Study area (Masha Woreda)

Fig. 1: Map of study area

agro-ecological distribution. Hence, a total of six kebeles were selected, Beto, Wello, Keja, Dengele, Abelo and Gatimo.

Sample size: All enset cultivators, from each purposively selected Kebele was used as study population with the help of district agricultural experts (DA). Informants were included both sexes and elders to get good traditional knowledge. To determine the sample size of the study, the formula provided by Yamane[10] was applied. A simplified formula was used to calculate sample sizes. A 95% confidence level and the estimated proportion of an attribute that is present in the population (p = 50%) and acceptable sampling error (e = 5%). Due to different factors, the total number of informants was reduced to 150.

Data collection methods: Data collection and constraints identification were performed through the following parameters: This includes questionnaires, semi-structured interviews, field observations and focus group discussions.

Interview: In each selected Kebele and village, interviews was carried out by incorporating both sexes and ages groups (above 20 years old) which were selected randomly with the help of a local translator. Semi-structured questionnaires with open and close ended questions were provided to get

clear information about cultivation, major constraints and management of enset in the farm land and home garden. Afterward, household informants were asked to list the name of cultivar and memorize different types of enset diseases and pests that they know about and the effect of these constraints on production of enset. Farmers' knowledge of the pests and diseases (type and nature of damage or symptoms, severity, traditional management practices or control measures, etc.) was recorded.

Focus group discussions: A focus group discussion with eight discussants in each group was carried out on different issues on enset cultivation, major constraints and management mechanisms by indigenous knowledge of the local people. These discussions were involved semi-structured and generally open-ended issues which led to discuss freely and intended to elicit views and opinions from the participants.

Field observation and sample collection: Field observation was done to identify the type of enset cultivation method, constraints that reduce products and traditional management system of the local farmers in the home garden and farm land. Field notes and photographs of plants representing the different local varieties, infected parts of enset with pests and diseases for further identification.

Identification of pests and diseases: After observation of enset growing area and well informed by interview from the informants and stakeholders, the samples (infected enset parts) were collected and identified constraints as diseases (bacteria, fungi or virus) and pests (animal, insects, worms or other conditions) carefully by characterizing certain feature of the constraints. These identification was done by taking the infected parts of the enset and/the organisms to laboratory for identifying the group.

Data analysis: The collected data was analyzed and summarized using Microsoft excel spread sheet and descriptive statistics that include the use of frequency distribution and percentages tables and bar charts.

RESULTS

Enset production for consumption and market: According to the respondents, even though the farmers produce enset mainly for consumption purposes, the low market linkage that confined only local and each other among the neighbors in specific locality makes them not to produce surplus production of enset that links with central market and generate money in the study area. The reason why the farmers were faced for producing and selling the products of enset in the respective markets in affordable prices that little or lost the linkage zonal and central markets for instance mainly due to lack of accessible road (35.65%) and followed by lack of accessibility of transportation (34.09%), harvesting insufficient amount of enset (17.15%) and others factors (13.11%) too for example distance of destination from the market and pre and post-spoilage of enset by diseases and pests and shortening fermentation that made inept to sell in the proper price of it (Fig. 2).

The researchers made a survey in domestic market in Masha towns and observed different type and forms of enset products availabilities. The market accessibility of enset products in the local market were analyzed on the affordable prices provided from different nearby kebeles of farmers. Of the most common types of enset products like kocho, amicho and bula were exclusively exchanged in the local market. Therefore, enset (kocho) was the leading crops in Masha domestic market which was the association of people from nearby kebeles using on horseback.

Constraints of enset production: As mentioned by informants (Fig. 3), the most common pre and post-harvest constraints hampered enset cultivation were pests and diseases accounts (28.94%) and followed by lack of planting materials (15.26%), lack of farmlands (13.07%), Infertility of soil (11.07%) and least constraints in the area was damage/threat by livestock (2.18%). These were the main problem that reduce pre and post product/harvest of enset. According to the informants' response, pests and diseases (28.94%) constraints of enset crop was the main problem by which the local farmers' challenges for managing their crops in the right manner and it reduced the products and damage growing and reduced the shelf life of enset products.

Most of the above types of losses can be attributed to infect and damage planting materials of different root and tuber crops in the field or home garden or at pre and post-harvest infection as well. But the effect of planting material quality is not limited to yield losses. It also affected the storage properties of the product and its eating quality even loss of marketability. It is therefore appropriate for agricultural programs to devote a significant share of their resources to this important aspect of crop production. The data collected from the informants and agricultural office of
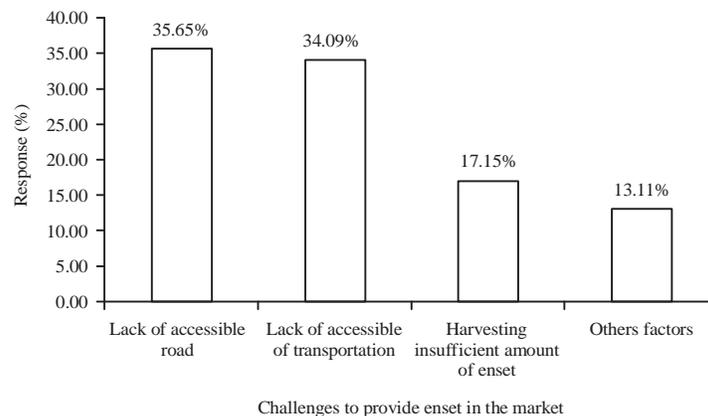

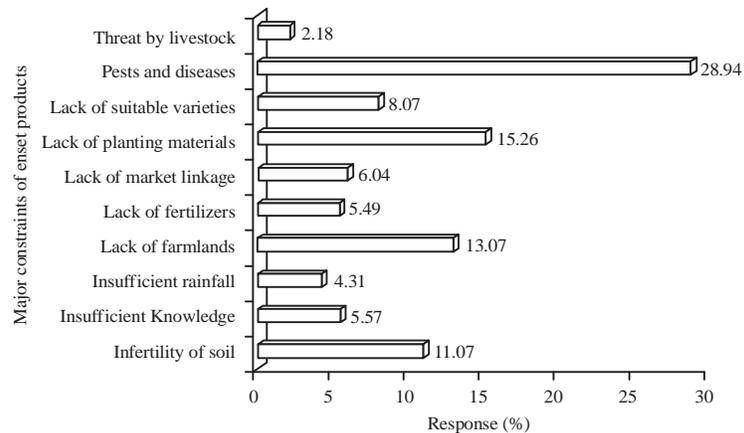Fig. 2: Reasons that farmers do not provide enset products to the market

Fig. 3: Major constraints to Enset productions and harvests in the Masha District
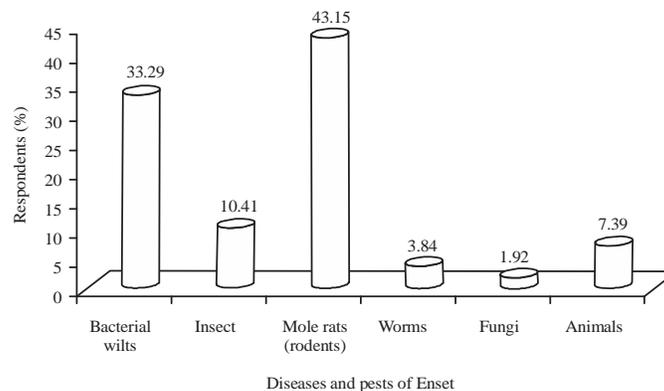

Fig. 4: Pests and diseases of enset that reduce the products in the study area

Masha district, the most devastating disease and pest of enset crops were mole rats accounts (43.15%) and followed by bacterial wilts (33.29%), insect (10.41%) and least one was fungi (1.92%) (Fig. 4). From the above diseases and pests of enset, some of them were not identified and managed by local farmers even by the agricultural office of the district. From which bacterial wilt and fungal diseases are not manageable by farmers which were the main factors that reduce the products of enset unexpectedly. For example, bacterial wilt was highly expanded and attacked the bud and leaves of the enset and meanwhile the enset are dried before it gives products.

Traditional control system of enset constraints: According to the respondents and field observation data, enset bacterial wilt which damage mostly the bud (locally called mushira) and leaves of the plant. It was also disappeared partly by factors like wild animal pests such as porcupine and mole rat that eat the root, pseudo stem and leaves of enset that devastate the whole plant at the end of the day. These types of constraints were the most common and unresolved by local farmers

scientifically in the study area (Fig. 5). To cope up with these problem, the local farmers developed enormous knowledge by selecting the most adaptable, disease and pest resistant varieties of enset selected by indigenous farmers were Gudiro', 'Nobo', 'Yobo' and 'Cherallo'.

The farmers attempted to alleviate the problem of these diseases and pests using traditional knowledge: using the smoke of grasses or straw of teff and then get in to the hole of mole rats. As a result, it can be died after some days later. Similarly mole rat traps or snares used to catch it and kill it physically (Fig. 5). One of the good examples was the trap invented and used for example against mole rats, which is one of the notorious pests of enset and other root crops. Even though there is a need to upgrade it, the technology is still appropriate in the area and has an important role in controlling the mole rats. But the disease especially bacterial wilt is not solved urgently as a serious problem even though the cases are known by the agricultural office of the Sheka zone to bring a sustainable solution and alleviate the issues.

Fig. 5(a-b): Deteriorate effect of mole rats on the corm of enset crop in the study area, (a) Infected enset and (b) Farmer removes the infected enset by digging

DISCUSSION

The enset crop is grown and adapted to unique ecosystems particularly in Ethiopia only for traditional foods consumption. Enset is important in the study area to meet local food preferences, providing an important part of the diet as they produce more edible energy per hectare per day than any other crops which play an important role in food security, nutrition and climate change adaptation[2,7,11]. From the common diseases and pests of enset in the area, some of them were not identified and managed by local farmers even by the agricultural office of the district. From which bacterial wilt and fungal diseases are not manageable by farmers which are the main factors that reduce the products of enset unexpectedly. For example, bacterial wilt was highly expanded and attacked the bud and leaves of the enset and meanwhile the enset are dried before it gives product. This result is compatible with finding of Hunduma *et al.*[5].

Different factors were hampered the activities of farmers to get remarkable products of enset. Realizing that there are benefits accruable in the cultivation of enset crops in the study area, efforts must be put in obtaining good production level[7]. However, there are lots of factors in achieving these activities which are supposed to be constraints. The productivity of enset crops is often affected by the accumulation of pests and diseases which are passed on through vegetative propagation. This constrains value chain development and the expansion of production and delivery at scale to kebele and district. There is a need for new, beneficial varieties that meet a range of consumer demands and being productive[5,7,8].

Enset contribute significantly to basic food requirements in urban and rural areas, especially for poorer communities[12]. The most common constraints of Enset and the useful varieties are highly susceptible to diseases such as enset bacterial wilt, mealy bug as well as global change in climate. Enset bacterial wilt which damage mostly the bud (locally called mushira) and leaves of the plant. It is also disappeared partly by factors like wild animal pests such as porcupine and mole rat that eat the root, pseudo stem and leaves of enset that devastate the whole plant at the end of the day. This also stated in similar manner with Yemataw *et al.*[8]. These types of constraints were the most common and unresolved by local farmers scientifically in the study area (Fig. 5). To cope up with these problem, the local farmers developed enormous knowledge by selecting the most adaptable, disease and pest resistant varieties of enset selected by indigenous farmers were Gudiro', 'Nobo', 'Yobo' and 'Cherallo'. The indigenous people attempted to alleviate the problem of these diseases and pests traditionally[11,13]: Using the smoke of grasses or straw of teff and then get in to the hole of mole rats. As a result, it can be died after some days later. Similarly mole rat traps or snares used to catch it and kill it physically. Because it requires great deal of energy and technology that is why it is widely distributed in the district. Generally, the activities what the farmers attempted to solve problems of pest and diseases using traditional knowledge were still full of problem and not quit effective. So, it requires further investigation. This result was agreed with the finding of Mulualem and Walle[14]. The shortage of farmland per household has reduced livestock size, which in turn has influenced the home garden soil fertility because livestock are sources of organic fertilizer, manure[7,8,15].

Therefore, many varieties that are reputed for their *hamicho* and *bulla* qualities as well as fast fermentation are disappearing. Furthermore, many young farmers with very small plots of farmland were found planting fast growing annual crops than enset. In order to estimate future genetic erosion as well as to preserve this agro-biodiversity, there is a need to conduct the diversity and management of existing enset land races in terms of local knowledge of enset land races as well as the genetic investigation.

CONCLUSION

The studies assessed and analyzed the major constraints and traditional management system of enset crops by farmers of Masha district. Enset was cultivated mainly for staple food in the district. Even though some enset varieties were naturally adaptable and disease and pest resistant which selected by indigenous farmers, the productivity of most enset varieties was often affected by different constraints. The most common and deteriorative constraints of pre and post-harvest of enset crops were pests and diseases which was not manageable and controllable by the local farmers alone. This needs urgent solution for enset cultivation from stakeholders. Therefore, further research needs to conduct and select good variety of enset and control the deteriorate diseases and pests that reduce the productivity of enset crops. Similarly the constraints can be managed by applying the Implementation of Integrated Pest Management for Sustainable Enset Pathogens and Pest Control.

SIGNIFICANCE STATEMENT

This study is focused on the enset production challenges and its traditional management. It is beneficial for surviving the critical problems on the production of enset using scientific methods in the near future. To do this, traditional management is a baseline and it can be improved by applying different constraint control methods. This can be done by stakeholders of the district and zonal agricultural and development office and food and sustainability program. Therefore, the findings will be remaining uncover for addressing each farmland of the districts, the researchers allow to search the critical areas of enset production challenge that were not able to explore yet. Thus a new investigation on the enset varieties and management may be arrived at with help of biotechnology.

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