection Research Center laboratory for confirmation of the insect and the status of the insect development stage.

Results and Discussion

Current Status of the pest

Secondary data review

The researchers and expertise team report from Federal Ministry of Agriculture and National Research center were identified the insect pest as attacking mango crop and also indicated it was "White Mango Scale Insect". They also confirmed that the pest is new for the locality and even for the country as a whole (Mohammed *et al.*, 2011 and Temesgen, 2012).

The preliminary survey result indicated that White Mango Scale was distributed from its original infestation area to all mango growing neighbor districts of the zone like; Sasiga, Gida Ayana, Limu, Diga, Sibum Sire and Gobu Sayo of East Wollega Zone mango growing districts to the East, North, West and South directions. Even though its first emergence was reported as Loko administrative kebele in Guto Gida district of East Wollega Zone, it takes only one and a half year for covering wider geographical areas. Hence, its distribution was rapid due to its flight capacity that contributes to disperse enormously. The insect was dispersing in any direction with a higher probability of contacting larger patches than they do smaller patches. As a result, the insect was found in all sampled five districts, where mango is growing, including the four districts of Guto Gida, Diga, Gobu Sayo and Gimbi districts except Mana Sibum (Gombo Kiltu Jale and Wajati Mendi, having 163 and 170 km air distances, respectively from the source). (Mohammed *et al.*, 2011 and Temsegen, 2012).

Laboratory observation

As part of the current assessment, a total of 20 mango growing farmers' fields were randomly surveyed (5 leaves per trees; a total of 10 leaves from two trees) with a total of 200 sample leaves collected for lab observation of Male, Female, Crawlers and Egg of whit mango scale was made through examination of the morphology and microscopic features of the insect. As the data showed, at this time infestation of male and female was less but crawlers and egg were high. This is due to the rainfall was not stopped but after the rain stop, the crawlers changed to adult, male and females. This evidence tails as the presence of mango scale with the mango trees all year round, with overlapping generations throughout the year and its peak population observed during the

flowering i.e., at the spring and harvesting period. Please see for the detailed laboratory observation report in below table.1.

From our observation for this assessment purpose, mango scale damaged the leaves and fruit, affected the commercial value of the fruits and the farmers left with no income from mango sale at all. It was also learned that there was no transportation of mango to the central markets and as result, this would most likely affect the ambition of foreign exchange income earning from this sub-sector. The insect attacked both the old and young trees, the young trees are particularly vulnerable to excessive leaves loss and death of twigs. This will affect the expansion and production of mango in the study areas.

Grower Farmers' perceptions about the pest

Insofar as the current distribution of the insect is concerned, all the mango growing kebeles in both districts were already infested and expecting the total loss in mango production, according to the discussants participated in the assessment. The discussants in Guttu Gida district disclosed that they observed the infestation of their mango trees for the first time in 2001 and those in Diga observed it in 2010. They also said that they had never ever seen such kind of problem in their mango farm and considered it as a new phenomenon for the people in both districts. For this reason, they did not know whether the problem was caused by pest or disease. They commonly called it "Cholera" because of its transmission ability and deadly disease to mango trees.

The participants described the effect of the pest on mango production and productivity, though they observed it in mango orchards since 2010, it did not affect the production level immediately, but through time starting from the year 2012 the pest was causing them a drastic reduction in production and productivity. In the year 2014, there was a total failure in mango production. And also the harvested one was no market value because of infestation.

It was learned that there had been a progressive reduction in mango production and quality right starting from the year 2010-2014. The insect was so quickly spreading from one mango farm to another, and as a result, now distributed all over the mango grower farmers in both district.

As per the discussant farmers, the insect was less in number during the rainy period. They just limited to itself to some part of the tree like leaves and lower part of the stem. However, with progressing to the end of the rainy period, they started to abundantly found on mango trees. Following the vegetative/leaves regenerated.

Also, following this, the insect gradually climbed to the top of the trees during the flowering stage and present in almost every part of the tree. This helped the insect to easily attack and infests the mango fruit under maturity.

Farmers' observations on the pest's symptoms

The discussants described the symptoms of the pest infestation on leaves whitish materials and created spots when it attacked and penetrated inside the leaves. This again caused the leave to drop down from the tree.

Then after, it began to attack the stems basement of the leave, fruit with conveying its original colour with varies spot, change colour of the leaf after penetrate inside, fix on the root of the tree along by covering of white small fibres and increasingly substantial infested to poor growth and finally drying out the tree.

They explained the damage caused on fruit affected as emitting honeydew which when accumulated on the upper leaf surface and colonized by black non-parasitic materials. For it was so, they often opted to remove the damaged tree with the intention to create aeration among the trees. This effort, however no longer yield the desired result as the pest spread itself in a higher pace. When the infestation was so serious in one tree, the tree started to die back from the top.

The observation was also taken as the pest is not selective for one or another type of mango varieties. Both improved grafted and local orchards were invariably attacked by the pest. Nonetheless, the extent of attack appears more severe in young seedlings than the older local variety trees, according to the discussants.

As a consequence of the pest, mango plantation expansion and development was recently curtailed in both districts. New land expansion for mango plantation was totally stopped, except the seedlings distributed by the Plan's project.

Effect of the pest on mango growers' income and livelihoods

The effect of the pest in mango growing farmers was so devastating as the mango sell proceeding was used to cover various household expenses like children schooling, purchase of oxen, fertilizer, seed and etc., were done with income derived from. The income earned from mango is, therefore, constituted some 10-12 percent of the annual income of the households. A total loss of this amount of income most likely caused a great disruption in annual outgoings of households. That means the household who used to cover the aforementioned purchases is now either under stress or used other coping mechanisms like selling of asset like oxen or renting part of their land to purchase fertilizer for other crop production.

The impact of the pest in the household livelihoods were more prominent due to its cumulative effects through time and causing disruption in the normal functioning integrated household economy which one depended on another.

As they described during the field discussion, loss of mango income has made everyone to be more vulnerable and feel insecure for any unforeseen circumstances he or she may face. That means that the income earned from mango sell proceeding is like one having the money in the bank account that can be withdrawn when desired to meet these unforeseen risks. They said that mango is one of the nutritionally rich fruits which the local people highly consumed for some 3-4 months in the area.

Especially, the dietary value of mango for local children is great given that children were used to be the major consumer of fresh mango fruits on the tree; lack of this may cause nutritional disorder on them.

The impact of the pest on the environment would be more likely if the current infestation level remains continue without any major control measures. This is because of the fact that the pest has a potential to cause dry back on standing mango tree if it would not be managed. The farmers who searched for alternate income sources may opt to cut trees and substitute the existing mango trees with another crop. This would cause deforestation, biodiversity loss, causing soil erosion, depletion of surface and underground water, wildfire and etc. That means the pest becomes an agent intensify desertification in the area at large. The other effect of the pest as discussed by participants was that the pest may

exacerbate the unemployment problem in the area as currently, an increasing number of youths become daily laborer to earn their living.

The pest made the following group of people more vulnerable. Accordingly, they identified children, women, older people, those people who extensively planted mango and relied on it and etc., as the most vulnerable. They explained the reason why these groups of people were considered as vulnerable because of the followings:

Children

The discussant adult groups considered children as a highly vulnerable group to the pest problem they said that they were the prime group which the pest inflicted a health problem ("typhoid") by eating the infested fruit. The other reason was that children were unaware of the problem and could not refrain themselves from consuming it, they easily exposed to the problem. The described that as a result these situations, a considerable number of families were exposed to unexpected health treatments of their children during the last cropping year.

Furthermore, children (boys and girls) who participated in the focus group discussion vied that the effect of the pest on them was primarily as a health problem. They said that children faced the health problem as a result of consuming mango fruit which appears as normal to them, but caused them the disease like *typhoid*. They were therefore asked in what they need to do and said that they need to create awareness among school children so that not to consume the fruit till the solution will be given to the problem.

Older people who have no labor support

This group of people largely depend on income from mango sale proceeding as mango crop does not require them labor or any investment - this group of people is reported as highly vulnerable because of their age could not shift to another crop as they also lack labor in their household.

Women

Women were also reported as highly vulnerable because of loss of income from mango sale proceeding as they often sell a small quantity of mango to cover their day to day outgoings. Now they were left with empty handed and became more dependent on their husbands.

Extensively mango grower farmers

This group of people is reported as the major losers since they have no alternate source of income to substitute the loss caused by the pest within a short period of time.

Cultural management practices

Grower farmers were opted to use the variety of cultural practices in efforts to mitigate the effect of the pest in mango production. Nonetheless, the farmer said that the whole range of efforts made to combat the pest was only given a temporary relief. They could not help to bring the insect under control and now it becomes spread everywhere mango trees found with great magnitude. The practices used by discussant farmers and the reason why they attempted outlined as follows:

Smoking of mango tree for chess out the pest from the tree, Washing with soluble ash and soap, Thinning; for spacing among the planted trees through removing the tree, Adding the urination of goat over attacked mango tree, Pruning; to inhibit the transmission of the pest, Removing the infected trees and burning and Keeping the sanitary of soil under the tree.

Farmer's current perspective

The discussant farmers gave the below recommendations to control the pest in such a way that:

External support (Go +NGOs) in the way chemical treatment will be made possible and also contribute anything that can beat their capacities to realize this.

Ensure their readiness to do anything which the technical experts want them to do. For instance, they expressed their willingness to prune large canopy trees and made manageable for spraying.

The discussant farmers, as their last option, started contemplating to use the land currently under the mango trees to cultivate other crops, provided that there will be no any other support given to control the pest.

The Implications of the pest to Mango Value Chain Project

Plan International Ethiopia-Oromiya Programme Area has instated its mango value chain in Gutto Gida and

Diga districts since 2013/14 with the goal to improve the income and livelihood of the grower farmers and their families, thereby improving productivity, production, and quality, improve markets, improve farmers participation in farmer groups and cooperatives and village savings and loan and linkage to financial institutions. It was during the last cropping season that Plan Ethiopia and the farmers learned about the dangerous insect infestation. This was when the farmer groups /cooperatives were for the first time linked to the central market (*Etfruit*) Enterprise under the contract agreement to supply and sell their products at a better prices after their first produce reached Addis Abeba. The *Etfruit* which noticed the infestation of the produce supplied at their warehouse immediately notified us its cancellation of the contract due to the devastating insect infestation. This was the bad news to the project and grower farmers expecting to benefit from such a marketing arrangement. As a result, the grower farmers could not benefit from its products as the infestation was widely spread in all kebeles during the last cropping season. This becomes a growing concern for Plan International Ethiopia –Oromia Program Area and realized the impossibility of continuing the project implementation as it is. Hence, working on this devastating pest has come as priority problem of the area in an effort to improve the income and livelihood of the people. So, to make more collaboration and coordination with concerned stakeholders also become a key strategy to mitigate/manage the pest so as to secure the livelihood of the communities in a sustainable way in the years to come.

This assessment was initiated with the intention to jointly seek solutions together with key actors and the farmer themselves. Thus, understanding the seriousness of the insect and its multifaceted negative-consequences is believed as the first step towards resolving this development problem. So, collaboratively dwelling on it to bring down the pest population to the level, where it could not bring economic damage to mango production appears as an urgent task ahead of all the concerned development agencies.

The emergence of the pest has become a stumbling block to realize the objectives of the mango value chain project in both districts. It, therefore, appears strongly advisable to do some adjustment in the way it will appreciate the pest problem. This will entail the adjustment in the project operational logic and its budget.

Table.1 Microscopic observation of 10 leaves collected from Farmers field

No	Farmers Name	Kebele	Woreda	NL	TNM	TNF	TNC	TNE
1	Tamerat Derse	Degaga Didesa	Diga	10	2	4	28	9
2	Kumera Gudeta	Degaga Didesa	Diga	10	0	2	33	12
3	Tesfaye Bayisa	Degaga Didesa	Diga	10	3	6	44	7
4	Aferem Hotel	Degaga Didesa	Diga	10	9	18	67	48
5	Aferem Hotel	Degaga Didesa	Diga	10	5	14	40	56
6	Mulatu Horedofa	Degaga Didesa	Diga	10	0	10	22	28
7	Tamen Deresa	Degaga Didesa	Diga	10	3	15	21	34
8	Haweni Kenea	Degaga Didesa	Diga	10	8	8	61	30
9	Birhanu Regasa	Degaga Didesa	Diga	10	13	12	46	30
10	Regasa Moti	Degaga Didesa	Diga	10	0	3	25	13
11	Abedi Fekadu	Uke Badiya	Guto Gida	10	0	3	13	18
12	Green Focus Farm	Uke Badiya	Guto Gida	10	11	16	103	49
13	Green Focus Farm	Uke Badiya	Guto Gida	10	9	16	112	29
14	Police Station	Uke Badiya	Guto Gida	10	2	4	19	18
15	Admasu Jibat	Jidugelesa Meti	Guto Gida	10	9	17	67	25
16	Dereje Emana	Jidugelesa Meti	Guto Gida	10	11	8	68	37
17	Girma Ayele	Jidugelesa Meti	Guto Gida	10	16	10	71	20
18	Dejene Tizaze	Jidugelesa Meti	Guto Gida	10	5	6	63	17
19	Gonfa Buli	Jidugelesa Meti	Guto Gida	10	4	21	94	44
20	Tolera Hatau	Jidugelesa Meti	Guto Gida	10	0	10	30	8

NB: NL= Number of leaves, TNM=Total no. of Male, TNF=Total no. Female, TNC=Total no.Crawlers, TNE= Total no. Egg

Fig.1 A, B, and C shows mango leaf infested by white mango scale

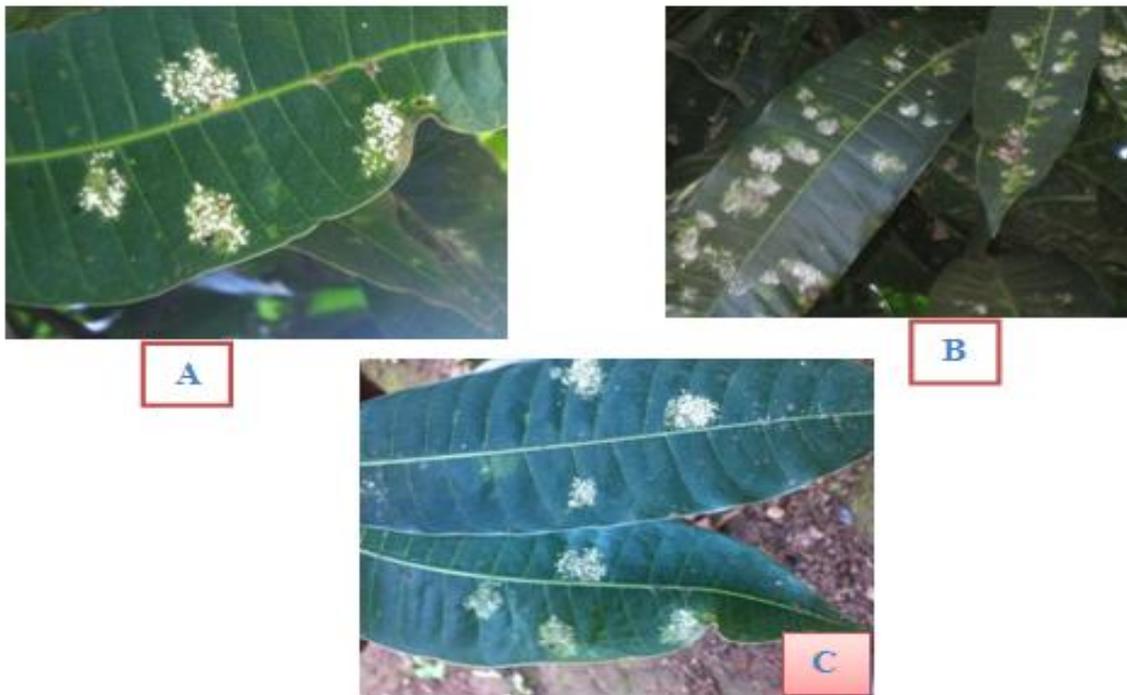


Fig.2 D shows mango fruit infested by white mango scale



The insect is a serious threat to the mango production in both Goto Gida and Diga districts. The pest has recently distributed all over where mango trees stand in Guto Gida and Diga districts. As a result of full-scale infestation of the pest hindered mango production severely. The grower farmers are currently no longer regarded mango tree as a crop that renders them economic benefits since infestation has already distributed all over mango growing areas and caused them a bad experience. This was mainly because of controlling the pest has become the issue beyond their capacity and this compounded by the absence of external support to overcome this challenge. As a result, they appeared somewhat frustrated and started to contemplate other negative measures like cutting the trees and using the land for alternative crops.

Given that many mango farmers in the area were not viable in diversifying in farm and off-farm income that they are more vulnerable to this kind of shock.

During the field discussion with the participating farmers of both districts, it was learned that the farming community looked more resilient to this shock. For it was so, there was no as such a conspicuous disruption on observed in their livelihood situation. However, this does not mean that all mango grower farmers were uniformly affected by the insect and responded to the pest's effects in a similar way. Economically, mango grower farmers were variously affected by the loss of mango income which was ascribed to failure in harvest during the last cropping season. The economic effect and degree of their resilience were ultimately lie on the individual

household's livelihood capacities. These capacities include possession of assets, household cropping pattern i.e. size and land allocation for various crops cultivation, availability of labor forces, household income diversifications and etc. Furthermore, this vulnerability is affected by other factors described by the discussant groups. These include age, gender, and etc. For instance, children and older people who have no labor support at home, as well as women were identified as a more vulnerable group to the pest.

The insect has currently, become a growing concern among various government organizations and civil societies and communities. The problem is no more regarded as an economic one as it has social, environmental, and other repercussions. Its wider implications, therefore, call for urgent coordinated and concerted measures to be taken against this challenge.

So, suppressing the insect population to the level where not cause economic damage on mango fruit will have no alternative. This calls for the establishment of a partnership that will channel and integrate the available resources and efforts towards the desired direction. Towards this, the following practical recommendations were forwarded as an outcome of this assessment.

Recommendations

From expertise point of views, the following practical recommendations were suggested. These include:
Selection of proper Mango varieties that will be adapted to the local conditions and it is advisable to communicate

with Ethiopian Institute of Agriculture Research Centers to find locally adopted and improved varieties of mango.

Adoption and disseminate current farmers cultural practices like: Application of proper pruning practice, smoking, clearing of different weed species from the surrounding and other plant residue, cutting of the all infected canopy of the tree and good management practice for newly emerging coppice, proper fertilization and irrigation of mango farmers, mulching to improve natural enemies and soil fertility

Regular monitoring and data recording on mango plant related problems and assigning of well-qualified plant protection expertise, in order to scout the problem.

Application of insecticides recommended by Ambo Plant Protection Research Center: applaud and white oil.

Searching for local natural enemies and mass production and augmentation in the field.

Introduction of bio-control agents like predators and parasitoids

Screening of other alternative safe insecticides must be important.

A strong awareness creation and provision of training for model farmers and development agents will be critical to overcoming the negative coping strategy that may be adopted by farmers. The inclusion of other crops with mango farm based on the scientific selection of the type of crop to be planted and conducting action research on effective management practices at farmers' level with the full participation and ownership of the farmers.

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