

White Mango Scale Insect's Infestations and Its Implications in Guto Gida and Diga Distrcts of East Wellega Zone

by

Tesfaye Hailu Terefe¹, Solomon Tsegaye², and Tadele Wakuma²,

¹Ambo Plant Protection Research Center, P.O Box 37, Ambo, Ethiopia

²Plan International Ethiopia Oromia Programme Area

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Executive Summary

The mango crop is among the crops cultivated in Ethiopia and in southwest Ethiopia, while in south-west Ethiopia, mango is the first fruit crop grown (Edossa et al., 2006). The area of mango production in the different regions 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 8808.64 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, Keit 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 2001/2002, 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).

This insect pest affected the production and expansion of mango in Ethiopia. According to the information obtained from farmers, they are harvest up to 10 qt of fruits per tree before the occurrence of this new insect pest. But the current condition of the trees suggest that fruit yield of 2-3 qt per tree may not be obtained due to the heavy infestation of white mango scale. Additional losses also occur during harvest and transportation to the local market. The Green Focus Ethiopia Ltd. farm experienced a lot of pre and post-harvest fruit loss due to the white mango scale starting from the first production year. The area coverage of the insect reaches on average 33% mango tree and is also spreading very fast (Mohammed et al., 2011).

Prior to this assessment, only little studies and researches were conducted on white mango scale insect in the areas. The report also indicted that the first occurrence of this pest was in Guto Gida

in Loke and Uke kebele. The pest has distributed itself immediately after its first emergence to the other adjacent administrative kebele's of low land mango producing areas of Guto Gida districts in the Anger Valleys. The insect infested mango at all stages, including improved varieties at Green Focus Ethiopia causing yellowing and drying of leaves, leaf drop and die-back of twigs. Blackburn and Miller (1984) confirmed and reported as mango trees that affected by white mango scale insect, especially mango plantation of small holder farmers' production was becoming less productive and low in quality as well (Temesgen, 2012).

The present assessment was to assess the current status, effects and implications of this havoc on the target beneficiaries, areas and mango value project under implementation in the two districts. Moreover, the findings of the limited research works were not widely disseminated among stakeholders. This contributed to the insect had remained unnoticed and provided little attention.

Plan International Ethiopia 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 saving and loan and linkage to financial institutions. It was during the last cropping season that Plan Ethiopia and the farmers learnt about the dangerous insect infestation. This was when the farmer groups/cooperatives was for the first time linked to the central market/Etfruit Enterprise under the contract agreement to supply and sell their produce in 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 marketing arrangement. As a result, the grower farmers could not benefit from its produce as the infestation was widely spreaded in all kebeles during the last cropping season. This become 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.

Among the recommendations given in this assessment included to convene a workshop among key stakeholders on the issue and seeking common solution to combat the pest in a coordinated and ensure accountability by developing joint action plan and subsequently monitoring, establishment of a platform to continuously coordinate the efforts in the way local farmers will be supported, supporting the research initiatives related to the insect, undergoing the adjustment in project operation logic and interventions in line with the emerging situation, providing training /awareness to practioners and the publics.

2. Background

Plan International Ethiopia –Oromia Programme Area has initiated Mango Value Chain Project for 3,000 beneficiaries (1800 males and 1200 females) of mango growers’ farmers in Guttu Gida and Diga districts of East Wellega Zone, Oromia Region. The project has adopted o value chain approach with the main emphasis to enhance mango productivity, production and quality as well to create access to potential market for fresh and processed mango products, empower farmers to involve on value chain process and implementing community managed saving and loan associations. Its overall goal is to bring a sustainable utilization of mango fruits for improved economic development through improvement of families in food security by promoting improvements in livelihoods. To attain this goal, the project has expected to bring changes around four components/thematic areas. These include:

1. Increasing use of market opportunities through new arrangements for fresh and processed products
2. Improving quality, productivity and production;

3. Increasing participation of organizations of farmers and other marketing groups in the value chains.
4. Promoting community managed saving and loan schemes

While reviewing the project's risks/ assumptions made during the design stage, several risks were assessed assumptions outlined as presented in the project document. Of all the risks considered and assumptions made, failure of mango production was envisaged due to the infestation of fruit, either by insect /pest and diseases. This risk was escaped at this stage for lack of adequate information on the pest at that time. Hence, the risk which was very fatal to the project has continued to realize itself and caused a failure in production. That means that if the project had adequate information about this insect it did not continue with its current operational logic. It would rather undergo for its revision, or else incorporate the various measures to manage the pest during implementation. Unfortunately this, however, could not happen because of the following reasons:

- White Mango Scale Insect was new to our country/the region that there had been little was known about it.
- The insect capability to reproduce itself and spread over a wider geographical area within a short period of time was beyond one could imagine. Hence, the insect almost covered the whole mango growing areas in both districts with less than two years period. And placed a heavy economic damage within 2-3 years period.
- Above all these, this insect remained unnoticed or/and not given adequate attention by the relevant agencies. As it was only recently that its wider distribution and damage has bring it to the notice of concerned like research center, Agricultural offices , NGOs and etc
- The other important point is that though, mango crop is economically important to the local farmers/area, the crop remained to suffer from lack of institutional extension support in the past and the like.

Prior to the present assessment, some research and rapid surveys were conducted on the pest in both Guto Gida and Diga districts of East Wellega Zone by the team of Federal in collaboration with Regional Agriculture Bureau. Later on Ambo Plant Protection Research Center conducted a

research in this insect in Private mango Farm in collaboration with local institutions. However, all the recommendations given by these bodies have not yet reached to the grower farmers' level. Further, this field discussion with officials made clear that despite, the recommended chemical request was made to the Regional Agricultural Bureau some months ago, and the Bureau in turn timely submitted to the Federal Agricultural Office. This was done because importing the chemical from abroad is the responsibility of the Federal Agricultural Ministry. In addition to this, Wellega University had made some preparatory work like setting-up a taskforce to undertake research on this pest and to provide technical support on this.

Apart from the above institutional efforts at initial level, there has not been a strong institutional support has yet provided to the farmers to manage the pest. This situation has provided a fertile ground for spread of the insect and resulted in full scale infestation that disrupted the production and marketing process. For this reason, the pest has now become more serious and a growing concern of all actors working with mango grower farmers in the area.

Statement of the Problem: In the past one year, Plan International Ethiopia-Oromia Program Area has been intensively working with mango grower farmers found in 17 Kebeles. Though the problem was previously believed to be a disease affecting the local mango trees, no one had knowledge whether it was really an insect or disease. It was for the first time declared as “White Mango scale Insect” by the survey team drawn from Agricultural offices and Agricultural research institution at Federal and regional levels in 2012. However, the team report was not as such widely disseminated and well known by the publics. For this reason, the Plan Ethiopia-Oromia Programme Area has intitated to implement its Mango Value Chain Project in both distrcts since 2013/14. This office had though, learnt during its initial assessment prior to the project design and in its baseline survey conducted just before the commencement project implementation, as the mango in the area was affected by some disease and insect pest. The office continued to implement the project as it was originally designed and implementing the various interventions with mango grower farmers. It is under this situation that the office heard about “White Mango Scale Insect” infestation of the fruits transported to Addis as per the already agreement entered with Efruit and the farmer groups/cooperatives in 2014. The Efruit who already observed the infestation on the fruit immediately notified the Plan its decision to

break the contract agreement and dispose the infested product at their warehouse. This was the saddest moment for both mango grower farmers and mango value chain project, which already successfully linked the farmers to the central market under legal contract. Prior to this time, the local farmers were highly exposed to exploitative intermediaries who haphazardly collected the produce from farmers at very low prices and causing high post-harvest loss. The market linkage initiative was thus, meant to ensure the farmers to be in direct link to the central market/whole sellers and increase the sell prices which would be turned to contribute to a higher farmer's income. This was unfortunately not possible because of a full scale infestation of the insect in last cropping season and the whole produce was almost could not escape this havoc. Under this condition, Plan Ethiopia has realized that it is almost not possible to attain the goal of mango value chain project by continue working with the existing project operation logic, which neglect the emerging priority problem of the area.

Since then, based on the federal survey team findings, Plan International Ethiopia-Oromia Program Area has made several discussions with various concerned government offices in the way the problem would get resolved. This assessment was commissioned with the intention to have first-hand information and to get some evidence base facts that will help facilitate discussions among stakeholders. Towards this end, involving the relevant stakeholders and key experts from concerned institutions as well as farmers themselves were believed as prerequisite to the envisaged aim.

This report was therefore, the result of the rapid assessment conducted by the team consisting of 10 members drawn from various institutions (Please see the composition of team members in an annex -2). As such, the team were drawn from Ambo Plant Protection Research Center, Zonal and Woreda Agricultural offices, Agricultural Universities (of Wellega and Shanboo) , and Plan International Ethiopia. The field survey included from 20-26, October, 2014).The assessment was initiated to meet the following objectives:

Objectives

The objectives of this assessment had multi-folds, including:

- 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 grassroots/community level so as to stimulate discussions among concerned agencies to influence the managements decisions at higher levels,
- to assess the various stakeholders perceptions and understanding about the pest and the control measures,
- to recognize the implications of the pest to mango value chain project; currently under implementation and necessitating any adjustments in project operational logic in line with the emerging circumstances, and
- to suggest ways and means to combat effect of the pest to the stakeholders as one development challenge .

3. Literature Review

3.1. General

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 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 second 380000MT of mango produced per year (Edward A. Evans, 2005).)

The mango crop is also cultivated in Ethiopia and in southwest Ethiopia, mango is the first fruit crop grown (Edossa et al., 2006) while in southwest Ethiopia, mango is the first fruit crop grown (Edossa et al., 2006). The area of mango production in the different regions 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, Keit 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 2001/2002 E.C /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).

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, Mealy bug, Powdery mildew, Scale, Spider mites, Mango tip borer, Stem-end rot, Termite, Thrips and White flies. 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 incidence 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 past status of this scale insect became apparent. Severe infestation of this scale insect can result in leaf drop and even die back of stems, especially in young trees (De Villiers and Viljoen, 1988). Not only has the seriousness of this pest intensified over time, 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 of 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 temporarily identified as *Aulacaspis tubercularis* Newstead (white mango scale) in Ambo Plant protection research center by the help of binocular microscope after getting aid from the internet. Moreover, the sample was sent through Animal and Plant Health Regulatory Directorate, Ministry of Agriculture, to America in January 2011 for further confirmation. It was identified by Gillian Watson senior insect bio system 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 suggest that fruit yield of 2-3 qt per tree may not be obtained due to the heavy infestation of white mango scale. Additional losses also occur during harvest and transportation to the local market. The Green Focus Ethiopia Ltd. farm experienced a lot of pre and post-harvest fruit loss due to the white mango scale starting from the first production year. (Mohammed et .al., 2011).

The following gaps were identified in relation to the pest control in Ethiopia. These include

- a. There is no any control method on white mango scale in Ethiopia.
- b. White mango scale is spreading very fast and mango tree is affected due to the infestation of white mango scale.
- c. The damage is increased and the financial income of the farmers is highly affected.

3.2. Distribution of white mango scale, *Aulacaspis tubercularis*

White mango scales are distributed in a wide range of climates (Ben-Dov et al. 2006; Watson 2007). It is a tropical species that may have originated in Asia (Borchsenius, 1966) and white mango scale has been firstly reported in India on mangoes (Ben-Dov et al. 2006). It has been spread by the transport of infested plant material and it is now widespread in many mango-growing countries, including the United State of America (Florida), northern part of South America (Brazil, Colombia, Jamaica, the Caribbean) the east and west coasts of Africa (Egypt, Ghana, South Africa, Kenya), Asia (India, China, Iraq, Indonesia, Japan, Pakistani), Italy and Australia. White mango scale was introduced in Florida and Australia with the importation of mango fruit from India (Suit 2006). The detection of white mango scale on Pakistani mangoes on arrival in the United Kingdom (DEFRA 2008) demonstrates that post-harvest cleaning and washing will not remove all scales and quality control inspectors within the packing house may miss some infested fruit.

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). At the moment the infestation has spread to five weredas, the area called the belt producing area of mango. The percentage of infestation is: 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).

3.3. Scale Insect symptoms on Mango trees

Aulacaspis tubercularis Newstead (Hemiptera : Diaspididae) (White mango scale insect) 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 of juice. *A. tubercularis* is a tropical species that may have 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).

3.4. Management practices of white mango scale

There are some white mango scale management options to control/mitigate the effect of mango production system. These include cultural control, biological control, integrated pest management and chemical control that can be implemented.

Mineral Oils:- Two successive field experiments for eight weeks during early spring (2009 – 2010) aimed to test some summer/light mineral oils, (super masrona®, CAPL2® and Diver®) against *A. tubercularis* on mango trees. The tested mineral oils were effective by the following descending order: Diver > CAPL2® > super masrona without significant differences between diver and CAPL2 and significant differences with super masrona, with the same effective trend and same statistical means, during the two seasonal experiments. The tested mineral oils caused mean reduction effects (95.43%), (93.55%) and (90.15%) with check reduction effect (7.75%) during the first experiment (2009) and the second experiment (2010) reduction effect (97.68%), (95.07%), (92.04%) and (6.36%) for Diver oil, CAPL2 and super masrona, respectively (Abo-Shanab, A.S.H. 2011).

Biological control :- This pest is under good biological control in most other mango producing countries and therefore it was decided to introduce an exotic biological control agent and try to establish it in different mango producing areas. Both the parasite and predators were successfully augmented, released in to mango orchards and became well established (Labuscegre, et.al., 1996; Daneel and Dreyer , 1997 ; 1998).

Chemical control: - Pesticides are an important tool not only in boosting agricultural production but also as a quick solution for insect control. Organophosphates insecticides and mineral oils to control white mango scale on mango tree match with many earlier studies in which chloropyrifos, methidathion, Dimethoate 40%EC,(Howard F.H 1989),Diver and CAPL2 oils have been found successful in reducing the population of white mango scale (Abo-Shanab, A.S.H. 2011; I.C. Cunningham, S.De.Faveri and B. Pinese1996). The timing of oil sprays is

important, as adverse effects such as reduced flowering, oil burns and fruit drop may occur if timing is incorrect (Brooks, 1992).

Integrated pest management: - An integrated pest management alternative could be applied that would consist of a combination of pesticides, cultural practices and the use of biological control agents (Dale E. Meyerdirk, 2002). And also Pesticide application in mango orchards resulted in high mortality of endemic parasitoid (Labuschagne and Pasques, 1994, Labuschagne and Froneman 1992) described the use of two insect-growth regulators and found them to be as effective as the currently used pesticides, but with greater potential for integrated control due to their specificity.

Integrated pest management is a pest management philosophy that utilizes all suitable pest management techniques and methods to keep pest populations below economically injurious levels.

Cultural control: -The following are possible cultural control measures outlined in literatures:

- Post-harvest pruning is an effective control measure and also helps the penetration of chemical sprays through the tree canopy (Cunningham, 1989)
- Quarantine new plants and treat before placing them with established plants. Spot treat with insecticidal soap if needed, taking care to cover all crack cervices and other possible hiding places.
- Water + Oil Treatments: Application of a garden hose with water in a hard spray and washing off white scales can be removed following the application of oil.
- Wash plants with soapy water (2 teaspoons mild detergent per gal of Water) and a soft cloth.
- When plants are lightly infested, kill scales by rubbing them off with your fingers, if possible.
- Where there are few plants and a light scale infestation, prune out the infestation.
- Dislodge scales by hosing down plants frequently, unless biological control agents are present.
- Use an insecticidal soap.

- Apply a 2% solution of horticultural oil.
- Use a botanical insecticide of pyrethrums and rotenone.
- Use a high pressure stream of water to dislodge scales. Wetting them also encourages fungal pathogens (Dale E. Meyerdirk, 2002).

4. Methodology

To realize the above objectives of this assessment, the team employed a participatory research data collection and analysis approach to the extent possible. Hence, the following steps employed in the process : identification of key stakeholders expectations, identification of key actors who should be part of the work (either as an assessment team members and/or discussants for the information to be sought) ; clarification on what type of data and methods to be employed for data collection and analysis ; enriching and ensuring the relevance, comprehensiveness and appropriateness of the interview guide questions with the team members through discussion; negotiation around responsibility of individual team members; commencing data collections and undertaking discussion to incorporate new learning from previous field visit and providing debriefings on the preliminary data analysis made from data gathered from individual study sites at Woreda and Zonal levels ; finally consolidating and synthesizing the final draft report at office and soliciting the feedback on draft report for possible incorporation of the final comments and then, sharing the results to the various audiences for its use were among the key steps followed.

The field data collection methods combined both qualitative and quantitative data collection methods and also primary and secondary data collection method. 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 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.

Also a sample mango tree leaves were collected from various farms located at different locations so that these to be investigated by Ambo Plant Protection laboratory to understand the current status of insect population per leaf. Accordingly, a farm level field observation was made with naked eyes and also 20 farmers' mango leaves and twigs were collected from various villages in both districts so as to be observed by using a magnifying hand lens to determine its current status.

The qualitative data collected from each FGD at different sites analyzed along the themes separately and then aggregated to give the general picture of the study area. This data source was therefore, organized in the way they could give some pattern and trend along the collected thematic areas of interest and present in the report. To help guide the collection of qualitative data from the discussants at community level and from individual key informants, an interview guide was developed and discussed among the team members to get a full understanding on it and also to further enrich it before the actual commencement of the field work.

Review of the secondary data was made before the commencement of the field and continues throughout field data collection period. The secondary data was checked and rechecked for relevance, consistency and uptodatedness. Accordingly, it was used in the way complement and **Data quality assurance:** the team paid a great concern for the quality of data collected during the field visit and since then, in analysis stage. The quality of data was maintained by triangulation i.e., using different methods of data collection on same issue, and with consultation made with knowledgeable individuals and review of previous similar studies on the topics. Moreover, feedbacks were given at the end of the field visit on preliminary data analysis made during the field to relevant government officials and staff in both at woredas and Zonal levels. Also, the group reflections were incorporated in the final report.

Ethical Issues: assurance was given to make this study more ethical and respect the right of the participants, especially, children. Hence, discussant group of men, women, boys and girls were

asked to agree or give their consent to participate in the discussion so as to make this work more ethical and keep the confidentiality of the participants.

5. Result and Discussion

5.1. Current Status of the pest

5.1.1 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 a new for the locality and even for the country as a whole (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, Sibul 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 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 Sibul (Gombo Kiltu Jale and Wajati Mendi, having 163 and 170 kms air distances, respectively from the source). (Temesgen , 2012).

5.1.2. 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 and 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 was high. This is due to the rain fall was not stopped but after the rain stop the crawlers changed to adult, male and females. This evidence the presence of mango scale with the mango tress 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 detail 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 learnt that there was no transportation of mango to the central markets and as result, this would most likely affects 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.

Table -1: Microscopic observation of 10 leaves collected from Farmers field

No	Farmers Name	Kebele	Woreda	No. of leaves	Total no. of Male	Total no. Female	Total no. Crawlers	Total no. Egg
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	10	0	3	13	18

			Gida					
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 Emanat	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

Source: Own samples lab's observation

5.2. 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 experience a 1 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 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 as "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 year 2012 the pest was causing them a drastic reduction in production and productivity. In year 2014, there was a total failure in mango production. And also the harvested one was no market value because of infestation.

It was learnt that there had been a progressive reduction in mango production and quality right starting from 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 tree like leaves and lower part of 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 up 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.

5.2. 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 colonised by a black non-parasitic materials. For it was so, they often opted to remove the damaged tree with 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.

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.

5.4. Effect of the pest on mango growers' income and livelihoods

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 per cent of the annual income of the households. A total loss of this amount of income most likely caused a great disruption in smoothening the annual outgoings of households. That means that the household who used to cover the aforementioned purchases is now either under stress or used other coping mechanism 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 will be more prominent due to its cumulative effects through time and causing disruption in the normally 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 unsecure for any unforeseen circumstances they may face. That means that the income earned from mango sell proceeding is like one having the money in bank account that can be withdrawn when desired to meet these unforeseen risks. They said that mango is one of the nutritionally rich fruit 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 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 other crop. This would cause deforestation, biodiversity loss, causing soil erosion, depletion of surface and underground water, wildfire and etc. That means that the pest becomes an agent to 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, 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. They described that as a result these situations, a considerable number of families were exposed for 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 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 are reported as highly vulnerable because of their age could not shift to other crop as they also lack labor in their household.

Women – were also reported as highly vulnerable because of loss of income from mango sale proceeding as they often sell 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.

5.4. Cultural management practices

Grower farmers were opted to use variety of cultural practices in efforts to stop/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 give a temporarily relief. They could not help to bring the insect under control and now it become 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 tress- not to contaminate other normal tree or part of the tree
- Burning
- Keeping the sanitary of soil under the tree

Insofar as the chemical control measures, the discussant farmers, though they were so eager to get and apply spraying to the mango trees. They were therefore, highly looking for any external assistance on this. And also vowed to do their part whatever that can be at their capacity level.

5.7. 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 be at 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 cut/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.

5.8. The Implications of the pest to Mango Value Chain Project

The emergence of the pest has become a stumbling block to realize the objectives of 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. Accordingly, the below table would provide a framework for undertaking of discussion that will further refine and guide the adjustment of current project operation logic. .

Table 2: Framework for amendment in project operational logic

Goal: Sustainable utilization of mango fruits for improved economic development through improvement of families in food security by promoting improvements in livelihoods.		
Objective	Recommended actions	Budgetary implication(s)
Increasing use of market opportunities through new arrangements for fresh and processed products	Reducing the interventions under this objective in the way to be replaced for newly added interventions that aimed at controlling the pest.	Moving more of the current budget under this object for the new interventions, for example for establishment of stakeholders' platform to control the pest.
Improving quality, productivity and production;	The interventions under this objective need to be fully diverted to the way in which the various pest control and mitigating measures can be implemented at farming level	The budget also fully shifts to the new interventions planned under the objective.
Increasing participation of organizations of farmers and other marketing groups in the value chains.	This objective also needs to be adjusted in the way the farmers' participation in farmers' organization will serve the purpose of IPM. Farmer Field School initiating FFS for IPM and liaising farmer groups with research centers.	Accordingly adjusted
Promoting community managed saving and loan scheme	This objective also needs to be revitalized by integrating with various disaster risk reduction activities.	Coninue as it is

6. Conclusion and Recommendations

6.1. Conclusion

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 render them economic benefits since infestation has already distributed all over mango growing areas and caused them bad experience. This was mainly because of controlling the pest has become the issue beyond their capacity and this compounded by absence of external support to overcome this challenge. As a result, they appeared somewhat frustrated and started to contemplate other negative measure 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 learnt 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 loss of mango income which was ascribed to failure in harvest during the last cropping season. The economic effect and degree of their resilience was ultimately lie on the individual household's livelihood capacities. These capacities include possession of assets (eg. live stock), 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 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 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 establishment of platform/partnership that will channel and integrate the available resources and efforts towards desired direction. Towards this, the following practical recommendations were forwarded as an outcome of this assessment.

6.2. 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; Melkassa research center 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 scouting the problem.
- Application of insecticides recommended by Ambo Plant Protection Research Center: applaud and white oil.
- Searching of 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 or/and provision of training for model farmers and development agents will be critical to overcome the negative coping strategy that may be adopted by farmers. eg. Cutting mango trees to plant other crops and etc.

- Inclusion of other crops /fruits with mango farm based on scientific selection of the type of crop to be planted.
- Conducting action research on effective management practices at farmers' level with the full participation and ownership of the farmers.

The following recommendations were suggested as the implications of this pest's effects to the mango value chain project. These included:

- Making an adjustment in mango value chain project interventions and budget in line with emerging pest problem.
- Obtaining additional one year no-cost extension period for mango value chain project to have an adequate time to implement the newly adjusted project's interventions.
- Searching for additional funding resources from donors to implement new project that may provide support to farmers alleviate the pest problem and help continue to ensure benefits from mango fruit production and marketing in the years to come.
- Providing training to the development agents and model farmers on the insect life cycle and the corresponding measures that can be cost effective and adoptable at local farmer's level to control the pest.
- Initiating large scale mobilization of mango grower farming communities to manage the pest through integrated pest management with application of farmer field school.
- Liaisoning with research institutions to seek long term solution which is appropriate and cost effective.
- Working in collaboration with concerned and Agricultural office to prepare manual on the insect and to be disseminated among targeted woredas to the practioners including zonal and woreda's experts and development agents.
- Facilitating provision of training on Farmer Field School (FFS) for Integrated Pest Management (IPM) application to project and government staff in the targeted districts.
- Facilitating the reinforcement/establishment of a platform for coordination and/or collaboration of efforts among stakeholders. The platform is expected to help channel their efforts towards mitigating the effect of this pest in a synergetic manner.
- Selection and distribution of pest free seedlings.

- Closely and continuously monitoring the effects of the pest in mango grower's farmers in general, and to those more vulnerable groups of people in particular.
- The mango grower farmers need to diversify their incomes either in farm and non-farm income so as to remain resilient in the future.

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Annexes

Annex 1: Details of assessment team composition

- i. Ato Tesfaye Hailu (Entomologist), Ambo Plant protection Research Center, Ethiopian Institute of Agriculture
- ii. Ato Solomon Tsegaye, Plan International Ethiopia – Oromia Programme Area - Monitoring and Evaluation Coordinator - Team Leader
- iii. Ato Tadele Wakuma , Plan International Ethiopia – Oromia Programme Area- Economic Security Coordinator
- iv. Dr. Hirpa Legese (Agronomist), Lecturer , Wollega University
- v. Ato Menegistu Terefe (Crop Protection), East Wollega Zone Agricultural Development
- vi. Ato Wondu Balch , Plan International Ethiopia – Oromia Programme Area , Mango Vale Chain Project Coordinator
- vii. Ato Gobisa Ayichilu , Plan International Ethiopia – Oromia Programme Area –Assistant Project Coordinator of Mango Value Chain Project
- viii. Ato Temesegen Fita (Entomologist), Lecturer, Wollega University, Shambu Campus
- ix. W/ro Tarike Mosisa (Agronomist) Guto Gida Agricultural Office
- x. Ato Demisse (Agronmist) , Diga Agricultural Office

Annex 2: Interview Guide Questions

Location:

Woreda _____

Kebele _____

Village _____

Date: _____

Participants:

Total No _____ Males _____ Females _____

Participants ' age range _____

Opening

- Greeting the participants
- Thanking them for coming
- Tell them how much hour they will stay with team (maximum 1: 30 minutes)
- Introduce the team members to the participants
- Introduce t the objectives of survey to the participants
- Ask the participants permission /consent to voluntarily participate

Name of Facilitator _____

Name of Note Taker _____

I. Guiding Questions to capture farmers perspectives about the pest

- When where and how did you learn about the pest for the first time?
- Please ask how many of discussant knows the name of the pest? or if they have already given a local name for it , ask them what that is meant for?
- Please tell us the extent of damage caused by this pest in your respective?
- Which parts of the plants were first attacked by the pest? Please probe them to put them in an orderly manner?
- How do you describe the effects the pest on infested mango trees, right starting from its first symptom on mango trees and its subsequent manifestations?
- How long the pest will take to spread to the whole area in your neighborhood farms/please ask them to use weeks or month?
- Did you have observation whether the pest was affected the local varieties and exogenous ones equally or not? if they answer , no ,please ask them the reason why?
- Have you ever seen such kind of pest or diseases affecting the mango trees in such magnitude in your life in this area?
- Please ask what cultural practices have used since the emergence of the pest? Please ask them what was the measure taken and what stage of the pest, what

was result obtained. Please probe them why /how the cultural practices affected the pest at what stage of pest development applied ?.

- Please ask whether they used chemicals, where do they get from, the rating applied and what results obtained?
- Please ask them whether they have received any external supports (from Government, NGOs or any other agencies)? If yes, ask them what ere the type of support and the results obtained?
- Did you have an observation as to whether the newly distributed improved mango seedlings distributed to them by the project infested or not? I
- Have you seen any chance of survival on the new mango seedlings planted on their farms? If so, ask them whether they still need further support on this , or not?
- What protection measures did you take for the new mango seedlings not to be affected by this pest?
- Please tell us any other observations you may have regarding the pest infestation?

II. Guiding questions related to effect of the pest on the growers livelihood situation

- Can you please tell us the extent of average mango production collected from a tree in this year?
- Can you please tell us the average household production of mango and the corresponding income earned from sale of mango during the last cropping year?
- Can you please explain us how the pest has recently affected your households' economy and your livelihood situation? (impact on food security , nutritional security , schooling children , agricultural crop productivity and etc.)
- In your opinion who are the most vulnerable group of people to the pest in your society? and tell us the reason why?
- Can you please tell us how you are preparing yourselves to cope up with the effects of the problem?

Closing

- Please asks them if they have any questions related to our discussion before closing?
- Thank them for their time and sharing us their experience.
- Close the discussion.