FINAL EVALUATION OF PHASE 1 REPORT

PROJECT GCP/ETH/084/SWI

Reducing Food Losses through Improved Postharvest Management in Ethiopia

Addis Ababa, March 2018

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Abbreviations

ANRS	Amhara National Regional State
B/C	Benefit/Cost
BoAs	Bureaus of Agriculture
CBOs	community-based organizations
CSI	Coping Strategy Index
DA	Development Agents
Das	Development Agents (DAs),
EIAR	Ethiopia Agriculture Research Institute (EIAR)
FAO	Food and Agriculture Organization of the United Nations
FAOETH	FAO Ethiopia Country Office
FCA	Federal Cooperative Agency
FCS	Food Consumption Score
FGDs	Focus Group Discussions
FTC	Farmer Training Centre
GDP	Gross Domestic Product
GTPII	Growth and Transformation Plan II
HDDI	Household Dietary Diversification Indicator
HHS	Household Hunger Scale
KIs	Informant interviews
LF	Log Frame
M&E	Monitoring and Evaluation
MoANR	Ministry of Agriculture and Natural Resources
MoI	Ministry of Industry
NPV	Net Present Value
NSC	National Steering Committee
OECD-DAC	Organization for Economic Cooperation and Development-Development Assistance Committee
ONRS	Oromia National Regional State
PHLM	Post-harvest Loss Management
PHLs	Post-harvest Losses
RARI	Regional Agricultural Research Institute
RSC	Regional Steering Committees
SDC	Swiss Development Cooperation
SNNP	Southern Nations, Nationalities and Peoples
TNRS	Tigray National Regional State
TVET	Technical and Vocational Education Training

Executive Summary

1. This report presents the results of final evaluation of Phase I of the project GCP/ETH/084/SWI "*Reducing Food Loses through Improved Postharvest Management in Ethiopia"*. The 4-year project commenced in 2013 and ended in December 2017 implemented by Food and Agriculture Organization of the United Nations (FAO) and financed by Swiss Confederation through Swiss Development Cooperation (SDC). The project targeted four outcomes including;
   - *Outcome 1*: Improving the knowledge, attitude and practice of smallholder men and women farmers, development agents, youths and others on postharvest management to change the behavior of all stakeholders on postharvest loss management.
   - *Outcome 2*: Strengthening the human resource and institutional capacity on postharvest management
   - *Outcome 3*: Scaling up compilation and dissemination of good practice options for reducing postharvest to small holder men and women farmers
   - *Outcome 4*: Formulating a country postharvest management policy and strategy.

   The project was implemented in four (4) regions including the Amhara (ANRS), Oromia (ONRS), Southern Nations, Nationalities and Peoples (SNNP) and Tigray (TNRS) National Regional States. It was set to benefit 7,746 households directly from 14 selected woredas (districts). The major stakeholders and implementing partners included: the target communities (small-scale farmers, grain traders, processors and primary cooperatives); FAO; Ministry of Agriculture and Natural Resources (MoANR); Ethiopian Institute of Agricultural Research (EIAR); Regional Bureaus of Agriculture (BoAs); Regional Research Institutes (RARIs); Higher Learning Agricultural Institutions; Non-Governmental Organizations (NGOs); other UN agencies; community-based organizations (CBOs) and the private sector. A National Steering Committee (NSC) with members from the relevant ministries, FAO and SDC provided oversight of the project at national level whereas Regional Steering Committees (RSC) provided oversight at region level. FAO, as the coordinating agency, played a leading role in directing, supervising and supporting the progress of project implementation.

   An independent consultant was tasked with the final evaluation using a mixed method approach within the OECD-DAC criteria of development project evaluations. This criteria entails evaluating the relevance, effectiveness, efficiency, impact and sustainability of the project.

2. Results of the evaluation indicated that the project was highly relevant in addressing the needs (postharvest lose management) of the small-scale. Its relevance resonates well with goals of reducing postharvest loses at global, regional and national levels as well as sub-regional levels thus cannot be overemphasized and is highly relevant within the context of Ethiopia which continues to experience considerable postharvest loses in present of spiraling food insecurity and persistent poverty. The project design and risks assumed were largely adequate in driving the achievement of the goals lest for few inadequately unanticipated risks which did not hamper the achievement of the broad goal. The goal of the project "*Reducing*

food loses through improved postharvest management" was quite instrumental in bringing behavioral change at national and regional levels of governments as well as at the farmers' level.

3. Evaluating the achieves and mapping them according to the expected outcomes, the assessment found that the project made significant achievements towards *outcome 1* of improving the knowledge, attitude and practice of smallholder men and women farmers, development agents, youths and others on postharvest management to change the behavior of all stakeholders on postharvest loss management. Among the benefits were;
    i) Behavioral change realized through trainings, awareness creation and capacity building which reached more the 95 percent of the targeted beneficiaries. The training and capacity building enabled farmers to understand the magnitude of postharvest losses and the manner in which they can mitigate them,
    ii) Although food storage was limited to the storage volume of the metal silo, it allowed farmers to store an estimated 23 percent of the farm production away from the damage by postharvest factors. However, a significant 54 percent remained to be stored in traditional structures,
    iii) the metal silo enabled farmers to prolong the storage of food over the food deficit months of June and November, more than 6 months enhancing food security at household level, and
    iv) Of the total food stored in the silos, 36 percent was consumed at household level ensuring smoothening of food consumption over the deficit months,
    v) On the household income, the capacity to store food enabled farmers to bargain for better prices. Moreover, 64 percent of the total food stored was sold at least at double the prices they would have sold had the silos not been available.

4. Reducing postharvest loses requires able human resource and institutionalization of the agenda within the stakeholders and the policy, legal and institutional frameworks. In terms of *outcome 2,* the project made tremendous efforts in building the capacity of Development Agents (DAs), Farmer Training Centres (FTCs), and Technical and Vocational Education Training (TVET) Centres and in supporting research centres and higher learning institutions on PHLM and this enabled them to play effectively their roles in the project. The ministry of agriculture, the regional bureaus of agriculture as well as research benefited from the capacity building efforts. The nitrogen analyzer at Jimma University and the Melkassa metal shearing machine are some of the capital-based facilitations that enable the two institutions to play their roles better. As such, there institutions are better placed to drive the postharvest knowledge development and dissemination.

5. In terms of *outcome 3,* the postharvest loss management was widely accepted by the communities, woredas or *Kebeles* where it was promoted and even within non-beneficiaries. All the regional training centres, extension staff regional agricultural bureaus accepted the metal silo storage technology with ease. The project supplied 2,800 metal silos over the

project period to farmers who used them for storage. Those farmers who benefited from the project have shifted their storage from the traditional to the effective and efficient metal silo after realizing the benefits. The good practices even extended to non-beneficiaries in several of the woredas with farmers purchasing and expressing demand for metal silos.

6. The achievement of *outcome 4* was most significant. The project push towards entrenching postharvest agenda within the national and regional polices was highly successful. It resulted in the formulation of the postharvest management strategy in grains in Ethiopia that never existed before the project. Further, it also led to formulation of policy briefs that informed the necessary changes in the policy levels. The postharvest agenda now sits in the center of national and regional government's policymaking. With the postharvest loss management strategy launched, a conducive policy and institutional environment was set to deal with postharvest loses leading to incorporation of the postharvest loss agenda in regional governments annual planning and supporting artisans to fabricate metal silos.

7. **Way forward:** following the assessment, a seven points have been deemed important for consideration in Phase II. The second phase of reducing postharvest loses will be market/private sector driven in order to guarantee continuity and sustainability in absence of the donor funding. As such, Phase II should explore among others, the following;
   i. Continued training on and promotion of the PHLM technologies and practices to reach those farmers within and outside the project areas who still have limited information in the PHLM technologies.
   ii. The extent and effects of PHLs still remain unrecognized in many of the farmers and hence widening and deepening of awareness creation on the extent of short and long-term impacts of postharvest loses will be important in Phase II.
   iii. In order to gain an upper hand in driving the acceptance of PHLM technologies, increased research and dissemination of information regarding access and utilization of silo storage technology will be important. Such research will entail, but not limited to *i) investigations and identification of into macro- and micro economic environment, ii) cost effective volume of the silo and, iii) investigation into mechanisms that promote adoption of PHLM technologies.*
   iv. The linkages to affordable and favorable financial services has not been adequately addressed, yet this is a key driver of the PHLM technology adoption. Phase II should focus on development of market linkages to credit facilities for both artisans and small-scale farmers
   v. Further, there is need to reorient the metal silo supply model to allow for increased private sector participation. Market orientation of Phase II to enhance distribution of metal silos in Phase II need to look concentrate on; *i) increasing the number of players in sheet metal importation, ii) expanded local distribution of metal sheet, iii) increase access to financial services, iv) demand creation for increased uptake of metal silos*
   vi. As Phase II is being set, deliberate efforts should be made to establish a clear and feasible M&E plan that will enable telling the story of achievement through the project life cycle

and in the final evaluation, lent itself to assessment (in qualitative and quantitative approaches) of the achievement on PHLM interventions.

In the design of Phase II, key assumptions need to be given due attention if the project is to confer maximum benefits to the beneficiaries. Key assumptions that need attention include *local availability of sheet metal, political upheavals and macro-economic stability.*

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1. Introduction and purpose of the evaluation

8. This report presents the results of final evaluation of Phase I of the project GCP/ETH/084/SWI "*Reducing Food Loses through Improved Postharvest Management in Ethiopia"*. The Phase I, which is an entry phase, implemented by the Food and Agriculture Organization of the United Nations (FAO) and financed by the Swiss Confederation through the Swiss Development Cooperation (SDC) aims at prioritizing long-term intervention areas in postharvest loss reduction for major food grains. The Phase I of the 4-year project started in 2013 and concluded in 2017. The independent evaluation of the project was commissioned by FAO Ethiopia office, and took place over the month of February 2018.

9. The evaluation focused on the four project areas including Amhara (ANRS), Oromia (ONRS), Southern Nations, Nationalities and Peoples (SNNP) and Tigray (TNRS) National Regional States and the four target crops-maize, wheat, sorghum and haricot beans. The findings of this evaluation will guide future SDC related projects and in designing and formulation of Phase II of the post-harvest loss reduction project.

10. The purpose of the evaluation was to provide the FAO Ethiopia, SDC and other stakeholders with an independent assessment of the achievements towards the project purpose. The evaluation assessed how the project achievements contributed towards food security, household income and behavioral change at household and policy level. Moreover, it entailed looking at the sustainability and replicability over time and space of these achievements.

2. Approach, Methodology and Data collection

11. The evaluation adopted a mixed methods approach using quantitative and qualitative analysis techniques. The analysis was conducted within the Organization for Economic Cooperation and Development-Development Assistance Committee (OECD-DAC[1]) criteria for development project impact evaluation. The evaluation also took into consideration the FAO's monitoring and evaluation guidance. The OECD-DAC comprises of five criterion including relevance, effectiveness, efficiency, impact and sustainability. Quantitative and qualitative analysis was built within these criterions. A variety of economic evaluation criteria including Benefit/Cost ratio (B/C ratio), Net Present Value (NPV) and the Internal Rate of Return (IRR) were employed to draw insights from the project data.

12. Data and information was collected and collated through several techniques. **Literature review:** Project documents, government policies and relevant published and unpublished literature were reviewed. Some of the documents include the project background report,

[1] "The five evaluation criteria from the Development Assistance Committee of the Economic Cooperation and Development (OECD/DAC) have been a strong foundation for international development evaluation since 1991"-(Chianca, 2008)

several specific subject report prepared during the implementation of the project, government strategic documents e.g. the Growth and Transformation Plan II (GTP II) 2015/16-2019/20 among others. Key Informant interviews (**KIs)** and Focus Group Discussions **(FGDs)** were conducted and included the project management staff at FAOETH, the Ministry of Agriculture and Natural Resource, Learning institutions (Jimma University), and artisans across the project region, individual beneficiary and non-beneficiary farmers, and representatives from Regional Research Bureaus. The Focus Group Discussion were conducted to collect qualitative data and information.

13. **Validation Field Visit and observations:** The consultant accompanied by the FAOETH project staff conducted field validation visits. These visits checked on the level of the utilization of the interventions and made observations on any environmental factors that may be of interest to the project. However, the field evaluation exercise was limited by time and security concerns that restricted movement to several of the project sites. As such, extensive fieldwork especially with regard to collecting quantitative data for more comprehensive analysis was limited calling for careful interpretation of the responses obtained from the field visits.

Figure 1: Focus Group Discussion (FGD) at Debre Elias

3. Background of Food loss and Post-Harvest Management

14. Reducing food insecurity remains a global goal and concern especially in the developing countries where a considerable population remains food insecure and malnourished. A third of global food production or even more goes to waste in developed and developing countries (Gustavsson et al., 2011[2]; Foley et al., 2011[3]). In addition to food insecurity, the backward effects of food losses amplify to waste of land, water, energy, financial, agrichemical and mechanical inputs and hence project an environmental and natural resource constraint concern as population continues to expand. The population is expected to grow by 33 percent between 2017 and 2050 driving increase in food demand amidst continued higher levels of food losses with up to 30 percent being reported. In the developing countries, 40 percent of the losses occur at post-harvest and processing levels, whereas in the industrialized countries, 40 percent occur at retail and consumer levels (Gustavsson et al., 2011). Therefore, improving post-harvest loss management and technologies (in particular for smallholders) and reducing food waste help to address the major challenges towards achieving global food security.

15. Compared to enhancement of agricultural productivity, post-harvest loss management has received, if any, limited attention in form of funding, policy and strategy development from policy makers and even funding, yet, increasing agricultural productivity does not necessarily lead to improved food security situation. Whereas it is estimated that there is sufficient food production in the world, the availability of food does not guarantee access at household level. The future of food security may increasingly depend on controlling post-harvest loses to make the lost 30 percent available for household use. This will save on the resources committed towards increased production, will have direct environmental impacts and will lower or stabilize food prices hence reducing the effects of food price volatility and negative effects on food security.

16. In Ethiopia, agriculture contributes 40 percent of the total GDP and employs 80 percent of the population. The sector holds the key to structural economic transformation, growth and the continued quest to alleviate poverty and reduction of food insecurity in the country. Evidence shows that for every 1 percent increment in agricultural GDP, poverty declined by 0.9 (World Bank, 2016[4]). The country faces poverty incidences as high as 29 percent cutting across the urban and rural divide driven by unemployment (World Bank, 2016) and 15 million

[2] Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., Meybeck A., 2011. Global Food Losses and Food Waste: Extent, causes and Prevention. FAO, Rome, Italy.

[3] Foley, J.A., Ramankutty, N., Brauman, K.A., Cassidy, E.S., Gerber, J.S., Johnston, M., Mueller, N.D., O'Connell, C., Ray, D.K., West, P.C., Balzer, C., Bennett, E.M., Carpenter, S.R., Hill, J., Monfreda, C., Polasky, S., Rockström, J., Sheehan, J., Siebert, S., Tilman, G.D., Zaks, D.P.M., 2011. Solutions for a cultivated planet. Nature 478, 337–342.

[4] World Bank, 2016. Priorities for Ending Extreme Poverty and promoting Shared Prosperity, in Ethiopia.

people are food insecure. Majority of the extreme poor, about 40 percent of the poor live and reside in rural areas and are dependent on agriculture.

17. Post-harvest loses are identified as one of the drivers of food insecurity in Ethiopia with an estimated 30-50 percent of total food produced being lost at the storage stage (Tadesse et al., 2013)[5]. Storage facilities in Ethiopia are largely traditional (Figure 2). Poor storage practices and technologies in developing countries have failed to guarantee minimal quantitative and qualitative loss of food after harvest (Tafera et. al., 2011) prompting the search for more effective post-harvest storage technologies including the metal silo and or hermetic bags. The working principle of the metal silo is based on creation of hermetic concept that excludes oxygen in the galvanized container killing insects and pests present in crops.

18. Evidence shows that post-harvest loss management will be successful following adequate capacity development and making available appropriate effective storage technologies (WFP, 2014). For instance, in Burkina Faso and Uganda, the impacts of postharvest storage technologies were found to reduce effectively post-harvest loses by 98 percent regardless of the crop and duration of storage (WFP, 2014). More specifically, metal silos have been found to positively influence food security, empower smallholder farmers and enhance income opportunities, reduce poverty, employment creation through artisanal work and above all, they have positive impact on agro-ecosystems in Africa, Asia and Latin (Tafera et. al., 2011).

Kitchen roof drying and storage technique

Traditional storage (gotta/ gubi) in South Achefer Woreda

Makeshift maize drying structure made of wooden rafters and maize straw

Figure 2: Traditional storage structures in Ethiopia

[5] Abraham Tadesse, 2013: Assessment of status of postharvest losses in grain crops, current practices and technology for loss reduction among smallscale farmers in the highlands of Ethiopia. The case case of Enebse Sar Mider and Enar Enawga woredas of Eastern Gojam zone of Amhara region.

3.1. Purpose, goal and outputs of Reducing Food Loses through Improved Post-Harvest Management Project-Phase 1

19. The overall goal of reducing food loses through improved post-harvest management project, henceforth referred to as "the project" was to contribute to improved food security of smallholder farmers in Ethiopia through reduction of crop postharvest losses at farm and primary cooperatives level.

20. Reducing food loses through improved postharvest management project, a multi-stakeholder project, was set to benefit 7,746 households directly from 14 selected woredas (districts) of the Amhara (ANRS), Oromia (ONRS), Southern Nations, Nationalities and Peoples (SNNP) and Tigray (TNRS) National Regional States. The major stakeholders and implementing partners included: the target communities (small-scale farmers, grain traders, processors and primary cooperatives); FAO; Ministry of Agriculture and Natural Resources (MoANR); Ethiopian Institute of Agricultural Research (EIAR); Regional Bureaus of Agriculture (BoAs); Regional Research Institutes (RARIs); Higher Learning Agricultural Institutions; Non-Governmental Organizations (NGOs); other UN agencies; community-based organizations (CBOs) and the private sector. A National Steering Committee (NSC) with members from the relevant ministries, FAO and SDC provided oversight of the project at national level whereas Regional Steering Committees (RSC) provided oversight at region level. FAO, as the coordinating agency, played a leading role in directing, supervising and supporting the progress of project implementation.

21. Despite the substantial production in Ethiopia, a high level of grain loss occurs at each stage of postharvest operations including harvesting, drying, threshing, winnowing, transportation and storage. A baseline survey conducted at the start of the project found that the postharvest losses for maize, wheat, sorghum and haricot beans in the 14 woredas in which the project was to be implemented were 16.7 percent, 14.8 percent, 24.8 percent and 21.8 percent respectively. The project overall impact was to reduce postharvest Losses by 20 percent in the project woredas by 2017/2018 and by 50 percent by 2022.

22. The project focused on four fronts to drive the reduction of postharvest loses;
    i) Improving the knowledge, attitude and practice of smallholder men and women farmers, development agents, youths and others on postharvest management to change the behavior of all stakeholders on postharvest loss management.
    ii) Strengthening the human resource and institutional capacity on postharvest management
    iii) Scaling up compilation and dissemination of good practice options for reducing postharvest to small holder men and women farmers
    iv) Formulating a country postharvest management policy and strategy.

4. Relevance and Quality of the Project Design

23. The Phase I of the project "Reducing Food Loses through Improved Postharvest Management in Ethiopia" set out to enhance the knowledge and skills on postharvest, develop the human and institutional capacity on postharvest loss management, scale up collection and dissemination of the relevant information and development of the country's strategic direction on postharvest loss management. The manner and approach in which these four outcomes are defined in the logical framework makes it relevant towards reduction of the postharvest losses. The relevance of the project was thus evaluated on the background of;

    i) Response to lessons drawn from previous experiences and studies
    ii) The alignment with the stakeholder needs regarding postharvest loses and management including food security, increasing household incomes and cross cutting gender issues
    iii) Policy frameworks in postharvest loss management in the country.
    iv) The effectiveness of the design and implementation in achieving the project objectives
    v) The relevance of the silo distribution business model
    vi) Assumptions of risk

24. ***Response to lessons from previous studies in PHLM:*** The Phase I of *Reducing Food Loses through Improved Postharvest Management in Ethiopia* was premised on lessons from previous studies (Tadesse, 2013) conducted to establish the levels of postharvest loses in the country. The lessons, outlined in the project proposal pointed out several issues including;

    (i) In addition to focusing on the technical aspects of the technology, focus should also be directed to the relevance of the postharvest technology to the context, that is, the (a) situation or the context of the community need, (b) its acceptability in terms of culture, and (c) favorable costs and benefits which are determined by factors and constraints at farm level and also along the value chain
    (ii) Understanding not only the ability of farmers to overcome constraints related to technical know-how but also the local availability of materials, financial resources, and overcoming market constrains is critical.
    (iii) Need for a strong M&E by establishing baseline data and information as a prerequisite for making a proper assessment of postharvest - related problems and establish their underlying causes and suggesting solutions based on concrete evidences.
    (iv) The need to build synergies with the private sector to enable sustainability of the PHLMs.

25. These issues which confirmed the need for bridging knowledge gaps, human and institutional capacities, increased information dissemination with regard to PHLMs and development of national policy frameworks were incorporated in the formulation and designing of the project. Indeed, the outcomes of these lessons formed the four front pronged approach to tackling postharvest loses in the project. Although there were lessons regarding to monitoring and evaluation them, the project M&E and the setup was not adequate to reveal changes in reduction of postharvest loses. Whereas a baseline was conducted, the final evaluation, which should bring out the impact of the project, experienced inadequacies in quantitative data that would have been used to ascertain with evidence the reduction by 20 percent of the postharvest loses. As such, the overall impact and outcomes can only be qualitatively imputed and simulated.

26. ***Alignment with beneficiaries' priorities and expectations, country and global priorities:*** That the global food loses account for a third or more on the total agricultural production has been substantiated in several studies. The initiation of any program directly dealing with postharvest loses has a positive impact and addresses core needs of food insecurity and poverty through availing more food and increasing household incomes. At household level, the overall household needs relate to food security and generation of incomes. Agriculture is the livelihood for many rural households. Yet, many households, despite investing in agricultural production, end up food insecure and poverty-stricken. The overall objective of this project relate to improvement of household food security status and poverty alleviation through reducing postharvest loses and augers well with household needs. Moreover, this project awakens the realization of the magnitude of the postharvest loses within the communities and imparts them with the limiting knowledge, capacity and technologies of postharvest loss management. The technologies put forward by the project targeting smallholder farmers are effective, efficient and easy to use and accelerates the households towards achievement of their priority goals of food security and household income.

27. ***Policy frameworks in postharvest loss management in the country:*** Earlier attempts towards postharvest loss management failed to result in policy space that would have allowed continuation of the agenda through this project. Although there are policies that entailed meeting food and nutritional security, the advocacy was towards increased production at farm level with less concern at the postharvest end of the value chain. This project, while in line with the agenda of achieving food and nutritional security, targeted a different but yet important aspect of achieving same national and global goals.

28. ***The effectiveness of the design and implementation in achieving the project objectives:*** The evaluation found logical consistency in the manner in which the project was implemented. The knowledge, training and skill development that ensued through the research and training before fully rolling out the project was requisite for adoption. Moreover, the awareness that was created amongst the beneficiaries of the project were equally important for adoption of more efficient and effective postharvest storage structures.

29. ***Relevance of the silo distribution business:*** The business model used to distribute silos was also effective in several ways. One, the fabrication of the silos was at the village level allowing the farmers to discuss with the fabricators and to make their own choice on the type of a silo that befits their needs and capacity. Two, the model allowed for training metal silo fabrication, capacity building and creation of employment among the youth artisans besides imparting them with long-term business skills of fabrication metal silos. For instance, in South Achefer, by the time of final project evaluation, the artisans had sold 239 metal silos, 205 from the FAO supported project and 34 to non-project beneficiaries. Of the 205, FAO provided materials for 67 of the silos then FAO bought them at 2,167 Birr for further distribution to the farmers. This was meant for the artisans to fully practice the fabrication and acquaint themselves with the process of fabrication. For the rest 138 (205 less 67), the artisans raised capital and purchased all the material for fabrication. FAO purchased these at 3,176 birr and distributed them to the farmers. This second process was meant for the artisans to acquaint and train themselves with the logistical procurement of the materials required for the metal silos. Besides these FAO supported process, non-beneficiaries had requested more than 34 silos, an indicator of the demand for the technology. Indeed, some of the requests were from the urban dwellers who demanded a fabrication of one (1) quintal silo for storing of flour.

30. ***Assumptions and Risks:*** the project made plausible assumptions of risks. These major assumptions of risks are evaluated in ANNEXES

31. Annex 1 for their relevance and adequacy. Some of the key assumptions made relate to availability of raw materials (metal sheets), availability of resource experts on PHLM, effective network connectivity among others. The assumption “towards” availability of metal sheet was not adequate as revealed later in the assessment that this posed the main challenge towards fabrication of the silos. It is for this reason the project took initiatives to introduce the hermetic storage bags that are equally effective and efficient in storing grain.

5. Effectiveness (Achievement of Purpose)

32. The effects of the project was assessed based on 10 indicators (1-impact level indicator and 9 outcome level indicators) as defined on the Logical Framework (LF). Many of the output indicators were already evaluated in the mid-term exercise that took place almost at the end of the project. As such, we found no reason to relook at the progress of implementation because almost all of the implementation activities had been completed by the time the mid-term exercise was conducted. The 10 indicators which are spread across the four outcomes were not covered in the mid-term evaluation and so our focus.

5.1. Behavioral change towards postharvest management

33. The project has adequately promoted behavioral change towards postharvest loss management through improvement in knowledge, attitudes and changes in postharvest

practices. Trainings on postharvest management practices, on fabrications of metal silos spearheaded by the project, research and dissemination of postharvest loses among the stakeholders has resulted in changes in attitudes and perceptions towards PHLs. The availability of acceptable and culturally compatible technologies such as metal silos and hermetic bags has also led to actual shifts from the traditional storage structures to the more efficient and effective storage techniques.

34. At household level, the perceptions towards PHLM has changed. The understanding of the magnitude of postharvest loses incurred after harvest has prompted farmers to be keen on measures aimed at reducing postharvest loses. The project has resulted into a behavioral and attitudes change towards postharvest loss management among the beneficiaries. The change from the traditional and chemical intensive storage practices to the silo storage points to changing storage practices. These shifts towards more effective and efficient storage structures was driven by the trainings, capacity building, creation of awareness (through leaflets, posters, radio and TV programmes including in local languages) and consensus building amongst the postharvest stakeholders.

35. At the policy and institutional level, the project has led to changes in the way the government addressed the postharvest loses. The realization that it is difficult to realize the national food security in presence of PHLs has heralded the shift of development agenda at national and regional governments to pay attention to these loses. The development of the Post-harvest Management Strategy in Grains in Ethiopia, development of a postharvest loss management platform and a webpage hosted by the Ministry of Agriculture and Natural Resources (MoANR) are clear indications of the government willingness to the subject. These outputs related to policy changes bring together various stakeholders to share information and inform policy on postharvest losses and the appropriate management intervention. At the lower levels of governance, the woreda level of administration demonstrated commitment towards postharvest loss management through supporting artisans with working plots with urban centres easing the cost of metal silo fabrication.

5.2. Reduction in postharvest losses

36. The project targeted to reduce postharvest losses by 20 percent in the project woredas by 2017/2018. While this was not a mean feat, efforts show that the project succeeded in demonstrating that postharvest losses could be minimized through management. The project supported the farmers with about 2,800, 6 quinta [6] (600 Kg) metal silos to project beneficiaries for storage of their grains. Farmer focus group discussions in South Achefer

[6] Quinta is a local measure and is equivalent to 100 Kgs

revealed that the amount of grain being stored in the metal silos was about 23 percent with 54 percent of their total farm produce (Figure 3) still stored in the traditional structures because the silos were not voluminous to accommodate all their produce. The 23 percent stored in the metal silos is effectively protected from PHLs and can proportionally be extrapolated that, of the 20 percent target, about 5 percent of the postharvest loses have been reduced. Moreover, farmers attested to the fact that they are losing less of their produce because not all of it is subjected to the effects of insects, rodents and moulds. Further, using the silos, they have good control of PHL compared to the traditional structures known locally as *Gotta*. It is expected that in the longer term, farmers having realized the importance of the metal silos and hermetic storage bags will invest into purchasing additional silos and bags to address their requirements.

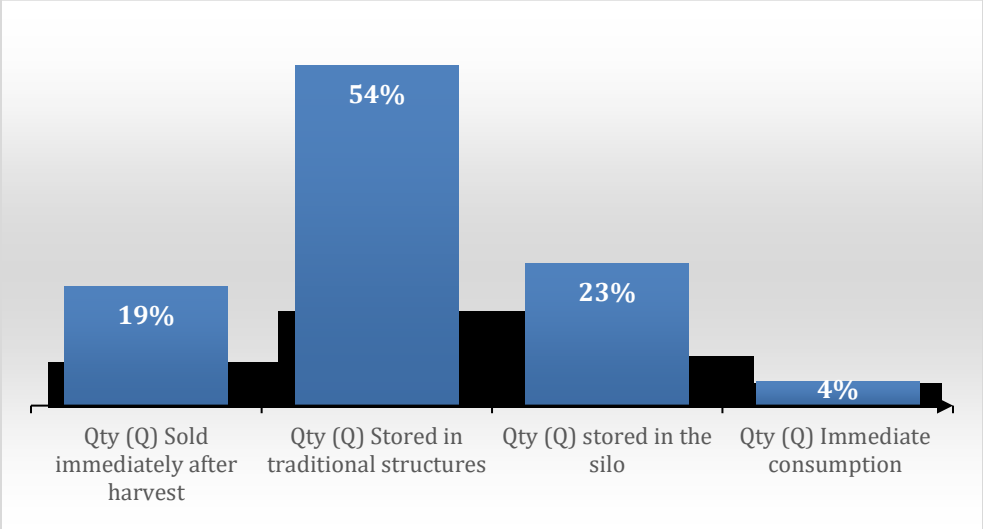

Figure 3: Structure of storage in South Achefer woreda

5.3. Effect on household food security

37. The overall goal of the project is to contribute to improved food security of smallholder farmers in Ethiopia through reduction of crop postharvest losses at farm and primary cooperatives level. With the metal silo technology and hermetic bags, farmers reported increase in months in which they could store food. With food supply deficit months running between June and September, effects on food security was assessed in line with the increase in number of months that the household could store food and improvement in the quality of food consumed.

- *Lengthened storage time that availed food for consumption over food deficit months*

38. Usually, households experience food deficits between February and September since they were initially forced to sell all their harvest soon after harvest fearing the risk of losing it to weevils, molds, rodents and aflatoxins. The use of the metal silos provided by the project in the project areas is contributing to changing this situation as it;

    i) Enabled the households to store food effectively through the deficit months leading to streamlined consumption, increased frequency of consumption and even the quantities consumed. Focus group discussion and interviews with key farmers in DebreElias revealed that farmers were able to store food throughout the year unlike in the previous years. This guaranteed them household food availability across the seasons.
    ii) Shielded the households from price inflation on food items that erodes their meagre monetary resources.
    iii) Allowed the households to commit the saved food expenditures to other investments especially education and health of their families as well as investment in other assets.
    iv) Improved quality of food consumed. Farmers, aware of the negative effects of PHLM chemicals, have prioritized consuming the grains stored in the silos and then selling those stored in other storage facilities where chemicals are still applied. This reduces the exposure to chemical, molds or aflatoxin contaminated foods.
    v) Although prolonged storage of seeds in hermetic bags and metal silos has a likelihood of reducing their viability, it is evident that those who use silos to store seeds for not a prolonged period of time, food availability is expected to increase as seed germination rates are maintained. Discussion with key informants in research and small-scale farmers indicate that seed germination rate was enhanced from 40 percent to 82 percent comparing traditional and the grain metal silo.

5.4. Effects on household income

39. Household income is expected to increase proportionally to the increase in available marketed surplus once the household has had sufficient food. The income will also vary with seasonal price change. In the context of poor households, the relevance of any project is pegged on whether it is economically viable to the community. Projects that commit household's resources without a return are likely not to be relevant to a community seeking to reduce poverty and create wealth. In this case, postharvest storage technologies can be evaluated on profitability or the increase in income based on the quantities stored and temporal price change. Farmers are likely to store farm produce if they are sure that the

prices will respond positively to yield significant returns in future. These gains are related to current and future prices compared to the cost of storage[7].

- *Improvement in household income*

40. Not only were farmers able to store their farm produce for more months, but were also capacitated to take advantage of the price increases unlike when they disposed their food immediately after harvest and at very low prices. Indeed, as revealed by the field visits, most (64 percent) of the food stored in the silos was sold at better prices to earn households extra cash (Figure 4). In both South Achefer and DebreElias woredas, farmers benefited from double the prices they would have received during the harvest period. Initially, they would sell soon after harvest when prices slumped to 400 birrs/Quinta (quintal=100Kg) but with the silos, farmers in the area managed to store produce and sell at least at 950 birr/Quinta (double the price) during the lean season. This is a clear indicator that the household incomes increased by the changes in prices and the quantities stored.

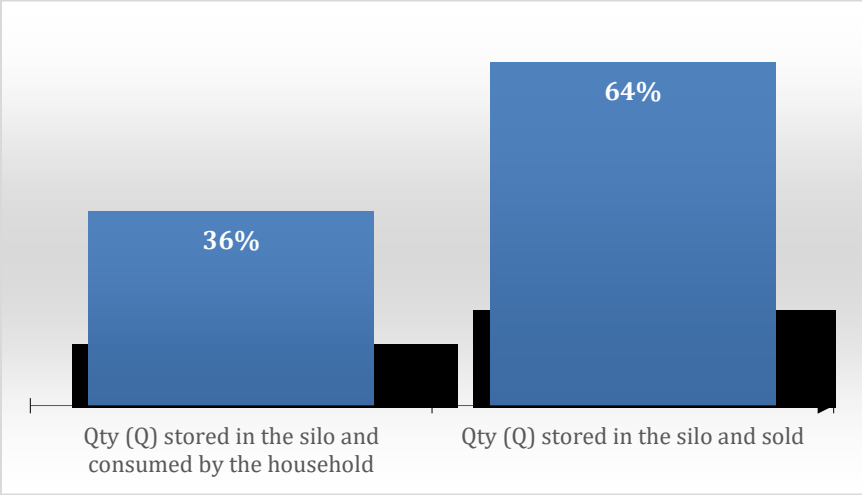

Figure 4: Utilization of food stored in the metal silos

41. Overt the lifespan of the silo (15 years), the cumulative benefits will amount to the profits realized and so the household income. A simple estimate from field data reveals that farmers will gain significantly in the long-term pocketing an average of 3,512 Birr (in absence of current price inflation) of 806 Birr (factoring in the price increase)- Table 1. However, this

[7] Farmers will find incentives in post-harvest storage if the Cost of storage T_c over time is less than the gains in future, $Q_s(P_f - P_c)$, that is if; $T_{ci} < \sum_{j=1}^{n} Q_{si}(P_f - P_c)$ where P_f is the price expected at a future date and P_c is the current price and Q_s is the quantity stored (scale of storage). i can be a household/farmer or a region or sub-region to make the formula decomposable over households, subgroups or regions while. n is the lifespan of the metal silo, considered to be 15 years.

assumes that the seasonal price change will continue with prices at least or more than doubling during the supply deficit months.

Table 1: Profit from 6-Quintal investment cumulative for 15yrs (The lifespan)

	Before Inflation	After Inflation
Cumulative Profit/Income overtime – Birrs	52,686	12,084
Cost of investment (6Q Silo)- Birrs	2,752	3,498
% of gain to investment cost	1,914	345
Annual Gain (6 Q)- Birrs/Year	3,512	806

- *Improvement in bargaining power*

42. The capacity to store grains without the risk of damage has increased farmers' bargaining power with traders. Before acquiring the silos and hermetic bags, farmers disposed their produce soon after harvest in fear of losing it to damage caused by pests and rodents to traders who would delay their payments. The silos have enhanced their bargaining power making it possible for farmers to delay selling their produce until the time and prices are satisfactory.

5.5. Effects of the project on governance and policy level changes towards PHLM

43. The evaluation assessed the possibility of changes in the governance and policy level changes that may have resulted from the project. Two effects were identified as having resulted from the project: the formulation and launch of the postharvest management strategy and the creation of postharvest loss management platform.

- *The formulation and launch of the postharvest loss management strategy*

44. Although there were minimum efforts towards postharvest loss management before the FAO led program, changes in the policy, institutional levels were not felt, and hence postharvest lose management was not given significant attention. The project, by providing information on the depth of postharvest losses, attracted the interest of the national government leading to the formulation of the postharvest management strategy in grains for Ethiopia. The process leading to the strategy formulation was inclusive and involved key stakeholders. The launch of the postharvest management strategy in grains in Ethiopia heralds a new chapter that incorporates postharvest loss management as an agenda in the government planning. This strategy highlights the government's priority in reducing postharvest loses going forward. Indeed, following the national policy on postharvest loss management, the regional governments have pushed to have the agenda of postharvest management in their annual plans. For instance, field visits and validations found that the Amhara region has incorporated

postharvest management into their next annual plans and has become an agenda in the regional government.

- *The creation of postharvest loss management platform*

45. The project resulted in the creation of the postharvest platform comprising of various members of institutions that enhances information and data sharing among postharvest loss management partners. Collating and sharing information with regard to magnitudes of PHLs, strategies towards management and the impacts of PHLM projects brings on table important decision-making element that has impact of policy and institutional changes. Several government and non-governmental organizations including the Ministry of Agriculture and Natural Resources (MoANR), Jimma University, Ethiopian Institute of Agricultural Research (EIAR), Ministry of Industry (MoI), Federal Cooperative Agency (FCA), SG-2000 and other private institutions are involved in the platform.

- *Support of artisans by woreda administration*

46. The changes in governance of postharvest loss reduction management is even reflected at the woreda level administrations who, after the creation of awareness of the effects and the importance of the management, have shown their support in several ways. In some of the woredas, artisans have been allocated plots of land within urban areas to fabricate metal silos and undertake other related business ventures. For instance, in Debre Elias woreda, the woreda's administration has allocated land for artisans to fabricate and display metal silos. This support has facilitated the youth artisans making it easy to have central working points at no cost. The woreda offices have also allocated time and officials to support the project. These officials, mostly the agriculture extension staff and crops officers have facilitated the knowledge transfer and assisted in creating and spreading knowledge to both beneficiary and non-beneficiary farmers. This has significantly increased awareness on the postharvest management in general and postharvest loss reduction in grains in particular.

5.6. Gender equality and improvement of social cohesiveness

47. The impacts of the silo, as a PHLM storage structure has far reaching impacts on the gender realm. Women, who were included in field validations and focus group discussions attested to benefiting from the metal silo in several ways;

i. **The metal silo reduced women of *Gotta* construction workload:** For women and children, metal silos has reduced labour and effort used in construction and cleaning of the traditional storage. It takes almost 30 working days for a woman to construct 15-Quintals *Gotta.* Furthermore, once the produce is stored, it has to be laboriously checked every three months throughout the storage period. On the contrary, the metal silo is not labour intensive, is easy to clean, and has thus relieved women of time that they employ in other economic activities.

ii. **Reduced exposure to toxic chemicals:** Usually the chemicals, which were used in excess and without following the instructions, had healthy effects causing coughing and negatively affecting pregnant women and young children.

iii. **Stability in household food security:** Women are relieved from the psychological stress of feeding their families especially during the food deficit months. With the grains available, the time dedicated to searching for other food items is now reduced and besides, the increase in quantities and quality of food consumed has nutritional gains.

iv. **Village social cohesion:** In Debre Elias, villages have formed village groups where they check on each other with regard to PHLM practices. The often meet (weekly) and randomly select to visit a village farmer and assess how he/she is doing with the silos. These meetings have fostered village cohesion and a focus on PHLM with a view of improving household income and food security.

6. Efficiency of Planning, Implementation and Economic viability

48. The efficiency criterion concerns how well the various activities transformed the available resources into the intended results (sometimes referred to as outputs), in terms of quantity, quality and timeliness. During the end term evaluation, comparison was made against what was planned.

6.1. Implementation efficiency

49. Almost all the project activities were completed within the planned timeframe. However, some of the activities such as linking farmers and artisans with credit and saving institutions needs focus for the remaining period of the project. An economic Analysis of PHLM technology was conducted. This related to estimation of the cost-benefit and a return on investment analysis.

50. **Cost Benefit Analysis:** A cost benefit analysis shows the gains from adoption of post-harvest management against the costs of adopting metal silos[8]. The baseline survey indicated that it was profitable to adopt different indigenous and advanced storage technologies. Benefits calculated from direct gains and indirect gains (grains stored in the silos) reveals that the metal silo has benefits in both short and long terms and is a viable investment for farmers. The ratio of the benefits to costs is greater than one (1), indicating that the benefits are more than the costs and hence there is value for investment. From the silos distributed by the project, farmers have benefits of more than 30 percent (assuming they purchased the silo at

[8] Focus was given to metal silos in absence of adequate data and information on hermetic bags.

the market price). However, these benefits are eroded by price inflation to less than 6 percent (Table 2).

51. **Returns on Investment in PHLM:** In order to identify opportunities for the private sector led PHLs, the assessment conducted an economic analysis of returns on metal silo investment. We compared the Net Present Values[9] (NPVs) against the fixed investment cost of the metal silos. The NPV was estimated based on the benefits, costs and discounting rate of 13 percent per annum that matched to the interest rate of local financial institutions. The estimation considers a 15-year lifespan of the metal silo conferring constant household income over the years. The positive estimates indicate that the present value of the cash inflow is greater than the present cash outflow (Table 2), and hence the investment is acceptable in economic sense.

52. The investment on silos, gauged against the cumulative values indicate that the farmers will gain their cost of investment in the first year of storage. Comparing the estimated cost of investment (cost of silo) as 2,752 Birr against an estimated return of 3,720 Birr (estimated from price change and quantity stored). However, recovery on investment is slightly delayed by the inflation that increase the investment cost on silo to 3.498 Birr (Figure 5).

Table 2: Benefit-Cost and Net Present Value estimation of the Silo

Benefit With Project 6Q Metal Silo (Calculated from Qty and prices of produce stored	**3720**
Investment Cost (Before inflation)	2752
Investment Cost (After inflation)	3498
BCR Before Inflation	1.35
BCR factoring Inflation	1.06
NPV (Before Inflation)	21,288
NPV (Factoring Inflation)	20,542

[9] The estimated $NPV = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} - C_t$, where, B_t is the benefit of using metal silo in year t, C_t is the investment and maintenance (recurrent) cost at time t, t is the time horizon and r is the discount rate.

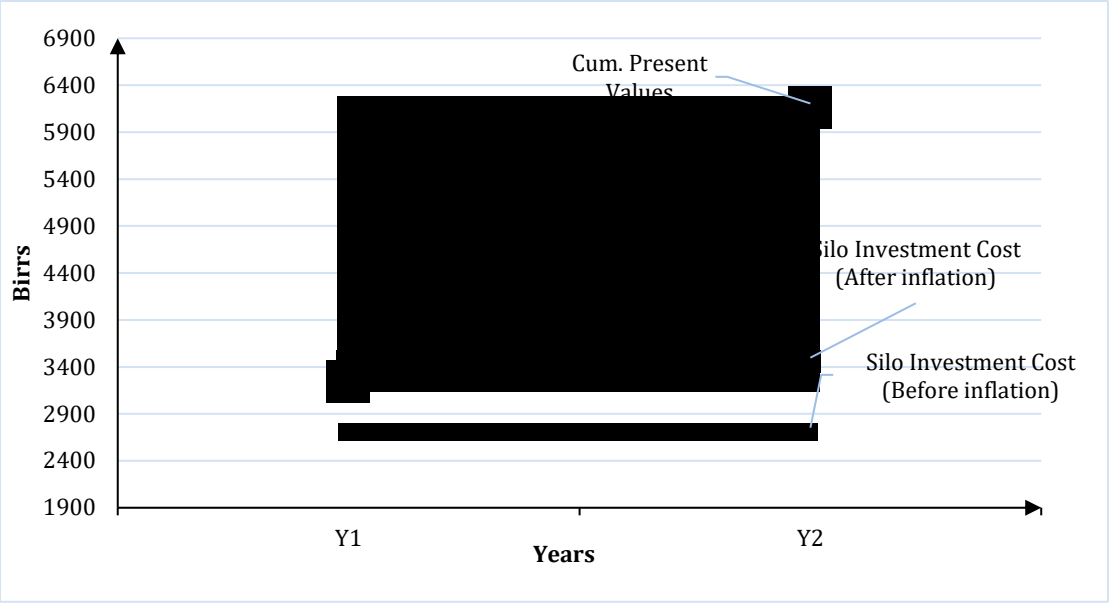

Figure 5: Cumulative Present Values Compared to Silo Investment costs

7. Sustainability and replication of postharvest loss management agenda

7.1. Sustainability pillars

53. The project made huge strides towards ensuring the sustainability of the postharvest agenda through development of positive attitudes, human capacity, knowledge and skills. These strides towards sustainability are evident through in several realms including;

i. ***Development of capacity, knowledge and skills on postharvest loss:*** The training offered to the beneficiary farmers, regional research bureaus, agriculture bureaus, and the agriculture staff in the Ministry of Agriculture and Natural Resources (MoANR) has entrenched the skills and improved the knowledge towards postharvest loss management. This knowledge and skills are expected to form a strong foundation for continuity as more farmers are trained. Further, the skills and knowledge are buttressed by the development of a postharvest training manual and curriculum that spells the process, practices and approaches towards PHLMs. The existence of the PHLM manual and the stakeholder's acceptance to adopt it in trainings gives a milestone to the sustainability of the knowledge and skills needed for continuity of the project. Further, the progress made towards equipping of higher learning and research institutions-Jimma University-the nitrogen analyzer equipment and in Melkassa Agricultural Research Center-shearing machine are expected to foster capacity development support going forward.

ii. ***Institutional changes in the government:*** The project made notable progress through successful establishment of the postharvest loss management platform comprising of all stakeholders interested in the agenda for collecting and collating information regarding

postharvest losses that were not available before. The postharvest loss management platform is expected to continue and carryover the roles of providing information to PHLM stakeholders and move the agenda deeper into the government organs. The platform, entrenched in the Ministry of Agriculture and Natural Resources (MoANR) attracted interests of research institutions, universities and other development partners.

iii. ***Policy level changes that will allow continuity:*** The project made significant progress towards entrenching the agenda of postharvest loss management in the policy arena including the postharvest loss management strategy and two policy briefs. The development and launch of the postharvest loss management strategy heralded a wave of change with which the government perceived postharvest loses and management. Whereas the postharvest loss management strategy shed light on the strategic approach to reducing postharvest losses, the policy briefs provided more detailed and targeted information to policy makers highlighting the magnitudes of the loses and what actions need to be taken. Both, the postharvest loss management strategy and policy briefs led to adoption of postharvest loss management as an agenda in the annual plans of many regional governments, an indication of the continued and sustained quest for reduced postharvest loses.

iv. ***Changes in gender perspective:*** At the community level, the realization of women and men regarding postharvest loss is worth the project. The mere understanding of the postharvest losses incurred and the impact, which, if mitigated, could have on the households' income and food security, was enthralling. Moreover, at the household level, women realized an alternative to their long-standing challenge of constructing *Gottas* and a solution to their perpetual household food security. The change in perspectives, understanding, management and the realization that the metal silo and hermetic bags could save women time and assure them of food security and above all, some increase in income at household level, is expected to drive the postharvest loss management agenda within the lower levels.

7.2. Replicability

54. The postharvest losses management project is easily replicable within the context of dwindling agricultural production, food insecurity and low household incomes. Already, non-beneficiary households in urban and rural areas are engaging in project related activities expressing the demand for silos for storage. Even though the project targeted the small-scale farmers, it is understood that medium and large-scale farmers are also facing postharvest loss challenges. The replicability of the project will however depend on the dissemination and the effectiveness with which lessons learned are taken up by the policy and established institutions. The momentum realized through the launching of the postharvest management strategy heralds the potential for replication and amplification of the achievements.

7.3. Evaluation of potential future risks

55. There are eminent risks faced by the PHLM projects. Major risks emanate from markets where prices may change to yield lower returns to stored produce than expected. Inflation and deflation are likely events bearing in mind that agricultural production is seasonal. Other possible risks that need to be foreseen is possible hoarding of the produce creating immediate price surges in the markets with a likelihood of leading to food insecurity in the short run. How these risks are evaluated, based on the long-term trends have an impact on the sustainability.

8. Lessons from the Project Implementation

56. Although there were no serious derailing challenges towards implementation, the project faced some minor constraints which were easily addressed by the stakeholders;

i. **Local availability and access of sheet metal:** At the inception of the project, it was presumed that the availability of metal sheet (gauge 28 inches) would be plenty in the market for artisans to access for fabrication. The administrative requirements for metal sheet lengthened the procurement period leading to delays in training of artisans by more than 8 months eating into the project's time. In addition, the high cost of the metal sheet that accounts for more than 35 percent of the metal silo fabrication costs, is too high for the artisans to purchase. This high price of metal sheet also compounds the total cost of the silo to a level higher than small-scale farmers' affordability.

ii. **Increasing demand for voluminous metal silos:** There is an increasing demand for metal silos in all regions. This demand is propped by the 54 percent of the farm produce still stored in the traditional facilities and is still prone to damage by different factors. The need to increase the number and expand on the regional scope was evident even on discussions with the local farmers. An estimate to correlate the volume and costs of the silos point to the fact that a unit increase in volume leads to 0.7 percent increase in costs of fabrication (Figure 6). The less than proportionate volume to cost translation implies that farmers are better off with a voluminous silo rather than having silos of the same volume hence increasing the cost of investment proportionally.

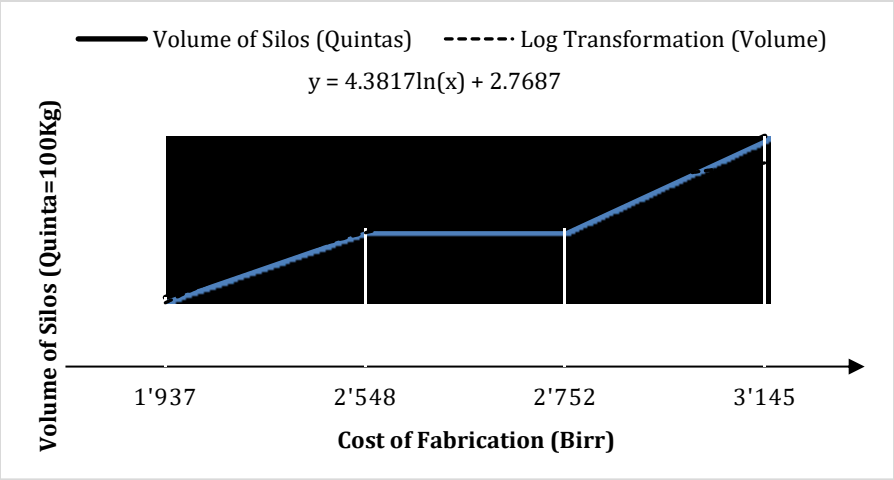

Figure 6: Silo volume to Cost translation

iii. **Attrition of artisans in some areas of the project implementation:** Although a large number of artisans have remained after the training and are in business in most of regions (Tigray, Amhara and SNNPR), in Oromia region, about 50 percent of the trained have not engaged in fabrication of the silos. This is due to the delay in providing materials for fabrication of metal silos and some of the youth artisans were uncertain of the profitability of the business.

iv. **Human resource turnover through transfers:** at the different levels of woreda administration, the offices of agriculture supported implementation of the postharvest loss management project. While these technical staff were trained by the project on the specifics, the prerogative to move them from one woreda to another or to a different administrative level remains wholly government. At times, the government moved the project trained staff to other non-project areas prompting the project to train other administrative staff to take over from those who have left.

v. **Poor access to credit by artisans and small-scale farmers:** the support to artisans followed training and artisans were supplied with materials to fabricate a predefined number of silos of which these were purchased by FAO and distributed to small-scale farmers. In order to expand their metal silo fabrication businesses, the artisans were expected to secure support from financial institutions. However, the artisans faced challenges in securing support from the financial institutions. The challenges to artisans included lack of collateral, inappropriate financial products that did not match their business requirements, high interest rates and unfavorable repayment rates for silo fabrication. Small-scale farmers faced similar challenges but in addition, they found it challenging to afford the silo if offered at the market prices.

9. Conclusion and Overall Assessment

57. The relevance of reducing postharvest loses at global, regional and national levels as well as sub-regional levels cannot be overemphasized. Ethiopia continues to experience

considerable postharvest loses in present of spiraling food insecurity and persistent poverty. The goal of the project Reducing food loses through improved postharvest management was quite instrumental in bringing behavioral change at national and regional levels of governments as well as at the farmers level.

58. The project made significant achievements towards *outcome 1* of improving the knowledge, attitude and practice of smallholder men and women farmers, development agents, youths and others on postharvest management to change the behavior of all stakeholders on postharvest loss management. Through trainings, awareness creation and capacity building, the project managed to reach more the 95 percent of the targeted beneficiaries. The training and capacity building enabled farmers to understand the magnitude of postharvest losses and the manner in which they can mitigate them. Farmers managed to reduce postharvest loses to some extent by adopting the metal silo and moving away from the traditional storage structures, which are prone to various factors that damage crops after harvest. However, the achievement of reduction of loses was limited the volume of storage because only six (6) quinta (600Kg) silos were provided by the project. This has allowed farmers to store only an estimated 23 percent of the farm production while a significant 54 percent is still stored in traditional structures. In addition, the project accelerated gains towards household food security and household income. The metal silo enabled farmers to store food over the food deficit months of June and November, more than 6 months. Of the total food stored in the silos, 36 percent was consumed at household level ensuring smoothening of food consumption over the deficit months. The capacity to store food enabled farmers to bargain for better prices. On the other hand, 64 percent of the total food stored was sold at least at double the prices they would have sold had the silos not been available.

59. Reducing postharvest loses requires able human resource and institutionalization of the agenda within the stakeholders. In terms of *outcome 2,* the project made tremendous efforts in building the capacity of Development Agents (DAs), Farmer Training Centres (FTCs), and Technical and Vocational Education Training (TVET) Centres and supporting research centres and higher learning institutions on PHLM and this enabled them to play effectively their roles in the project. The ministry of agriculture, the regional bureaus of agriculture as well as research benefited from the capacity building efforts. As such, there institutions are better placed to drive the postharvest knowledge development and dissemination.

60. In terms of *outcome 3,* the postharvest loss management was widely accepted by the communities, woredas or *Kebeles* where it was promoted and even among the non-beneficiaries. All the regional training centres, extension staff regional agricultural bureaus accepted the metal silo storage technology with ease. The project supplied 2,800 metal silos over the project period to farmers who used them for storage. Those farmers who benefited from the project have shifted their storage from the traditional to the effective and efficient metal silo after realizing the benefits. The good practices even extended to non-beneficiaries in several of the woredas with farmers purchasing and expressing demand for metal silos.

61. The achievement of *outcome 4* was most significant. The project push towards entrenching postharvest agenda within the national and regional polices was highly successful. It resulted in the formulation of the postharvest management strategy in grains in Ethiopia that never existed before the project. The postharvest agenda now sits in the center of national and regional government's policymaking. With the postharvest loss management strategy launched, a conducive policy and institutional environment was set to deal with postharvest loses leading to incorporation of the postharvest loss agenda in regional governments annual planning and supporting artisans to fabricate metal silos.

10. Way forward and Priority actions for Phase II

62. Phase 1 of the project *Reducing Food Loses through Improved Postharvest Management in Ethiopia* has concluded with seemingly tremendous achievements on the postharvest agenda. However, these gains were driven by the project through funding of the several activities. Looking forward and drawing from the lessons, Phase II of the project needs to be market oriented with the market providing the pull factor to sustain the postharvest agenda. The market driven postharvest agenda calls for an increased and sustained private sector involvement. Evidently, private sector investment is nascent in Ethiopia in the past; however, there is need to recognize the role of private sector in driving the growth transformation in Ethiopia (World Bank, 2016). Private sector is profit driven and will engage in the postharvest agenda if there are considerable profits or return to investment. The return on investment is guaranteed if there is sustained growth in demand for the technology. To get the market going and attract the private sector into the business, Phase II of the project needs to continue with activities that are likely to stimulate demand for the technology and create conducive environment for the private sector entry. Priorities for Phase II of the project will largely relate to;

    i. **Continued training on and promotion of the PHLM technologies and practices**: even after adoption of metal silos and attesting that they are efficient in reducing postharvest losses, a significant proportion, an estimated 54 percent of the farm produce still finds its way into traditional structures. The storage of grain is prompted by inadequate access, knowledge, and access to PHLM technologies and practices. In order to deepen the knowledge on the technologies, the second phase of this program would create more impact through continued training on the promotion of PHLM technologies from harvesting to storage. Moreover, the demand for voluminous silos is on the rise especially in areas where farmers produce more than the 6-quinta silo offered by the project. The increasing demand for even more voluminous silos calls for deepened and more focused training of the artisans in the second phase.

ii. **Widening and deepening of awareness creation on the extent of short and long-term impacts of postharvest loses**: Although the project covered four regions (Amhara, Oromia, SNNPR, and Tigray) targeting over 7,746 beneficiaries, this is a small proportion of the population of Ethiopia. There is need for continued awareness creation to meet the rest of population who are yet to get information about effects of postharvest loses.

iii. **Increased research and dissemination of information regarding access and utilization of silo storage technology**: The currently witnessed behavioral change in the post-harvest loss agenda was triggered by the information availed to the policy makers regarding the depth of effects of postharvest losses. The project facilitated research institutions to collate and analyze evidence-based information. To widen the behavioral change and drive deeper and wider policy changes, there are areas of research which still require further research investigations including;

   a. *Investigations and identification of macro- and micro economic environment* that will create a conducive environment to influence access to affordable metal sheet for metal silo fabrication. Metal sheet accounts for more than 35 percent of the total cost of the silo. The market price of the silo is prohibitive to most of small-scale farmers and hence, low adoption. Policies regarding exchange rate devaluation, price inflation and interest rates at the macro-economic level can be investigated to identify mechanisms that can ease the cost of the metal silo. Moreover, evaluation of alternative storage structures need to be looked into with also affordable alternatives to metal sheet used in making the metal silo. Creating a conducive environment will influence the private sector participation in the postharvest loss management. For instance, policies that enhance competition in the importation of metal sheets and that ease port clearance and logistics will attract participation in importation and distribution of the metals sheets.
   b. *Cost effective volume of the silo:* Although evidence shows that a 10-quinta silo confers to farmers economies of scale, the context upon which this is economical varies from place to place. Most likely, the volume to cost translation is less proportionate (1:0.7, estimated on a 6 quinta silo) indicating that farmers are more likely to benefit with voluminous silos unlike with two silos of the same volume (6 quinta volume). The volume of storage adopted by the farmer depends on his level of production and the different uses of the farm produce.
   c. *Investigation into mechanisms that promote adoption of PHLM technologies*. The second phase should also entail studies that seek to unravel mechanisms that promote adoption of postharvest storage facilities.

iv. **Development of market linkages to credit facilities for both artisans and small-scale farmers:** Many farmers and artisans still find it difficult to access affordable credit facilities to do business. Whereas the second phase of the project will be market driven, the farmer demand of the metal silos will be propped by their level or income and prices. Many of the small-scale farmers may not be able to afford the silo at once

without financial assistance or a well-formulated credit facility. Similarly, artisans indicated that they faced challenges relating to collateral used to access available financial services. As such, it will be important, in order to stimulate demand, to create market linkages between the artisans, farmer and financial institutions in the respective regions.

v. **Market orientation of Phase II to enhance distribution of metal silos.** Donor funding supported Phase I of the project on reducing postharvest losses. In the second phase, the focus should be on strengthening the involvement of the private sector in the project to guarantee a self-driving process of postharvest loss management. The model of metal silo supply through the youth artisans-'*the artisan model*'-still portents the best approach due to numerous factors. One of the key advantage is the economic redistribution through employment that the artisan model accords compared to a centralized production and distribution. The artisans' model accords youthful artisans several advantages. *i)* Employment in an environment of increasing unemployment and social-economic constraint, *ii)* it also has the advantage of reducing the costs of fabrication due to shared transportation and lower rental costs as woreda administration offer artisans pieces of plots to operate from, and *iii)* gives the small-scale farmers a choice to customize the metal silos according to their demands. However, this model should be strengthened through strengthening the supply push and demand pull forces (see Figure 7). The *supply push* forces relate to *i)* creation of a competitive environment to allow entry for more players in the supply of the metal sheet which, has in Phase I, been in short supply, and *ii)* expansion of local distribution. The *Demand-pull* factors include *i)* enhancing access to affordable financial services, and *ii)* widening, and deepening the training and awareness creation among the small and medium scale farmers. Some of the key approaches include;

   a. *Increasing the number of players in sheet metal importation:* Affordable access to metal sheet used in metal silo fabrication will be sustainable if importation is made competitive thus leading to possible lower prices of the metal sheet. The government and development partners seek and implement ways of importing affordable metal sheets. This involves assessing the macro-economic environment variables including exchange rates and inflation that have significant effects on the price of metal sheet.
   b. *Expanded local distribution of metal sheet:* The few regional metal sheet distributors are located in the main urban centres of the regions. Some of these urban centres are still far from the artisans and cost of transport is high. In order to increase availability and access at the local levels, there is need to increase incentivize more stockists of the required metal sheet gauges at the lower levels.
   c. *Increase access to financial services:* Artisans face challenges in kicking off their businesses or accessing affordable seed money to grow their businesses. Increased awareness and knowledge on efficient storage technologies is likely to

translate to increased demand for the metal silos and artisans, due to financial constraints, may not be able to match the demand. Usually, artisans lack collateral to secure their financial access. As such, a deliberate effort has to be made by the government to guarantee artisans in order to access financial support for their businesses.

d. *Demand creation for increased uptake of metal silos:* Farmers are the ultimate beneficiaries of the food storage structures-metal silo. The success of any private investment in the process of metal silo fabrication will depend on the magnitude of the demand-pull (*pull factor)* at the farmers' level. In order to stimulate more demand, Phase II of the project needs to focus on;
   i. Continued training on post-harvest management practices and awareness on the availability of the project. This training should be expanded to reach the middle level farmers who are also suffering from post-harvest loses.
   ii. Enabled access to affordable financial services to enhance and support demand for storage structures.

A schematic diagram of this model/approach proposed above is shown in Figure 7.

vi. **Development of effective and efficient M&E system for Phase II.** Project M&E is often accorded little attention during project conceptualization. This leads to challenges in implementation and above all, greater challenges in accounting for the achievements at the end of the project cycle. In the second phase of this project, due attention should be accorded to;

vii. **Development of a suite of postharvest reduction and food security indicators;** although there are a hoard of food and nutrition security indicators, there will be need to identify SMART indicators to measure food security and poverty if at all the contribution of the project is to be measured at the end of the project. A set of food security indicators include; the household dietary diversification indicator (HDDI), household hunger scale (HHS), food consumption score (FCS), and coping strategy index (CSI). The choice of any indicator depends on the context and the ease with which it can be measured. Moreover, establishing a measure for postharvest reduction will be important, though a huge challenge.

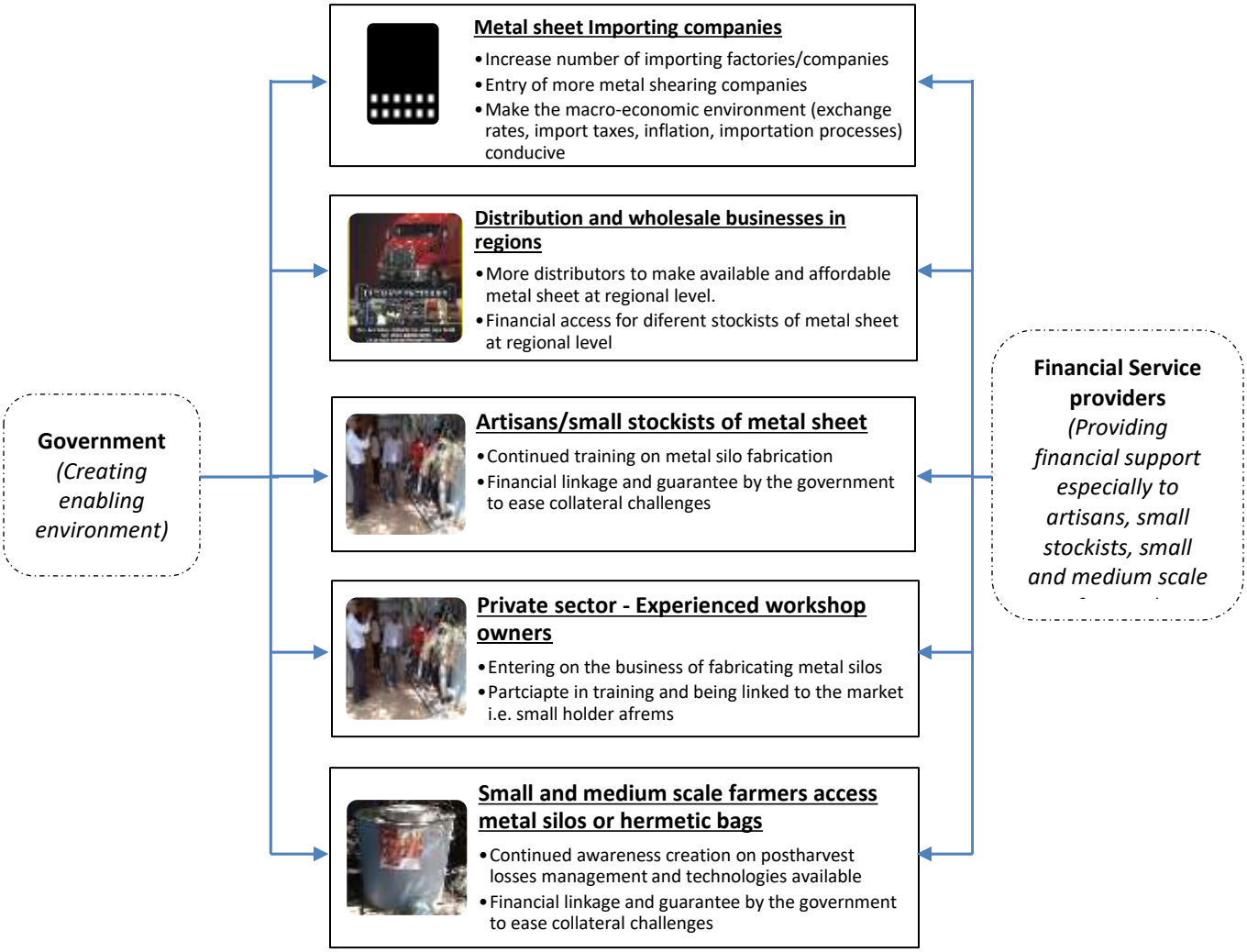

Figure 7: Proposed Phase II Business model

viii. **Some key assumptions for Phase II:** Going into Phase II, several key assumptions need to be considered. These assumptions are likely to determine the achievement of the objectives of the second phase.

- *Local availability of metal sheets*: Approaches to make available metal sheet for fabrication of silos may take long to be actualized. As such, the project in its promotion of the private sector/market led postharvest loss management need to factor in continued availability of high cost metal sheet which may hamper adoption of the storage technologies.

- *Political upheavals*-The country is facing political changes, which can only be hoped to be short-term, and not reversing the gains made so far achieved on accepting the agenda of postharvest management at policy and institutional levels.

- *Macro-economic stability*-the continued exchange rate devaluation (currency devaluation) may continue through the project life and this will affect negatively on the price of the metal sheet and consequently on the cost of fabricated metal silos.

Annex 1: Relevance and Adequacy of risk assumptions for the project

Assumptions of Risks	Relevancy and Adequacy
• All stakeholders are willing to collaborate fully in project implementation	From Kebeles to Woredas and the Regional and National levels, the agriculture ministry staff and administration arms at woreda and kebele level are implementing the project collaboratively. The project needed to have assumed that all these collaborators represent the true needs of the beneficiaries and had considerable interest and commitment to the project.
• Benefit of PHLM accrue to the poor beneficiary households	While it is true that the benefits of the projects are relevant and adequately assumed to accrue to the beneficiaries, the project needed to assume that price change would drive the benefits. There lacks an assumption on agricultural product change which is the key driver of the benefits. Further, these benefits also depend on the scale of operation; the assumption should have looked into the scale of storage vis-à-vis the level of benefit.
• No weather change that disrupt the project output and outcomes	Risky; the effectiveness of storage structures are effective if weather responds well. Inadequate production leads to low production and hence households may fail to see how effective the storage may enhance their food security status.
• Stakeholders are willing and interested to learn about PHLM	Adequate
• Resource people (Subject matter specialists in the area of PHM) are available in the country. • Experts, extension workers are willing to learn and apply new PHLM practices.	Evidence shows that there were efforts to bring forth the issue of PHLM; however, this did not become as visible in the policy and institutional circles. As such, it was not adequate to assume that the country had enough subject matter specialists bearing in mind that PHLM was almost a new area of intervention that was not visibly considered in previous government and non-government structures
• Woreda authorities allocate sufficient time for political and technical personnel at all levels	The woreda authorities are mandated to administrate the development functions and activities at woreda level. While they have the role of supporting different development partners, at times, they are constrained logistically to be available for all projects. In several instances, the government also moves them to different working areas where the project may not be operating.
• Change of local government does not affect PHLM activities.	The woreda administration staff are employees of the government and the government retains the will and power

Assumptions of Risks	Relevancy and Adequacy
• No security problem	to transfer/move them to any location they wish or deem important. For the project, the assumption would have looked at having mechanisms to widen the training to of considerable number of woreda staff to reduce the risk of stagnating the project whenever the contact person is moved. Moreover, on the assumption of security, measures needed to have been considered in the event of insecurity that has negative effects on the implementation process as well as monitoring of the activities.
• Experts at woreda and higher level, staff of higher learning institutions and other stakeholders have access to internet services. • Stakeholders are willing to contribute to the website by providing ideas, documents, etc.	Although there is some level of network coverage in the country, it is evident that most of the project area lacks internet coverage giving challenges to timely communication. An assumption should have been made to subject the optimization of the website to sufficient connectivity
• Effective integration of PHLM in local government planning	This was a risky assumption since the government has a choice to drive the policies it aspires.
• Credit and Saving Institutions (CSI) will agree to take PHL as a new area of engagement. • Stakeholders (Credit and Saving Institutions, artisans, etc.) show willingness and commitment to participate	Credit and financial services are available at the local level (woreda and kebeles). Artisans and farmers are aware of the financial services. However, they have been accessing finance for purchase of agricultural inputs and economic activities that have a faster rate of return. Whereas it was relevant and adequate to assume the financial sector will take up the new area of engagement, there needed to be an assumption of that financial products befitting PHLM will be created and that the pricing (interest rates) of the products will be acceptable to the farmers.
• Medium and Small Enterprises (MSE), artisans, youths will be motivated to invest in PHM related value chain	The artisans have enthusiastically taken up fabrication of the metal silos. In some instances, their output has been constrained by the lack of capital and others have fallen out of the system. This assumption ought to have considered the challenge of financial access faced by the youth artisans for effective participation in the project
• timely implementation by relevant organisation outside project control	Adequate but risk to assume
• Effective integration of PHLM in local government planning.	This was adequate but risky. The assumption needed to highlight that the lessons that would be drawn would

Assumptions of Risks	Relevancy and Adequacy
• PHM considered as high priority by MoA and BoAs	incentivize the government at national and local level to incorporate PHLM in planning.
• stakeholders interested and agree to PHLM plan	Adequate but risky
• improved indigenous/traditional technology structures and practices adopted	Adequate
• improved PHM technologies and the knowledge transferred and used effectively	Adequate and relevant. However, there was need to assume that the technology will be compatible with the culture and the context. In addition there was need to assume that the technology will be affordable to the farmers.
• Materials available in the country	The assumption of availability of materials was risky. Most of the imports are monopolized and the imported material is of 28 inches gauge that is weaker than 26 inches gauge. Moreover, these materials are not locally available at affordable prices to the artisans and the price is highly affected by exchange rate deflation.
• stakeholders will read the reports and make use of them	Adequate but risk. The high likelihood of low level of commitment and engagement by policy makers & high ranking officials.
• The government believes in the need for PHLM policy and strategy	Adequate but highly risky because of the numerous agenda of the government and the belief that low agricultural productivity is the only challenge would have marred the visibility of the PHLM policy and strategy within the government circles.