EVALUATION OF GENDER ROLES AND RELATIONSHIPS AND SOCIAL EQUITY IN POST-HARVEST MANAGEMENT IN MOZAMBIQUE

Storage and Drying for Aflatoxin Prevention: http://www.fao.org/food-loss-reduction/en/

By: Pedro Tomo

MAPUTO, 28 JULY, 2016

TABLE OF CONTENTS

ACRONYMS

AGRIDEA - Centre for Agricultural Advisory and Extension Services

AFAAS - African Forum for Agricultural Advisory Services

AGRA - Alliance for a Green Revolution in Africa

APHLIS - African Postharvest Losses Information System

CAADP - Comprehensive African Agricultural and Development Programme

CFS - Committee on World Food Security

CIMMYT - International Maize & Wheat Improvement Centre

CTI - Compatible Technology International

FAEF/UEM – Faculty of Agronomy and Forestry Engineering, Eduardo Mondlane University

FAENG/UEM – Faculty of Engineering /Eduardo Mondlane University

FANRPAN - Food Agriculture and Natural Resources Policy Analysis Network

FAO - Food and Agriculture Organization

GAPI – Sociedade de Promoção de Pequenos Investimentos, SARL

GoM – Government of Mozambique

GoR - Government of Rwanda

HELVETAS - Association for International Cooperation of Switzerland

HIV/AIDS – Immunodeficiency Virus/Acquired Immunodeficiency Syndrome

ICT - Information and Communications Technologies

IIAM - Agriculture Research Institute of Mozambique

IITA - International Institute for Tropical Agriculture

INE – National Statistics Institute

INGC - National Institute For Disasters Management

ISUTC – High Scholl of Transports and Communications

MINAG – Ministry of Agriculture and Food Security

NGOs - Non-Government Organizations

PAPA - Strategic Plan For Food Production

PAPIR - Project for the Rural Small-scale Industry

PEDSA - Strategic Plan for Development of the Agricultural Sector

PHL - Postharvest Loss

PHLR - Postharvest Loss Reduction

PHM - Post Harvest Management

PHM-SSA - Postharvest Management in Sub Saharan Africa

PNISA – National Investment Plan for the Agricultural Sector

PODA – Plan and Budget for Agricultural Development

RAS - Rural Advisory Services

R&D - Research and Development

SADC - Southern African Development Community

SDAE - District Services for Economic Activities

SETSAN – Technical Secretariat for Food Security and Nutrition

SSA - Sub-Saharan Africa

S&T - Science and Technology

TECAP - Tecnologia e Serviços de Consultoria Agro-pecuária

UEM – Eduardo Mondlane University, Mozambique

UN - United Nations

UNAC – National Farmers´ Union

UNILURIO - Lurio University, Mozambique

USD – American Dollar

VAT – Value Added Tax

WFP – World Food Programme

WRS - Warehouse Receipts Systems

EVALUATION OF GENDER ROLES AND RELATIONSHIPS AND SOCIAL EQUITY IN POST-HARVEST MANAGEMENT IN MOZAMBIQUE

EXECUTIVE SUMMARY

Although agriculture is the main source of income for 80% of the Mozambican families, the country faces high post-harvest losses of grains, a similar reality of other SADC and Sub-Saharan African countries. Many national, regional and global initiatives in the context of postharvest loss reduction activities are being implemented by many agencies and recognized as part of an integrated approach to realize agriculture's full potential. Maize is the staple crop cultivated by the majority of Mozambican small farmers, followed in order of importance by the black-eyed peas (nhemba beans), peanuts, pigeon, sorghum, rice and cowpeas and millet. Ninety nine point three percent (99,3%) of the farmers involved in agriculture in Mozambique are small scale (3.801.259 farms), more than 80% of the cultivated area is rain fed and only 10% of the arable land is used.

Women-headed farm units represent 27.5% of total number of farms, 49,9% of the farm units are headed by children and young farmers (10 to 39 years old) and 15% by elderly people (60-year olds and above). The whole southern Mozambique as well as Cabo Delgado and Niassa provinces have above average percentages of women-headed farm units. Around 61.3% of farms are 0,5 to 2 ha in size and farms between 1 and 2 ha are cultivated by the majority (37,25%) of the total households. Farmers 'illiteracy levels are high, at 40,27% of the farmers´ community. Within women farmers the illiteracy levels are higher (62,91% of the female farmers), than within male farmers (31,69% of the male farmers). HIV/AIDS infection levels are higher for women (13,1%) than men (9,2%). Mora than 54% population live below the poverty line. Women are poorer than men.

More than 22 different cultural African sub-groups of matrilineal and patrilineal systems are found, mainly (i) the Tsonga, (ii) Sena/Ndau, (iii) Lomwe/Chuwabo, (i) Macua, (v) 'Other' (a residual of the remaining local languages) and (vi) Portuguese/foreigner. No one African language is spoken by more than 25% population and only 10,7% can speak the official language (Portuguese). According to the number of believers, the Roman Catholic is the most attended religion in Mozambique, followed by Muslims, by Zionist Christians and finally by Protestants.

Almost all Mozambican farmers own only hand agricultural tools such as hoes, mortars and machetes, more than half store harvests in traditional storage structures (only 4% use improved barns), do not to use any chemical preservation to harvests, lack maize milling equipment in their villages and walk more than 2 hours to reach one and pay to process their maize.

In the above context, HELVETAS, FANRPAN, AFAAS and AGRIDEA have joined efforts to implement a 6-year project aiming at increasing food security of small scale farmers in Sub-Saharan Africa, through reduced postharvest losses at farm and community levels by improving:

i) post-harvest management and storage of grains and pulses to ensure food supply at household and community level and

ii)) post-harvest management as income generator through improved market access.

In this context, a study was commissioned to review national, regional and global literature on PHM as well as bring relevant case studies to light on avenues for improvements. The following findings based on PHM activities in Mozambique and elsewhere could be gathered:

Post-harvest losses occur along the chain from farm to plate, reducing real income especially for the poor. Overall losses have been estimated as high for cereals in Mozambique (maize, sorghum, millet and rice), at between 19 and 21,6%. Sub-Saharan average loss figures for each cereal are 16,4 – 22,4% for maize, 9 – 13,6% for wheat, 12 – 12,5% for sorghum, 10,9 – 12,5% for millet and 11 – 11,1% for rice. Estimations for sorghum and millet for Mozambique are 6% loss, indicating that those crops are less susceptible to storage pests and that lower volumes are stored. A 10 % loss for rice was referred for Mozambique. There is an indication that maize PH losses are higher in southern Mozambique due to less efficient traditional storage structures as compared to those used in central/northern Mozambique.

Women and men have different perspectives and social labour responsibilities. As such policies, programs, and projects must be designed in close considerations of both sides. Adoption rates of improved technologies will increase if awareness that include demonstrations, videos and involvement of the local media are implemented, considering the high poverty levels, high illiteracy levels of farmers, higher within women farmers. Another challenge is that women, mainly young females face more restrictions to attend formal training and awareness raising events due to their multiple household roles and cultural rules.

Dissemination of improved silos is the main PHM activity being undertaken in Mozambique and elsewhere, however, despite reported successes, high initial costs are a significant challenge to widespread adoption. Alternatively, dissemination of post-harvest bags, of improved handling and storage hygiene, good storage management practices, use of cheaper improved tools (e.g. hermetically sealed bags/drums) and low cost improvements to their existing structures and systems is envisaged to benefit women and the poor.

Gender equity and better labour distribution in PHM rely on dissemination of simple/medium level, time- and energy-saving PHM technologies by motivating men to participate actively and allowing women access to equipment that reduce their hardships. Women empowerment based on easing access to resources and power by women without a proper attitude change of men and women is ineffective.

Awareness raising around the magnitude of PH losses and on the benefits of postharvest management improvements at a wider scale (farmers, private sector and policy levels) and working towards building the capacity to achieve such improvements should be top priority.

From a set of experiences being undertaken in Mozambique, some of "best practice" examples that can potentially enlighten implementation of PHL reduction activities can be recommended, as follows:

- Automating selected segments of PHM value chains by acting where women, children and the youth usually face the most strenuous workload, improves the chances of social acceptance of the innovations. Automation must be selective because women still want to meet physically while doing other less labour-demanding activities. Making processing equipment and packaging available and accessible in the local market should be included.
- Ensuring local access of beneficiaries to technologies that are gender- and social equity-sensitive, tools that are designed and tested to be used by women farmers, easy to assemble, relevant to the end-users including the youth, affordable, durable, aligned with local customs and do not require any kind of engines.
- Developing an adequate institutional arrangement guided by experiences from elsewhere to drive innovation much faster and accurately by placing researchers physically closer to beneficiaries for a better understanding of all the dimensions of traditional PHM practices that need to be improved.
- Improving the efficiency of and access to transportation services of harvested crops by women and vulnerable people through joint marketing groups.
- Enforcing value-chain approach in crop research, from variety development to post-harvest management and nutritional uses, emphasizing on the scientific validation and adjustment of traditional PHM technologies, along with introduction of new ones, which would turn them gender- and social equity ventures.
- Demonstrating (in on-station and on-farm research trials) the effectiveness of PHM solutions in different environments and production systems to promote credibility around the technology by their end-users.
- Developing technologies that are accessible to the end-users, including adjusting sizes/quantities of marketed materials/packages.
- Developing gender and nutrition mainstreaming around PHM activities in research and academic activities of the researchers and lecturers.
- Using power relation advantages for women from polygamous marriages and those heading households to deliver tangible PHM benefits (improved tools, knowledge, etc.) if detailed studies confirm that to be the case in Mozambique as found elsewhere.

- Considering the role of religions that promote women subordination attitudes as part of family values by balancing respect to local culture and to human rights.
- **G**etting both men and women to work together and encouraging women to voice their ideas freely before men can promote involvement of women in decision-making with their men and at community level.
- Finding ways to involve more women in capacity-building actions on PHM (training and empowerment initiatives) because they play the main role in all stages of PHM. However, men must always be around, in order both to improve their ability of collaborating and working together.
- Conducting experience-sharing trips involving farmer change-agents and representatives of the academy, policy-makers, private sector and R&D institutions to learn from good practice examples of PHM initiatives in Mozambique, in Africa and in Central America.
- Investing in long-term PHM activities supported by consistent M&E to get meaningful changes by institutionalizing and mainstreaming specific PHM policies and strategies to the national development programmes.
- Committing part of the 10% Mozambique Government budget expenditure for agriculture as per the "Maputo Declaration" to be made mandatory for use in PHM issues and detailed expenditures reflecting PHM actions to be recorded.
- Taking advantage to the fact that Information and Communication Technologies are being used all over the country even by disadvantaged farmer communities to develop capacity-building and information sharing interventions that can help raise the PHM agenda.
- Providing agricultural extension and advisory services in Mozambique is still a challenge despite the fact that the country has more than 100 radio stations and that this is the most accessible of all information and knowledge-sharing sources and instruments available in Africa. Existing radio stations already air 15-30 minutes long agriculture programmes once or twice a week using various languages (Portuguese and major vernacular languages). Using radio allows information sharing with the around 40% Mozambican farmers who cannot listen or speak Portuguese, including poorer farmers. Creating radio listening groups in the communities can extend access of radio messages on PHM also to vulnerable farmers.

I. INTRODUCTION

Agriculture is the main source of income for 80% of the Mozambican families. The country is endowed with 36 million ha arable land, of which only 10% are used, being 90% cultivated by subsistence farmers. More than 80% cultivated area is rain fed and food security crops (maize, cassava and beans) occupies around 60% of total cultivated area (MINAG, 2010).

According to MINAG (2010), food security is based on grains such as maize, rice, black-eyed peas (Nhemba), common beans, sorghum, millet, peanuts, pigeon peas and cowpeas, alongside cassava, sweet potato and vegetables. However, INE indicated maize is cultivated by 71,46% of small farmers, followed by 45,88% for black-eyed peas (nhemba beans), and 42,82% for peanuts. Pigeon peas are grown by 28,01% of farmers, sorghum by 26,48%, rice and cowpeas by 14,47% each, common beans by 8,21% and millet by 4,23% of the small farmers. On the other hand, Cugala et. al (2012) considered Maize and cassava as the main staple food in Mozambique.

Small subsistence farming dominates the country´s agricultural context with 3.801.259 small farm units, which represent 99.3% of all farms in Mozambique. Around 43.4% of all farm units are located in Nampula and Zambézia provinces (INE, 2011).

Based on the whole Mozambican population statistics, 52% of the population are women and 72% of the women are based in rural areas (MINAG, 2010). According to data from INE (2011), 27,5% of the farmers were women-headed and from the total, 49,9% were headed by male and female farmers aged from 10 to 39 years old (youth). Within the youth headed farms, 43,4% were headed by 10 to 29 year-old farmers. The elderly (60 years old and above) formed 15% of total farm heads and the provinces of Niassa, Cabo Delgado (in the north) and the whole southern region (Inhambane, Gaza and Maputo) had above average numbers of female-headed farms. Gaza was at the forefront number of female-headed farms (35.14%). Average cultivated area per household for 61.3% farmers was 0,5 to 2 ha, with the highest percentage of farmers (37,25%) cultivating between 1 and 2 ha (INE, 2011).

The illiteracy levels of the Mozambicans were estimated by Mozambique Demographics Profile (2014), to be lower for males, with 29.2%, than for females, with 57.2%. However, INE (2011), focusing only on the farmer population, stated that illiteracy covered 40,27% of the farmer community, of which, 62.91% of the female farmers were the more illiterate, against 31.69% of the male farmers. According to the same author, within the Mozambican farmer community, only 11% had secondary education and above and 48,9% had up to primary education (47,7% of the males and 32,4% of the females). HIV/AIDS in Mozambique is said to have a female face since 15-24 year old women infection figures were 3 times higher those of men at same age and overall infection figures were 13.1% for women and 9,2% for males in 2009.

Although Mozambican women are custodians of enormous knowledge about the environment and their natural resources, which they use to provide their households with water and

firewood/charcoal, they face major restrictions to carry out their tasks, due to the existing gender relations in rural communities. They have limited access to and control over resources and services (land, inputs, credit, cash crop production, raising middle sized and large animals, extension services, information, training, technology and employment) and take little part in decision-making bodies regarding productive and economic matters, due to the roles they have been given socially and traditionally (MINAG, 2010).

Mozambique is ethnically diverse with more than 22 different cultural African sub-groups of matrilineal and patrilineal systems. Based on first language, six major ethnic groups are (i) the Tsonga, (ii) Sena/Ndau, (iii) Lomwe/Chuwabo, (i) Macua, (v) 'Other' (a residual of the remaining local languages) and (vi) Portuguese/foreigner. The Portuguese/foreigner is an elite and most educated and urbanized group that in the 1997 census accounted for only 6% of the total population (about 1 million people).

According to Mozambique Demographics Profile (2014) based on the 1997 census, no one language is spoken by more than 25% population and only 10,7% can speak Portuguese, the official language. The same author estimated total literacy levels at 56,1%, with higher for males (70.8%) and significantly lower for women (42.8%), in 2010. This finding poses a challenge regarding strategies to overcome constraints due to difficult communication between extension officers and farmers. Because of cultural barriers, it is difficult in some areas for the extension workers, who are for the most part male, to have direct communication with the women even though women are expected to be their major target as far as food crop production is concerned.

Various religions are found in Mozambique. According to the number of believers, the Roman Catholic is attended by 28.4% of the population,17.9% are Muslims, 15.5% are Zionist Christians, 12.2% Protestants (including Pentecostal 10.9% and Anglican 1.3%) and other religions congregate 6.7% of the Mozambicans. Non-religious are 18.7% and unspecified 0.7% (Mozambique Demographics Profile (2014). Religions have something to say when it comes to moral principles they disseminate, some of them may clash with some gender and social equity principles.

On the local ethnic groups, the Tsonga (who live in the Southern Region) are the most educated and urbanized, then the Sena/Ndau of Central Region follow. The Macua are the least educated and the Lomwe/Chuwabo the least urbanized. Macua and Lomwe/Chuwabo are matrilineal, with lower prevalence of polygamy and higher marital dissolution, the Tsonga and Sena/Ndau are patrilineal and the "Other" Category is a mix of patrilineal and matrilineal Arnaldo (2004).

Polygamy is fairly common in Mozambique, representing 28% of married women in the 1997 census (Arnaldo, 2004). According to the same author, highest levels of this social phenomena were observed among the patrilineal ethnic groups, namely Sena/Ndau (40%) followed by the Tsonga (28%), more than the matrilineal with 22% for the Macua, 15% for the Lomwe/Chuwabo. The mixed ethnic group (Other) represented 20%. Within the matrilineal ethnic group, Arnaldo (2004) reported a higher prevalence of polygamy among the Macua than

the Lomwe/Chuwabo, partly related to their Muslim influence, with Macua men residing at their senior wives' family and visiting the other wives elsewhere in turns.

According to Vletter (2006), the Mozambican urban informal sector is nowadays saturated and thus, less attractive for the rural labour. Crop farming unreliability of southern Mozambique and high unemployment rates has turned external migration to South Africa to be the preferred employment option for many Mozambicans in these regions. In fact, Mozambicans represented 25% of the goldmine workforce in 2006. That author found the Tsonga and Sena/Ndau as the highest rate of male migration to South Africa or to Maputo City looking for employment opportunities, as compared to the Lomwe/Chuwabo and the Macua.

Migration and ethnicity patterns suggest that despite that rural southern Mozambique is relatively poorer in natural resources and traditionally less productive agriculturally than other regions of Mozambique (with poorer soils and erratic weather) this region is more developed and has better average income and levels of wealth than other rural areas because the pool of economic assets of the average rural household in the south is far greater than that in other regions. However, many migrant households remain poor, with low levels of agricultural production and highly dependent on lower levels of wage transfers because only after several generations of miners can households build up assets and a home-based production capacity to be well above the economic status of other households in their regions.

The following are main constraints for agriculture development in Mozambique (MINAG, 2011):

- Deficient post-harvest handling of the produce
- High post-harvest losses, due to both pests and physical deterioration of the products in store.
- Lack of adequate storage infrastructures
- Inadequate implementation of quality norms
- Lack of access to credit for marketing
- Low availability of market information (markets and prices)
- Lack of extension services for marketing
- Absence of strong farmer´s associations
- Electricity only available in towns and cities and at high costs
- Poor rural roads infrastructure

Due to their importance, global scale postharvest loss (PHL) reduction initiatives such as the Comprehensive Framework for Action, UN 2009; Global Agricultural and Food Security Program, World Bank, January 2010; and the Committee on World Food Security CFS are being undertaken.

Mozambique faces a high post-harvest loss, estimated at 30% (Zvomuya, 2014), in agreement with Costa (2014) and Tivana et al (2014) who reported postharvest losses (PHLs) as devastating the Agriculture Sector in Sub-Saharan Africa (SSA). According to Cugala et. al (2012),

agricultural production could play a more significant role in the national economy if the country could be able to manage postharvest losses. According to them, no exact figure has been established on the level of postharvest losses in Mozambique but for maize, an estimation of as high as 25% in certain locations is quoted, while citing other figures of 12% in northern and central Mozambique and of 18 % for southern Mozambique for the same crop. They established that lower PH losses in the northern/central Mozambique, could be attributed to better storage facilities as compared to the mostly traditional and less protective ones in southern Mozambique.

On the other hand, Rembold et al. (2011) published PHL estimation figures for Mozambique between 2003 and 2010, where overall weight lost for maize, sorghum, millet and rice was between 19 and 21,6%. Average losses for each cereal in the sub-Saharan region were established by the same authors as 16,4 – 22,4% for maize, 9 – 13,6% for wheat, 12 – 12,5% for sorghum, 10,9 – 12,5% for millet and 11 – 11,1% for rice. Estimations of PHLs in sorghum and millet for Mozambique were set at 6% throughout the country, reflecting the relatively lower susceptibility of those crops to storage pests and the lower volumes stored. A 10 % loss has been assumed for wheat and rice (Cugala, et. al., 2012), somehow lower than the regional estimates presented by Rembold et al. (2011).

Post-harvest losses occur along the chain from farm to plate, reducing real income especially for the poor, who must then dispose of higher percentage of their income to acquire staple foods. In fact, Rembold et al (2011) gave the estimations of losses in different phases of PHM presented in Table 1 below.

Table 1: PHM loss estimations at different PHM stages of different crops in different countries

PHASE OF PHM	FIGURE (%)	COUNTRY	CROP
Harvesting and drying	16,6	Swaziland	Maize
	9,5	Zimbabwe	Maize
	5,8	Zimbabwe	Maize
	6,9	Madagascar	Rice
	4,3	China	Rice
	11,3	-	Sorghum
	12,2	-	Millet
Threshing and shelling	1-2,5	Zimbabwe	Maize
	6,5	Madagascar	Rice
	6%	Ethiopia	Rice
Winnowing	Not relevant		Maize
	2,5	Madagascar	Rice
	5,0	Ethiopia	Cereals
Transport from field to store	2,25	Madagascar	Rice
	1,0-3,0	Madagascar	Cereals
Transport from store to market	1,0	-	Maize

Adapted from: Rembold et. al. (2011)

Postharvest loss refers not only to grain and pulses quantity but also to quality. Particularly, qualitative PHL losses can lead to missed market opportunities and nutritional value sometimes posing serious health hazards to human health (e.g. aflatoxin-contaminated grains). As such, post-harvest loss reduction can improve food quality and safety whilst enhancing supply-chain efficiencies, rural income generation and employment. In many cases reducing post-harvest losses is more cost-effective and environmentally sustainable than increasing production through more intensive farming or expanding the area under cultivation.

Postharvest losses can be physical (volume shrinkage), nutritional (grain contamination), monetary (change in unit sales value), or economic (inability to access certain markets). Physical grain losses (prior to processing) are said to be between 10 to 20%, well below the 40–50 percent frequently reported by the development community (World Bank, 2011), but still too high to be ignored since in Eastern and Southern Africa alone, losses are estimated to be valued at US$1.6 billion per year (13.5 percent of the total value of grain production).

In the above context, postharvest loss reduction (PHLR) activities are being seen by many agencies as important to reduce food insecurity in Sub Saharan Africa (SSA). In fact, postharvest loss (PHL) is increasingly being recognized as part of an integrated approach to realize agriculture's full potential.

The "*Postharvest Management in Sub Saharan Africa*" (PHM-SSA), a regional project coordinated by HELVETAS Swiss Inter-cooperation and implemented in a consortium with FANRPAN (Food, Agriculture and Natural Resources Policy Analysis Network), AFAAS (African Forum for Agricultural Advisory Services) and AGRIDEA is aiming at increasing food security of small scale farmers in Sub-Saharan Africa. It is scheduled for 6 years to improve food security of smallholder farmers in Sub-Saharan Africa through reduced postharvest losses at farm and community levels by improving i) post-harvest management and storage of grains and pulses to ensure food supply at household and community level and ii) post-harvest management as income generator through improved market access.

The project addresses major constraining factors of technology dissemination and adoption, knowledge and information sharing, rural advisory services (RAS) and policies related to PHM and have a regional focus and intervention logic, including pilot activities in Benin and Mozambique (2013 to 2019). In this context, a study was commissioned to:

- Conduct an assessment of the gender dimension in PHM in Mozambique, reviewing existing gender roles and relationships and social equity;
- Identify gaps, challenges and opportunities in the existing PHM policy frameworks through gender and social equity lens and identify potential improvements;
- Identify PHM innovations, tools or mechanisms that can be scaled up to improve gender and social equity balance;

- Identify good practices on improved participation of women smallholder farmers and marginalized social groups in PHM and
- Develop and share policy recommendations (briefs) at national and regional levels.

This study combined a desktop literature that included review of national, regional and global literature on PHM as well as case studies (that even if they are not universally applicable, they demonstrate how important the discussed issues are and why they must be considered) and live interviews to relevant stakeholders in order to collect their views on the issues to be presented thereafter.

The study was faced with scarcity of postharvest loss data and analysis. In fact, Cugala et al (2012) after reviewing literature on PH losses in various commodities in Mozambique found few publications on the issue, where out of 73 relevant documents consulted, only 7 were suitable for full text review, of which, only 5 were on maize and no one on another crop whatsoever. Furthermore, the papers reported losses or innovations mainly at storage, with all of them focusing on on-farm storage. For beans, cowpea, sorghum and groundnuts, no data was found. As a result, most data and analysis in this document was based on international literature, from countries within similar agro-ecological and socio-cultural and economic characteristics as Mozambique. Likewise, APHLIS - African Postharvest Losses Information System (http://www.aphlis.net), out of 79 publications on PHM in sub-Saharan Africa, since the 70´s to date, not a single one referred to Mozambique.

II. LITERATURE REVIEW

II.1. POLICIES AND LEGISLATION ON GENDER AND SOCIAL EQUITY RELEVANT TO PHM IN MOZAMBIQUE

Legal framework for PHL reduction in Mozambique

The United Nations estimates that global postharvest losses are enough to feed the world's most vulnerable people (CIMMYT, 2013). Despite the heavy losses reported earlier, according to FANRPAN (2014) PHM has been minimized in the national reference policy documents approved by the GoM for the agriculture, industry and S&T sectors.

Despite the fact that reducing PHL is seen as key for poverty alleviation in many different reference documents where improved food and nutrition security and food export is recognized, no specific policy or strategy is set involving PHM improvement. In fact, from four legislative documents, no mention is made as for the importance of conducting targeted actions to reduce crops post-harvest losses with the intent of promoting food security and social equity.

While the country´s 2025 Agenda advocates for the promotion of research and innovation, food security and equal rights and opportunities by all social groups, when it comes to key strategic development options only i) promotion of food storage throughout the year and ii) promotion of agro-processing industries are referred (Comité de Conselheiros, 2003). Likewise, in the recently due Action Plan for Poverty Reduction 2011-2014, "*building of local storage facilities*" was one of the key objectives linked to "*Increased agricultural output and productivity*" (GoM, 2011). The same author situated crops post-harvest handling issues at the level of "*lack of infrastructure for better access to markets*". Same trend as above was found in the National Development Strategy (GoM, 2014), where PHL never appeared as a challenge, nor did PHM appear as a development opportunity.

Another important legal document – the 5-year government program (Imprensa Nacional de Moçambique, 2015) – despite having referred to issues relevant to this study in its priorities II (promotion of gender equality and equity and social assistance to the poor and vulnerable) and III (increase agricultural production and productivity), it just tackled around the promotion of general agricultural technologies with no specific indicator to measure progress towards PHL reduction. It must be stressed that this document shows where the government has committed in focusing efforts to solve constraints to social and economic development of Mozambique in a given 5-year period.

Agriculture sector strategies for promoting PHL reduction activities in Mozambique

Lack of specific policy or strategies on PHM improvement was also found to be true by Tivana et al., 2014 and Zvomuya, 2014). However, Tivana et al (2014) mentioned the *Mozambique Strategic Plan for Agriculture Development Sector 2011-2020* (PEDSA) as containing a PHM strategy. Similarly, Zvomuya (2014) reported that in the *Mozambique Strategic Plan for Food Production* (PAPA) PHM was indicated as a sub–program for food production promotion program.

CDIA (2007), presented the eight programs for the Mozambique green revolution and none of them was on PHM loss reduction. MINAG (2011), in turn, regarding PEDSA, although post-harvest management appears here and there, it does not reflect the magnitude of post-harvest losses. In other words, the fact that PNISA, operational instrument for PEDSA does not allocate any budget line for PHM actions, reflects the marginal nature the issue was given at the highest policy level of the agriculture sector.

Whilst 30% of the produced grain is wasted, PEDSA document does not list PHL as part of the main constraints to be addressed, as it does with "*low crop production and productivity*". It does recognize that farmers do not have the knowledge on production technologies and ignore the same problem with post-harvest management technologies. When PHM is addressed, it comes in the context of "*access to markets*", not as a food security and nutrition issue. In fact, nowhere the

document recognizes PHL as "*devastating*", but as "*deficient post-harvest handling*" and it stresses on perishable crops. Nevertheless, the document mentions superficially the fact that most smallholder farmers sell all their produce just after harvesting and buy them back during the lean season at higher prices. The only solution foreseen in the document to solve this problem is "*improved silos*".

SETSAN (2007), presented the strategy for food and nutritional security for Mozambique, where i) gender equity, ii) social justice, iii) equity, iv) equality and v) non-discrimination issues are presented which have a "*side-effect*" influence in PHM issues. The strategy details interventions on women empowerment, equity in development programmes and access to basic services as well as in decision-making.

Finally, MINAG (2005), presenting the Agriculture sector gender strategy, the document emphasizes on adult education to facilitate absorption of new knowledge by women. The strategy also advocates balanced participation of women and men in agriculture development activities, promotes inclusive mechanisms of agricultural trade and dissemination of food conservation technologies. The strategy is very superficial at touching on PHM and social equity issues.

For a comparative reference, the following are the most outstanding National Post-Harvest Staple Crop Strategy Objectives of Rwanda (GoR, 2011) that may be relevant to consider for developing PHM policies in Mozambique:

a) Strengthen food security among rural staple crop producers;

b) Improve consumer access to safe and affordable food;

c) Support the private sector to invest in strengthening the competitiveness of the staple crop value and supply chain;

d) Improve efficiency and decrease marketing costs along the staple crop value chain; and

e) Enhance producers' access to, and linkages with, markets.

Summary key policies of HELVETAS and SDC with regard to gender and social equity relevant to this study

a) Inclusion of the marginalized and excluded by ensuring that those who have the least space to develop their own development initiatives benefit the most from our interventions;

b) Sensitiveness to local culture whilst respecting human rights by understanding the rationale behind local cultural realities and to finding non-discriminatory responses that uphold human rights;

c) Focused interventions on women and other poor and disadvantaged individuals or groups

d) Acknowledging the needs and opinions of men and women to provide a more comprehensive picture of the working situations.

II.2. DIVISION OF LABOUR AND WORKLOAD FOR WOMEN/MEN, DIFFERENT AGE, ETHNICITY AND OTHER SOCIAL GROUPS

Although some gender roles indicate power relations, with men always dominating the main benefits, other gender roles are assigned specifically to men or women according to the physical strength required and the tools to be used because according to Chingarande et. al. (2015), some activities are done by all household members regardless of sex and age, others by men, women and/or children.

AGRA (2014) stated that majority of household-related rural small holder farming activities were the main responsibilities of women in Ethiopia, where they played 61% of post-harvest management activities against 39% for their male counterparts.

The burden faced by women and other vulnerable people

Manda and Mvumi, 2010; AGRA, 2014 and Cernansky, 2015), women beard most of the burden in PHM, responding for around half of agricultural labour on PHM in sub-Saharan Africa, with some estimates reaching up to 90% and at the same time, are the ones who are responsible for providing food over the table. Whether it is dry season or not, women are supposed to provide food for the family, spending hours looking for solutions before going to fetch water and wood. In this regard, women are seen as the pillars of family food and economic security. Among the different processing activities, threshing and winnowing are ranked as the most significant roles played by women in the crop value chains. Winnowing for separation of waste materials from grains is women are said to have the art and science of holding and shaking reed-woven trays using the wind speed and direction. These activities were said to affect women's health by being physically strenuous and subjecting women to the inhalation of dust during winnowing as well as exposing them to heat, rain, cold and wind.

In Mozambique, men and women participate in various stages of post-harvest management. Processing, of produce is widely accepted as responsibility of women. Women are said as having been processing grains and cereals for generations despite the labour intensiveness of the tasks - pistoling large quantities and milling 2-3 km away from the house. Men are involved in bean and maize marketing a task in which women participate in only 5%. For crops that are not typically income-generating, such as sorghum, millet and cowpea, women are more involved in trading them since income from such crops are relatively lower and perceived as household food security crops (AGRA, 2014). According to the same author, because PHM activities are performed on bare hands, Mozambican women can only handle small quantities at a time and are so heavily involved in these tasks to the extent that they are denied time to participate in marketing activities in equal terms as men (e.g., the time to travel longer distances to sell produce at better prices).

Participants in the Maputo July/016 Policy Dialogue informed that as a general rule, labour distribution at household level in central/northern Mozambique includes both men and women in the transportation of harvests, with men doing it by bicycles whereas women on head and both women and men participate in marketing but men being responsible for bulk sales and women selling small loads. For the whole country, PHM was said as an activity involving mainly women, youth and children.

Since these were the very few literature references on Mozambique and quantitative data on labour division on agriculture in general and on gender and social equity on PHM in Mozambique could not be found, this section will base much of the findings on other African/third world countries with similar socio-economic and cultural realities as for Mozambique. In addition, since most of those countries have maize as their main staple food crop (as for Mozambique where 72% small farmers grow it), most of the references will be on such crop.

According to Mulunga and Kandiwa (2015), reporting on maize production and PHM in Chipata and Katete districts, construction of the storage facility was reported as the major process in maize post-harvest management of that crop. Men and the male youths were involved in construction of the storage facility. The harvesting was usually done by the whole household to expedite the processes and reduce losses. Likewise, removing cobs from stalks was also conducted by all family members.

Provided country- and crop-specific realities are taken into account, AGRA (2014) reports that in countries like Kenya, Ethiopia, Tanzania, Uganda, Malawi, Mozambique, Zambia, Burkina Faso, Ghana and Mali, women play a significant role in post-harvest management of staple crops, mainly cereals and leguminous crops, while at the same time playing other multiple roles in society (reproductive, social, economic and community responsibilities). They are due to accomplish the most difficult, less rewarding and health-threatening tasks within the household farming activities, being faced with use of traditional processing technologies. Primary processing activities such as drying, storage and cleaning of grains are where the roles of women lay after they have collected at farm, transported the produce to the homestead mostly on head because they are many times unable to pay for transport costs both on- and off-farm, they have processed, stored and sold them. The same is the case for the poor and disadvantaged.

Household participation in PHM activities

According to the same authors, transport of harvests was done by men and male youth using ox-carts. Women loaded the ox-carts in the field and the men offloaded them at the homestead. Women then loaded the maize into the granary. Winnowing and cleaning was primarily women's role. Chemical pesticide application on grains was a role assigned to men due to their perceptions that they had the knowledge of how it had to be done. Maize retrieval and storage accessibility control was charged to women in traditional granaries.

In an assessment of post-harvest technologies and gender relations in maize loss reduction at village level in Tanzania, when cobs were transported from farm fields to homesteads along tracks, 75% women transported them on head and 84% of men used wheel burrows and hired bicycles. Bicycles, wheel burrows and tractors were least used by women. Female head of households transported their loads in small quantities within a relatively long period compared to males (Rugumamu, 2009). In such a context, pre-harvest insect infestations, theft and damage from dump weather were the main dangers faced by farmers that could be minimized by those few farmers who could hire means of crop transportation. In the case-study reported by this author, farmers reported access to a quick means of transportation to salvage the produce as key.

As reported by Nkwain, et al., (1993) for Cameroon, in most rural areas, food security crops are exclusively practiced by women while cash crops and livestock as well as other income generating activities are reserved for men. In reports by several authors (Rugumamu, 2009).

Chasing away animals is a task that may involve all household members. Mice attacks, mostly the risk to damage storage utensils are a concern for both men/women. Damage to crops quality (Disease risks a nutritional quality) as well as quantity can ultimately result in shortage of food at household level, affecting both men/women (AGRA, 2013).

Finally, because women are physically weaker as compared to their male mates, they are subjected to drudgery for handling heavy loads during transportation of produce (AGRA, 2014). This fact is going to be true for the 27,5% female-headed farms as well as the 15% farms headed by over 60 year olds in Mozambique, if they do not have suitable help from within their families or do not have the physical capacity to handle their produce at marketing.

In another dimension, while men were involved in many stages of the post-harvest management processes, they were dominant in marketing and seen as the managers of the "farm venture" overseeing the final stages of the farm produce, including storage management, stock taking and control over revenues from sales. As an example, in Malawi, AGRA (2014) estimated that men were involved in 70% of marketing work compared to 30% by women while only in 10% of processing work as compared to 90% of work done by women.

Haulage of produce from rural communities is male dominated who usually do not have any gender perspectives on PHM. As such, with no consideration to women´s interests, transporters determine haulage prices and timing of movement of goods to final destination. As such, these men contribute to post-harvest losses due to the delays they cause in the movement of crops.

Women are welcome to trade crops that are not typically known as cash generators such as sorghum, millet, cowpea and sweet potatoes, perceived as household food security crops, which in Mozambique are the least practiced (26,5% farming sorghum, 14.5% farming cowpeas and 4.23% farming millet in Mozambique, as per INE, 2011). However, women are excluded from bulk marketing of cash crops (including maize and beans) because they are perceived not to be good negotiators, and as such as cutting deals with buyers (AGRA, 2014). In the case of

Mozambique, maize is grown by 72% farmers and black-eyed peas (nhemba beans) are grown by 46% farmers (INE, 2011).

According to (AGRA, 2014), the use of bare hand methods for almost all post-harvest activities and lack of ability to manage large produce quantities prevent women from participating more actively in post-harvest activities including marketing. This is most likely to be the situation of Mozambican farmers since WFP (2010) indicated that Mozambican agriculture is poorly mechanized with the large majority of household owners found to own only hand agricultural tools such as hoes, mortars and machetes. More than half of households stored their harvests in traditional storage structures and only 4% used improved barns. Most households (85%) do not to use any chemical preservation to harvests due to unavailability – 42% or ignorance on their efficacy. In 3 provinces, farmers had the greatest difficulty in maize milling due to lack of a maize mill in their village. On the other hand, some households take more than 2 hours to reach the milling location where they have to pay for processing their maize. Additionally, based on data from INE (2011), only 2,4% of Mozambican farmers use pesticides in agriculture and 2,5% have access to credit. The same author estimated the use of agro processing equipment by Mozambican farmers as per Table below:

Table 2: Total farms using agro-processing equipment in Mozambique (% of total farms)

Province	Farmers using grinders	Farmers using Threshers	Farmers using Oil press	Farmers using Other equipment
Niassa	8.83	41.01	7.18	4.26
Cabo Delgado	11.62	3.35	6.42	8.33
Nampula	20.3	6.69	23.83	10.22
Zambézia	15.39	10.66	15.34	33.24
Tete	17.78	4.04	5.92	18.07
Manica	11.57	2.86	26.87	2.22
Sofala	12.17	10.07	7.55	8.29
Inhambane	1.69	1.46	5.75	11.00
Gaza	0.32	17.25	0.17	1.96
Maputo	0.31	0,3	0.96	1.86
Maputo-Capital ciity	0.02	2.31	0.00	0.56

Adapted from: INE (2011)

There are indications that roles in post-harvest management are changing over time. Based on experiences from Chipata and Katete districts, Zambia, Mulunga and Kandiwa (2015) indicated that while in the past women carried maize crops on head, nowadays men replace women, by transporting them by ox-carts. In addition, the same authors informed that household members are now working collectively together to take care of the crop and in some households even decision-making regarding to what should be sold or kept and how resources should be used involving women and to some extent the youth. Chingarande et. al. (2015) also reported an example of collaboration from Zimbabwe, in Shamva district where women/male farmers collaborated very well, with women winnowing the grain, men applying the chemicals to the

grain, then women bagging the grain and the children and men ultimately storing away the grain by taking bagged grain to the storage facility. In detail, men and boys gathered building material while women and girls cut thatch grass which were transported by men on scotch carts for large quantities or are transported on head by women if small quantities. Regarding pest control inside granaries, women plastered the floor of the granaries with cow dung to repel insects and were responsible for making ash, while children looked for eucalyptus leaves and men mixed the ash and eucalyptus leaves with the maize. Women could mix maize with ashes and eucalyptus leaves but in small quantities, taking longer as compared to men for the same quantity of maize. Locking the granary and safekeeping the storage facility were a responsibility assigned to men and women whereas children only physically entered the granary for grain retrieval. In male-headed households of the Korekore ethnic group, the granary keys were kept by the male head, while among the Zezuru the keys were kept by the female. The same authors reported that at grain retrieval, since the grain came dirty, women cleaned it before food preparation.

Manual shelling of maize is practiced by women and children on bare hands. When machine shelling is practiced, it is done by men. Mulunga and Kandiwa (2015) reported that interviewed Zambian farmers referred that the introduction of modern storage facilities was enabling men to take control of maize because it was stored already shelled and clean, so with no need of their wives' services, raising up the need to carefully introduce PHM technology alongside gender mainstreaming training.

These reports may indicate impact of training and awareness rising of both men/women and the youth on the need for a more equitable and balanced household relationship. Nevertheless, they show a pattern of men involvement in areas of either higher technical complexity or if some degree of mechanization is implemented. In Mozambique, illiteracy levels are higher among women (57,2%) than among men (29,2%), which is one of the issues to be dealt with to advance the agenda of agricultural productivity increase and PHL reduction.

In Table 3 elow, from Figs 1 to 5 some examples of PHM tasks socially assigned to women are presented, along with some suggestions of some improvements that, if done, could benefit both sexes or reduce gender/social imbalances.

Table 3: PHM labour / tasks division by gender or social group

EQUIPMENT	NAME	SOURCE COUNTRY	USE	APPLICABILITY	
				WOMEN	MEN
Figure 1 	Storage and Drying for Aflatoxin Prevention	Tanzania and Kenya FAO homepage http://www.fao.org/food-loss-reduction/en/	Low-cost, innovative storage and drying technology to reduce aflatoxin contamination and other post-harvest losses can help reduce post-harvest grain loss in Africa	Increased retail sales, better health and household nutrition; reduced stress for looking for feed alternatives.	Increased bulk sales, better health and individual nutrition
Figure 2 	Informed Policies Needed for Gender-Responsive Adaptation	Bangladesh Hi-Aware homepage http://www.hi-aware.org/index.php?id=107	PHM innovations that protect women from rain, heat, cold and wind in PHM (grain transport, hand drying, shelling, threshing, winnowing, grinding, etc.), must be promoted by appropriate policies for small scale agriculture	Improvements benefit the health through less exposure to climatic hardships and less labour through some mechanization of PH processes	
Figure 3 	Pestle and mortar	Africa 21 APR 2016 12:57 MAIL & GUARDIAN AFRICA REPORTER http://mgafrica.com/article/2016-04-18-cooking-utensils-africa	Across Africa the pestle and mortar are necessary daily since ancient times to prepare ingredients or substances by crushing and grinding them into a fine paste or powder. It is Labour-intense for large volumes of grains to be crushed.	Mechanization may reduce PH labour intensity and increase time availability for other duties. Improved quality of value-added products will fetch better prices in the market.	

Table 3: PHM labour / tasks division by gender or social group (Concl.)

EQUIPMENT	NAME	SOURCE COUNTRY	USE	APPLICABILITY	
				WOMEN	MEN
Figure 4 	African farmers threshing rice by hand	https://www.google.co.mz/#q=threshing+method+of+separation	In the traditional way, threshing is done manually by women, subjected to dust. Grain losses are high.	Physically strenuous and leads to high post-harvest grain losses, alongside lower grain quality, fetching lower market prices. Difficult to get men involved unless some sort of mechanization is implemented.	
Figure 5 	A new air screen machine is coming! (To replace hand winnowing)	Heirloomrice's Blog August 12, 2013 https://heirloomrice.wordpress.com/	Winnowing is the process of separating separating grains from chaffs. It is also used to remove weevils or other pests from stored grains. It is usually performed by women, the youth and children. As the volume of crop production increase, winnowing becomes more labour-intensive and exposure to dust becomes more intense. It is an important step in grains Processing which determines the quality of the finished product.	Improvements to hand winnowing benefit the health through less exposure to climatic hardships and less labour through some mechanization of PH processes	

Over the last 25 years the nature of migration to South Africa has changed significantly with increased migration of youngster Mozambican men looking for jobs in other areas (agriculture, trade, services, etc.), with much lower remittances (due to lower earnings) as compared to miner workers (Vletter, 2006). As per Nkwain, et al., (1993), youth migration involves loss of the active and more receptive and productive farm population, leaving a less active population of aging farmers and children to handle food production. This fact implies that migration of Mozambican labourers either from the rural areas to major cities (mainly to Maputo, the capital) or to South Africa has significant negative impact on agricultural production in general and specifically on PHM

II.3. DECISION-MAKING ON PHM RELATED ASPECTS BETWEEN WOMEN/MEN AND THE ABOVE MENTIONED DIFFERENT ETHNICAL AND SOCIAL GROUPS

Men as decision-makers

As stated by Mulunga and Kandiwa (2015), based on a study in the Chipata and Katete districts in Zambia, in patriarchal ethnic groups, the males (husbands and sons) are decision makers. In matrilineal groups men - nephews (husband's sister's children) are decision makers because biological children whether males or females cannot take decisions in their own homes.

Taking as an example reported in a case-study in Zimbabwe, Chingarande et al (2015) reported specific roles and expectations for men and women, with Korekore and Zezuru women performing reproductive roles using feminine/women's tools (all kitchen utensils: the pestle and mortar as well as the grinding stone) and owning all kitchen utensils. No man could lend kitchen utensils to anyone in the absence of the woman. This study reported cultural contradictory practices regarding ownership of harvests. While in the Korekore ethnic group the granary belonged to the man, he was just seen the custodian of family resources, keeping the granary for the entire household. As such, in the event of death of either the husband or wife, the crops remain with the household. In contrast, for the Zezuru ethnic group, upon the death of the wife, her relatives asked for keys to the granary and take all the crops from the granary, however, if the woman was alive, men still had the final decision on the grain stored and its retrieval, particularly when the grain was for sale, reflecting male dominance in both cases.

Although some progress is being observed here and there regarding promotion of gender equity in PHM, Maliro and Kandiwa (2015) informed that interviewed women suggested that even if ownership had improved for both of them, the husband still had more access and control over use than the wife.

Generally, but considering crop- country-specific realities and provisions for the socially accepted norms and traditions applied for patriarchal and matriarchal ethnic groups, in general women are excluded in decision-making regarding the use of profits from produce sales and

asset ownership, except in those so called "*women's crops*", such as cowpeas, beans and groundnuts. However, even in those crops, there was a report of males being attracted to the post-harvest management of groundnuts and cowpeas in Zambia as a result of the recent entry of large-scale buyers and processors (AGRA, 2014). *"…Men appear openly where money is around and quickly disappear where there is work…"* (Bohaen, 2015, *personal communication*). Men having control over assets and earnings worsens the gender-related problem of who controls and accesses earnings from produce sales.

Despite being responsible for the majority of farmland activities, women often don't have the authority to decide on financial issues for their families, even regarding managing or selling the crops they've grown themselves. According to a statement by Cernansky (2015), "*a woman may realize that new-and-improved storage bags for corn have the potential to save her family's entire harvest, but without approval from her husband, she won't be able to go out and buy any*". In Malawi, AGRA (2014) indicated that male spouses had their wives hiding sales without their knowledge and consent to solve particular household problems. Likewise, the author informed that in Ghana, female rice growers harvested, sold and handed over all the money to their male counterparts with the hope that the husbands would care for their needs, but only some of their needs were provided for.

In Zimbabwe, Manda and Mvumi (2010) noted that household strategies for store management implied a degree of co-operation between husbands and wives who worked towards household food security and common or individual livelihood objectives. These authors reported that husbands and wives bargained around the preferred use of grain (e.g. sales vs. consumption and sales vs. casual labour payment). As a matter of fact, those authors found out that women bargained around store management to ensure that income from grain jointly produced would be fairly distributed between household needs as well as husbands and wives' individual needs.

The same study (Manda and Mvumi, 2010) established that men largely controlled income from bulk sales at the beginning of the storage season and women controlled that of mid-season sales. Here, women tried to ensure that their needs were met by trading off one use for another (e.g. women with high labour requirements would do fewer mid-season sales to be able to use their grain to pay for casual labour at a later stage), improving food security in the next year. In this way, stored grain, apart from ensuring food for the family also helped women to ease their cultivation burden by allowing them to hire casual labour from mid-season sales. In this way, stored grain was an instrument for drudgery to vulnerable people.

Another women´s interest in having partial control over the finances generated from crop sales was to prevent their husbands from using the money to marry other wives, to the disadvantage of them and their children, meaning that women were more concerned with household food security than men (Manda and Mvumi, 2010).

From the study of Manda and Mvumi (2010), it can be depicted that even if women equity and empowerment is still far from satisfactory at households and society levels, they are employing

many forces of change and types of ‘‘power-play’’ to optimize their conditions within the societal norms. The study also showed specific areas where women could benefit directly from project activities that reinforce their bargaining power within the household or society, while not targeting on men´s preference to sell grain sooner after harvesting. Some examples of such types of interventions could be:

i) Promoting trade fairs and other trade enabling environment to facilitate mid-season sales and not early season sales and

ii) Structural modifications to granaries that can benefit women and the vulnerable by reducing grain store construction and maintenance costs.

Same focus could be applied to benefit other vulnerable people such as the youth and other socially disadvantaged people.

As per Mulunga and Kandiwa (2015), gender inequalities in agriculture start at early stages, with gender roles that hindered female youths from accessing information on PHM. In fact, according to such authors, female youths both married and single could not attend field days due to their gender roles, remained in their households performing various tasks such as cooking, doing laundry, washing dishes or taking care of their babies, with a negative implication on their level of knowledge on PHM. Young girls were said not to be supposed to be seen in public gatherings. Even if they came and attended field days, young single girls should not be seen mingling with men in such fora otherwise they would not be respected and married. This situation has implications on possibilities of both young men and women to access extension services, technology adoption and ultimately access and control farm produce and returns from produce.

The above described situation is comparable with that in Mozambique, following the same ethnicity considerations.

Women as decision-makers

Unmarried/single women heading households are independent in their decision- making, whether young or old. They decide with no interference even from their children and relatives, determining on their own how much crop they will sell and how much they will keep for food security in their homes. Majority of married women from male-headed households in Katete district were frustrated when it came to decision making processes in their homes as major decisions especially on maize and other crops marketing was done by their husbands, even the money obtained in some cases women did not get to know about it as well as that budgeting and purchase of assets was done by their husbands. Women from polygamous marriages had more decision making power compared to women from monogamous marriages (Mulunga and Kandiwa, 2015). It is estimated that over one-third of the married Mozambican females are in polygamous relationships, which despite not being legally recognized, it is recognized under customary law. WFP (2010) referred 21% as the figure for women-headed households for Mozambique.

In any male-headed household, no women has decision-making power except those in polygamous marriages, who are more autonomous regarding their own grain stores since they can decide to sell stored grain, use it otherwise and are not supposed to ask for permission of using the revenues. Mid-season income is important for women in both marital statuses since it contributes to their self-reliance and supplements urgent household needs. Women use such sales as a way of maintaining and supporting their individual interest (Manda and Mvumi, 2010). Chingarande et. al. (2015) also reported that often, women do not have and are not allowed easy access to funds needed for the purchase of food crop production inputs.

Male migration for employment in South Africa dominates the Tsonga and Ndau/Sena ethnic groups in southern/central Mozambique. In the absence of men, women stay in a relatively better decision-making position when the man is away. This situation can be used to increase impact of gender-equity strategies in those regions much more effectively than in Lomwe/Chuwabo and Macua ethnic groups (central-Northern Mozambique), where men dominate decision-making on PHM.

Having the above context in mind, specific areas where women can benefit directly from interventions as a strategy for bargaining for other benefits within the household or society in general are to be identified and leveraged. Examples could be interventions that can result in increased sales of grains in the mid-season or promotion of PHM activities targeting women with decision-making power as resulting income can be used for labour payments much later in the season and such interventions do not impact on the men's preference to sell grain soon after harvesting. Reducing costs of constructing storage structures can also be sensitive to gender and social interventions since it allows women and other vulnerable groups to build their own separate stores where they have more control over grain usage.

De described situation, despite referring to realities elsewhere in Africa, can be compared with Mozambique considering similarities in patterns of the patrilineal and matrilineal ethnic systems.

Decision-making differences by ethnic and age groups

Chingarande et. al. (2015) describing the Korekore and Zezuru ethnic groups in Zimbabwe referred that in male-headed households, both men and women had access to resources for production but men controlled those key normally regarded as belonging to the household head whereas children's access and control of resources varied with age and sex, with younger children getting less access and control over household resources and female children having less access and control over resources than male children of their age.

The above authors stated that in their case study, in male-headed households of the patrilineal ethnic groups, decision-making processes were often left to males implying that if certain crops were for men and others were for women, the investment dedicated to each type of crop (size of land under cultivation, quality of seed, money, fertilisers, labour and attention given to the crop) was not balanced, with women doing their crops during at "spare time" while men's crops

getting better attention (using most of the household's resources), with material implications to their post-harvest management such as that if multiple crops mature at the same time, priority was given to cash crops, leading to greater post-harvest losses for "minor", controlled by women. Lacking practical evidence for Mozambique but due to cultural similarities, it could be expected that Mozambican patrilineal ethnic groups, namely the Tsonga, covering the whole southern Mozambique and the Sena/Ndau covering Sofala province, would follow the same pattern. Maybe it is what explains the cropping pattern described by INE (2011) that must be taken into account when drawing PHM policies for the country, to ensure that women and other disadvantaged people benefit as well.

II.4. BENEFITS FROM PHM INNOVATIONS FOR WOMEN / MEN AND THE ABOVE MENTIONED DIFFERENT ETHNICAL AND SOCIAL GROUPS

Different perspectives in PHM innovations

Likewise other sections of this report, few literature references were found on innovative tools or approaches regarding PHM in Mozambique. As such, socio-cultural proximity with other African/third world countries will be explored to use their experiences and case-studies in order to inform on the likelihood the situation in Mozambique may be.

As previously stated by MINAG (2010), post-harvest losses in Mozambique reduce real income of farmers, especially for the poor, being due mainly to (i) Deficient post-harvest handling of the produce, (ii) High post-harvest losses at storage, (iii) Lack of adequate storage infrastructures, (iv) Lack of access to credit for marketing and (v) No electricity at the countryside. The context where farmer illiteracy is as high as 40,3% and only 11% have secondary education or above, the fact that 49,9% of farmer heads are 10 to 39 years-old (youth) and 15% are old and that 27,5% of farms are headed by women (who happen to be overloaded with productive and reproductive tasks) pose more constraints to be taken into account in identifying PHM innovations that can bring tangible benefits to both men, women, children, the youth and the elderly of different ethnic and social groups. In this context, to be gender and socially equitable, PHM innovations must be low cost, must add value to smallholder farmers, accessible to women and the elderly, attractive to the youth, and take into account local customs (culturally acceptable) to be useful.

General main constraints to post-harvest handling of grains lie at storage, with large quantity food shortening their lifespan, mainly due to rodent and insect attacks (Golob, 2009; AGRA, 2013). Nevertheless, they occur along the chain from farm to plate and are to be addressed all the way long. In fact, as said by AGRA (2013), losses also occur during transportation, bagging and packaging, due to long distances from farms to homesteads, low quality second-hand bags and inadequate packaging.

According to Golob (2009) and AGRA (2013), insect damage reduces the nutrient content, the weight and the quality of the grain whereas rodent attacks affect the quantity of stored grain as

well as its quality (mould formation). As for Mozambique, insect and rodent infestations were mentioned as the most relevant loss agents by Cugala, et. Al (2012). Resolving these issues can bring about tangible results to all beneficiaries as food would preserve its original nutritional contents, the stored quantity would not reduce and risks of mould or mice-borne diseases would be minimized.

All the above losses can affect dramatically household´s livelihoods and reduce grain market price and, at last, worsen the workload of women and the burden on the vulnerable and disadvantaged population. Lack of ability to manage large produce quantities prevent women from participating in other activities, excluding them further and pushing them further out of those involving decision-making. In addition, women and other socially disadvantaged groups tend to market their produce nearby their homes or at travelling middlemen at below market prices since they cannot enjoy the time for longer-distance travel looking for better market deals (Manda and Mvumi, 2010).

Women and men may diverge regarding their individual PHM interests within same household. According to AGRA (2014) in a legume post-harvest value-chain in Tanzania, women reported lack of post-harvest handling equipment and animal attacks (rodents and birds) at drying stage as their major post-harvest challenges. On the other angle, men proffered that spillage during storage and transportation was major post-harvest challenges. This indicates that women and men have different perspectives regarding priority actions in PHM which must be taken into account when drawing strategies.

Based on what has been stated earlier, women and other disadvantaged social groups must participate in product-design stage for developing PHM innovations, right in the beginning of the process, nut just as a matter of adapting equipment to accommodate those people but also to include their practical needs – e.g. a tool that the woman can still use while carrying her baby. It means that PHM innovations need to integrate gender sensitivity into their design and testing by considering women's needs from the design stage all the way through implementation and training on any new product's use. The same would be the case for the needs of the youth and the elderly.

Attitude towards change is important for the uptake of any innovations that can change the way farmers handle their crops. It is crucial to talk to both men and women in the process, not only about money, but also about traditions. By training only men on PHM, with no attitude change skills development, no meaningful change can be expected, unless men and women do understand the beauty of deciding together (Cernansky, 2015).

Challenges to promote gender equity in the access to PHM innovations include the need to take into account the biological differences and the different productive and reproductive roles between them. Maliro and Kandiwa (2015) reported for Malawi that despite the couple jointly owned their metal silos, the man was more knowledgeable about operations of the metal silos

because he had the chance to attend training sessions while the woman failed to attend because she was expectant. Other reasons could be that at the village, the woman could have had to help in funeral services in the neighbourhood or in taking part in another community task that men normally are exempted from taking active participation.

On the other hand, Maliro and Kandiwa (2015) reported that appropriate awareness channels on the benefits of metal silos was said to be to distribute silos to more role model farmers and to train and support more artisans, women farmers suggested that distributing silos to more females to act as role models would represent appropriate information channels that could mobilize more women.

Engaging women artisans is another strategy with potential to promote participation of more women if some cultural challenges can be overcome. For example, Maliro and Kandiwa (2015) reported for Malawi that after defeating the stereotypes of the masculine nature of the metal silo construction, female artisans faced their inability to climb a raised platform in order to weld the top part of the metal silo because they would have to over-stretch their legs in the presence of men which would not be acceptable in the Malawi culture.

Pre-storage technologies

To address pre-storage losses, oxcarts/handcarts/motorcycles and jute bags are considered by AGRA (2013) as crucial. PHM innovations that improve shelling, threshing, drying, grinding and winnowing easing such activities, socially due to be undertaken by women, the youth and children on bare hand are important instruments to promote equity. Some of these activities involve dealing with dust, endangering the health status of the people involved. This is the case of Mozambique as earlier discussed in the "*Gender labour division chapter"*. Apart from married women who do not have decision-making power as regards to the use of revenues, eventually to invest in improvements on PHM tools or services, or in hiring of PHM services, the elderly and the poor may face the same issues.

Storage technologies

Since Rugumamu (2009) stated that PHLosses are comparatively higher at storage than in other phases of PHM, due to mostly poor drying and storage issues, leading to high insect and fungal infestations, storage gets more attention from farmers, national governments and non-government institutions to either improve traditional stores and drying cribs or promote new, improved ones. Different innovations on food grain storage structures alongside improvements to locally available traditional storage structures that help reduce losses at storage stage are available and two of approaches will be discussed herein, namely i) the improvement of local/traditional grain storage structures or ii) introduction and dissemination of improved silos/granaries (Metal silos and Gorongosa type improved barns). Such improvements in crops storage facilities are more feasible if coupled with improved post-harvest handling techniques.

a) Improvement of local storage granaries

Farmers are forced to sell their produce soon after harvesting when the prices are at their lowest. Since the lean season lasts from October to February, when the food stocks of the poorest households are depleted and food prices are high (FAO, 2016), they may become food and nutrition insecure.

Although traditional silos are not efficient in protecting against pests and elements of the weather on grains, it has been scientifically proven that after adjustments for effectiveness and scientific validation, such technologies have high potential adoption rates. For example, introducing rat guards and using locally available building materials that drives out residual humidity from stored grain is in itself an outstanding advancement of local granaries.

There are available various Mozambican or other African/Asian examples which can be scaled up if proven successful, more than the improved models, by research.

Improvements to local storage granaries has the potential to target the specific needs of women, mainly of the married women, alongside with the less prosperous farmers due to their high cultural acceptance levels by beneficiaries if adjustments consist of identification of low cost improvements to farmer´s current structures and handling systems.

Considering the above and the fact that men tend to concentrate investments on cash crops and not on food security crops (or "women´s crops"), promotion of gender and social equity of PHM innovations should consider promoting R&D on local and other traditional methods of grain conservation that may be relevant to respond to the needs and interests of farmers (ex. storage of small loads of multiple crops to feed the family).

b) Metal silos

For Mozambique, Tivana et. Al (2014) reported that the promotion of metal silos has been hindered by i) deficient skills and capital of local artisans ii) scarcity of appropriate metal sheets on the local market.

On the available alternatives worth to be discussed, Chingarande (2015) reported challenges with the metal silo not being compartmentalized, resulting in men monopolizing the use of the silo for maize, while women's crops (groundnuts), were stored in the traditional granaries. As such, this tool did not benefit the couples in a balanced way. On the other hand, for both men and women, the metal silo was too small to for their grain reserves and so, they needed to go back to the traditional granary to store surplus maize. Both men and women recommended that metal silos should be sold at an affordable price and different payment terms should be implemented, including use of crops for payment for the silos.

Regarding the metal silos, Chingarande et. Al. (2015) recorded women´s perceptions on the usefulness of the innovation to them in Zimbabwe as they stated that the metal silos promoted health and hygiene benefits because no chemicals were applied on the grains and entry into the

silos to retrieve grain was not necessary. This finding is important considering the high illiteracy levels of farmers mentioned earlier as well as access issues (high cost and market failures), to industrial pesticides and the threat they represent to the user´s health and life if not well handled, as said by Rugumamu (2009). Women also viewed the silo as a symbol of prestige in the community due to its shiny and imposing nature.

The following issues seem to have constrained gender and social equity with metal silos in Zimbabwe (Chingarande et. Al. 2015) and must be taken care seriously in Mozambique:

- Artisans were only trained on business development skills to take the fabrication of metal silos as a business. No gender training was conveyed to them so as to understand the different needs of men and women at adopting the metal silos;

- The recruitment criteria of the artisans prioritized people who had been practicing tinsmiths. As such, most of the artisans were believers of the *Johane Marange Apostolic sect* (such sect encourages tinsmiths), which promotes subordination of women to men. In this way, aspects other than gender (i.e. religion), appeared as drivers of social inequality. Considering the different religious congregations in Mozambique, this event must be taken into account as many other religions may work against gender equality and equity in their philosophies.

Various references reported technology cost complaints by farmers on the metal silo. This can become a gender and social equity issue since poverty in Africa in general and in Mozambique in particular is high, rural and has a female face. According to Mozambique Demographics Profile (2014), 54% of the Mozambican population lives below the poverty line, on less than 1,5USD a day. This can be worsened in the Tsonga and Sena/Ndau ethnic groups where males migrate to South Africa or to Maputo city for employment, with a higher likelihood of incidence of female-headed households. In fact, Inhambane, Gaza and Maputo provinces presented high prevalence of women-headed households, as such, mitigation measures to increase farmers access to metal silos, such as those suggested by Maliro and Kandiwa (2015), in Malawi (seasonal instalments – payments after crop harvests and/or subsidy to make costs more affordable) are to be implemented.

c) Gorongosa type improved barns

According to FAO (2016), the Gorongosa type improved barn was developed between 1997 and 2002 in Sofala province as an "…appropriate and economically feasible grain conservation technology for small farmers…". It is built on locally developed technology and local building materials such as mud and clay along with conventional ones (cement and iron rods). It can last for up to 20 years with good maintenance, is impervious to fire and protects against rats, pests (including the grain borer) and diseases while retaining the quality of the grain for up to ten months. It is more affordable if compared to the metal silo. Furthermore, PRODEZA NEWS (2015) stated that the Gorongosa barn allows grain treatment with Phostoxin (aluminium

phosphide), drives out residual humidity without condensation, which helps secures grain conservation until next harvest, allowing the farmers to wait for better market prices.

PRODEZA NEWS (2015) suggested that for a 6-member family cropping in 2 ha land and harvesting 0,9 ton sorghum and 1,8 ton maize in Sofala province (Mozambique), two one tone Gorongosa barns (costing USD70,00 each) would be enough to allow 1.5 grains ton sales/year, raising an extra income of USD264,00 for the family.

II.5. GAPS, CHALLENGES AND OPPORTUNITIES ON HOW GENDER AND SOCIAL EQUITY OF PHM ARE ADDRESSED IN THE EXISTING POLICY FRAMEWORKS AND HOW THE CURRENT SITUATION CAN BE IMPROVED

This section is elaborated based on national, regional and international literature, considering HELVETAS´s and SDC´s (the commissioners of the study), own policies on gender and social equity.

Gaps

As reported by Tivana et al (2014):

a) At SADC level, the Agricultural Policy of 2013 concentrated investment promotion at national and regional levels on storage and agro-processing, with no specific reference on a regional community PHM strategy with particular incidence on gender and social equity. Furthermore, post-harvest issues are under-represented in most SADC country agricultural R&D strategies, limiting the scope of experience learning at this regional level;

b) The agriculture policies and the gender policy of the Agriculture sector in Mozambique as well as the agriculture investment plan do not focus on promotion and transfer/adoption of improved agricultural/PHM technologies, missing opportunities to uplift the post-harvest management agenda by integrating and budgeting purposefully for gender and social equity;

c) There is lack of a specific PHM policy/strategy focus for Mozambique. Existing policies (PDESA, PNISA and PODA) should be mainstreamed of PHM issues, highlighting the need for them to be sensitive to gender and social equity and to cover the full chain of PHM activities. Implementation of new policy recommendations at ground level must be accompanied by permanent M&E activities to measure progress.

While AGRA (2014) reports government policies aimed at minimizing post-harvest losses, relevant strategic actions referred are around (i) storage facilities and (ii) strengthening markets linkages. Additional issues recorded are:

a) Poor investment climate;

b) Administrative and bureaucratic bottlenecks;

c) Regulatory/legal obstacles for private sector operations;

d) Lack of rural finances.

e) Need to revitalize the central coordinating institution for PHL Reduction activities in Mozambique.

Participants of the Policy Dialogue held in Maputo (July 016) recommended that the central coordination of PHM actions in Mozambique should involve more actors such as the Ministry of Women, Gender and Social Action (to deal with gender, child labour and the vulnerability components of PHM) and the Ministry of health (to deal with the nutrition component of PHM) and that multi-sector coordination mechanisms should be strengthened.

The participants to the above event recommended as additional policy gaps:

a) Lack of incentives for the manufacture of processing and packaging equipment available and accessible in the Mozambican market;

b) Lack of clear mechanisms for promotion of information-sharing around PHM under gender and social equity lens;

c) No incentives for acquisition of PHM-related goods through reduction of import tax or exemption of VAT.

The above discussed gaps indicate that either at regional or at SADC country level gender-sensitive and pro-poor PHM strategies has not been in the scope of the undertaken policies. Lack of studies/publications on causes of PH Losses on diversified crops and regions in Mozambique, as well as of proven technology options to overcome them for each social group constrains further the efforts to reduce PH Losses in Mozambique. The actions being implemented do not seem to have a gender and social equity lens and may lead to failure to impact on gender and social inclusion.

Challenges

Tivana et al (2014) and Zvomuya (2014), reported challenges against PHM in Mozambique that must be looked under the point of view of gender and social equity, such as:

a) Lack of institutions involved with training service providers on PHM;

b) Poor accessibility of farmers to finance and to building materials for tools and utensils;

c) Poor roads and transport systems;

d) Weak marketing channels;

e) Limited number of qualified PHM research personnel, limited research on PHM and lack of coordination of research agenda with farmer needs;

f) Weak link between research programs and public, private, NGOs and farmer´s development programs;

g) No institutionalization and mainstreaming of PHM in national development programmes due to lack of a specific PHM focus of the agricultural policies and strategy for Mozambique, resulting in ad-hoc interventions (e.g. UEM, IIAM, UC. FAO) and no gender and social equity perspective of interventions.

Focusing on gender-specific issues, Cernansky (2015) refers the following challenges:

a) High illiteracy levels of women (63% for Mozambique - INE, 2011) as compared to men, worsened by the fact that only 10,7% of the Mozambican population can speak Portuguese, the language used by the extension staff limits and seriously hampers communication when the staff and specialists are not of the same linguistic origin as the farmer they are dealing with, resulting in shortage of delivery of relevant information to them;

b) Lack of access to and control over family assets by women;

c) Time constraints preventing women from entering grain trade because they have to balance marketing activities with domestic roles;

d) Resistance to change by women tied to traditional customs;

e) Unavailability of post-harvest loss reduction technologies in all stages of PHM resulting in lack of reference of good practices.

Estimates by Chapota (2015) indicated that in 2012, only 6.6% of Mozambican farmers received agricultural extension and advisory services in the country, one of the reasons why adoption of improved technologies by smallholder farmers remains low in the country.

As proclaimed in PEDSA/PODA policies, increased grain production is to be pursued and improved seeds appear at the front line in the agricultural development programmes in Mozambique. In accordance with APHLIS (undated), introduction of high yielding but more susceptible to pest damage varieties and of additional cropping seasons that result in the need for harvesting and drying when weather is damp or cloudy or that lead to farmers producing significant surplus grain which are not well stored becomes a challenge to be carefully addressed.

The listed challenges do not promote an enabling environment focused on PHM plans, projects and activities that are gender-sensitive and pro-poor.

Opportunities

a) *"…Traditional practice is an unlikely culprit since farmers have survived difficult conditions over long periods by adapting their practice to prevailing circumstances…"* (Hodges, 2012). Low-cost improvements to some traditional farmers' PHM systems may bring about relevant innovations, which may be gender sensitive and pro-poor.

b) At least two companies available for public/private partnerships to develop hand shelling, harvesting, millers, hand graters small equipment in Mozambique, to ease the burden of women and the poor, allowing them more time for other tasks and rest (including learning) and protecting their health;

c) SDAE´s are already engaged in promoting PHM initiatives at district level, though more on improved storage, not in other value chain stages, nor involving the perspective of gender and social equity;

d) Some Mozambican line ministries have own strategy/policy documents on PHM issues (Agriculture, Science and Technology and Industry and Trade), which is a good stand point;

e) Women are best positioned to minimize potential post-harvest losses at farmer level as they deal with the majority of PHM tasks. Training and empowering them and improving their access to finances can be critical in reducing post-harvest losses;

f) Many of the interventions to bring about meaningful impacts of PHM innovations on women, the youth and other social disadvantaged groups are not technological complex and can be achieved by low-cost improvements of the current traditional systems;

g) Many on-going agricultural development initiatives can be used to implement women empowerment and food security enhancing interventions (Ex. PEDSA/PNISA/PODA), with focus on poor, marginalized and socially excluded beneficiaries provided relevant policy adjustments are made;

h) World Vision Mozambique is implementing PHM activities that go beyond storage, involving improved harvesting, drying and low-cost processing but no reference was found as to if the gender and social equity dimensions were considered the core part of their activities.

i) Existing multi-stakeholder Learning Teams can be for joint identification, sharing, and adaptation of good practices and solution of key problems. Interventions benefiting market actors stand better chances of adoption.

j) Among the public, private and community radio stations, over 100 radio stations operate in Mozambique, reaching 60 to 70% of the population and offering opportunities to utilize radio for agricultural extension and advisory services.

Recommendations on how to improve the current situation

These recommendations derive from reference readings from Coulter and Schneider (2004); AGRA, (2014); FANRPAN (2014); Tivana et al. (2014) and Zvomuya (2014), from Mozambique and elsewhere with a similar context.

Policy recommendations

a) Need to revitalize the national PHM working group (National Post-Harvest Steering Committee) led by the National Directorate of Agricultural Extension (DNEA) under the

Ministry of Agriculture and Food Security with representation and active participation from various stakeholders;

b) Need to strengthen existing policies towards strategic PHM interventions with gender and social equity consideration, based on the following key issues:

- Community-based approaches to reduce postharvest losses;
- Lessons learned from experiences of other countries;
- A thorough understanding of underlying factors driving adoption of PHM technologies;
- Relevance of the PHM technologies to their target group (cost, added value, accessibility, attractiveness and adjustment to local culture);
- Increased involvement of smallholder farmers in PHM research trials;
- Increased collaboration between research and extension services, farmer´s organizations and universities;
- Measurement of postharvest losses in the country;
- Strong focus on reducing losses at farmer level;
- PHL reduction innovation technologies suitable for smallholder farmers to be stimulated through special tax incentives for manufacturers;
- Research on improvement and transfer of PHLR technologies that must address development and dissemination of technical solutions affordable to farmers.

c) Sector strategy/policy documents to be aligned with one another and to regional policy documents;

d) Government spending on PHM should be detailed to allow prioritization of activities;

e) Information dissemination on PHM using mainly radio, but also other ICTs must be a significant component of the contents of agricultural radio programmes. New approaches such as promoting the use of cell phone-targeted services to deliver information relevant to the various aspects of PHM should be included in policy-making

f) Increase advocacy by institutions and champions key to PHM, to promote PHM issues in the *Comprehensive Africa Agriculture Development Programme* (CAADP) and PEDSA, by influencing policy makers to improve PHM-related actions;

Practical recommendations

a) Use of radio stations to broadcast PHM extension messages developing a business approach that can create profitable and sustainable outcomes for broadcasters willing to invest in such ventures (Chapota, 2015).

b) Provision of farm business school trainings to train:

- Women and men to learn to work together

- Women on customized improved post-harvest handling, storage, processing and marketing
- Women and men on gender and human rights
- Women and men on basic business skills
- Women to develop business mind-set, mainly on agro-processing.

c) Gender mainstreaming programs targeted at women. To overcome communication barriers between farmers and extension officers/subject matter specialists in promotion of PHM technologies for all social groups, Chingarande (2015) proposes workshops and field days as platforms for sharing information and for marketing new post-harvest storage technologies, to allow dialogue and direct interface with the technology and people, allowing them to seek clarity on "grey areas", as opposed to other strategies. Testimonies from men and women who have benefitted from the technologies and distribution of pamphlets and digital video devices that are in vernacular languages and that women and men can read and listen to at convenient times can improve efficiency of information dissemination;

d) Women-led micro-credit schemes to finance income generating activities that can help women assets;

e) Improvement of the transports system to minimize costs and improve access by women and vulnerable people;

f) Provision of infrastructure for women entrepreneurship (e.g. agro-processing);

g) Socio-cultural issues, especially "gender-" and "social-equity" should be priority components of PHM projects;

h) Development of low-cost processing equipment (shelling peeling, screening) adapted to local conditions: available materials, energy sources, etc. Same with

Fig 6: Percentage of people that had listened a radio station A week before the interview by province - Mozambique

small-scale low-cost storage facilities appropriate for smallholder farmers. Poorer farmers need a range of PHM options that include low cost improvements to their current structures and handling systems.

i) Promising traditional technologies suitable for poorer farmers can be systematized and subjected to research. If the research results indicate them to be better than not using any PHM technology, they should be disseminated along with the ones scientifically developed to give choices to poorer farmers.

j) Disseminate traditional technologies tested and validated by the HELVETAS`s project in Cabo Delgado as well as other that may have been dealt with elsewhere;

k) Develop intermediate transport systems (hand-driven, ox-driven or motorized) that can ease movement of crops from the field to home and market;

l) Appropriate and affordable packaging and storing materials;

m) Adequate management of moisture in stored crops;

n) Development of well-ventilated stores for final drying of grains prior to storage, for protection from rain, rodents, birds and for minimum temperature fluctuations.

o) Study determinants of the adoption rate of the widely disseminated "Gorongosa type" improved barn.

p) By understanding the customary rules of the communities, considering local culture in implementing PHM interventions that address gender and social equity;

q) Understanding the needs and opinions of both men and women when implementing PHM interventions provides a positive framework for sustainability of the interventions.

Some suggestions of possible technical entry points to improve PHM practices in Mozambique

As previously referred by Cugala et al (2012), reports on examples of dissemination of PH loss reduction innovations in Mozambique were very scarce, concentrated to on-farm maize and no reference to other crops. As such, the following contents is going to be based solely on recommendations found from the literature as having the potential to fit within the context, local practices and culture of Mozambique, as well as of being economically feasible for smallholders under gender and social equity perspective.

As described by several authors, the following are examples of technical entry points (tools and small scale equipment) that clearly have the potential to be tested to improve PHM of grains in the context of Mozambique. They are mostly simple, hand-operated/manual, are not run on electric power and ease the roles traditionally regarded as to be played by women, while

speeding up the PHM operations in order to reduce exposure to some of the risks associated to PH loss.

a) Ways to reduce field losses

Proper drying is critical for minimizing PHLs and cannot be achieved by just implementing adequate management practices World Bank (2011). Sun drying ensures that crop is sufficiently dry for storage for small-scale African farmers. As such, weather conditions should not be too cloudy, humid or even wet in order to avoid losses. Climate conditions at the time a crop should be drying is key to help reduce grain losses. However, successful drying alone is not a remedy against all postharvest losses since insects, rodents and birds may attack well dried grain in the field before harvest and/or invade drying cribs or stores after harvest (APHLIS, undated). In this context, the use of ICT´s to disseminate weather forecast messages in select locations as well as market information, such as commodity prices or availability of PHM pesticides, etc., should be part of the strategies to reduce them.

Rugumamu (2009) reported that at Tanzanian homesteads, maize cobs were dried by solar radiation and on a drying structure hanged over cooking fire to be fire-cured ("Dungu"). These empirical processes dry grains to acceptable levels of dryness before storage. practice by Mozambican farmers. Improved storage technologies and infrastructure are not well disseminated and used to benefit food security crops mostly because men concentrate investments to cash crops as well as information dissemination is not effective.

Rugumamu (2009) informed that testing for correct dryness of grains in Tanzania was mostly done by women by crashing the grains with the teeth with no clear practical technical guidelines that could be effective in reducing crop losses at storage. This means a need to disseminate information on simple, practical and straightforward ways on how correct dryness stage can be identified in field conditions as an instrument to promote post-harvest loss reduction at farmer level, benefiting women and the poor.

b) Grain storage issues

Losses at storage were reported by Rugumamu (2009) as comparatively higher than in other phases of PHM and due to mostly poor drying and subsequent storage defects. From this point on, grains face high insect infestations as well as fungal infections. This is why grain storage gets more attention from farmers themselves (through traditional grain storage systems) as well as national governments (including extension services), NGO´s, integrated rural development projects and other players that either improve traditional stores (with rat guards) and drying cribs or promote new, improved silos and develop networks of artisans to build storage structures and where necessary arrange for credit so that farmers can have access to these new technologies.

The uptake of PHM innovations has been slow in Mozambique. Reports by Tivana et al (2014) inform that adoption of the mud-brick silos has been constrained due to poor financial conditions of the rural farmers. The same report refers that FAO has been promoting construction of metal

silos unsuccessfully due to i) poor skills and capital by local artisans and ii) scarcity of appropriate metal sheets on the local market for construction of metals silos.

As proposed by Maize CRO (2013) based on Central America, Kenya and Malawi, governments must give tax exemptions to galvanized metal sheets for silo construction in agricultural imports, which would help establish a well-functioning, sustainable silo production industry, in order to increase access to poorer and marginalized groups. Most of storage improvements do not benefit women, either by resulting in innovations that men turn to keep for conserving cash crops or by not being designed to meet women´s expectations, among other constraints. Improved granaries tend to be owned by men, with women keeping ownership of traditional ones, for safekeeping food crops. In this way it is critically important to pay attention as to which improvements should be brought up in order to improve storage while caring for women´s interests.

According to Coulter and Schneider (2004) the benefits for adoption of the silos extend beyond the owner's families, reaching other families within the same rural communities, since more grain is stored and sold locally. This advantage can also be of greatest significance in Africa because greater local availability of stored grain forces prices to go down. Silos are also *convenient* because despite the poverty levels of most farmers, the structure of the silo is simple, it can be purchased "ready to use", does not require much maintenance, making this technology perfect to promote gender balance and social equity in PHL Reduction activities.

Rugumamu (2009) informed that apart from industrial pesticides (Actelic), grains could also be protected at storage through indigenous pesticides. Apart from access issues (cost and market failures), industrial pesticides pose a serious threat to user´s health and life due to farmer´s high illiteracy levels, mostly the poorer and disadvantaged.

Below, from Figs 7 to 22 some examples of PHM innovative tools or approaches with potential to be considered in Mozambique are presented, with some suggestions of some improvements that, if done, could benefit both sexes or reduce gender/social imbalances.

Table 4: Examples of innovations that can be used to promote gender and social equity in Post-Harvest management in Mozambique

EQUIPMENT	NAME	SOURCE COUNTRY	USE	APPLICABILITY	
				WOMEN	MEN
Figure 7 	Oxen-cart transporting harvests to local market in Zimbabwe	Zimbabwe FAO – Draught Animal Power: An overview http://www.fao.org/fileadmin/user_upload/animalwelfare/FAO_Draught_Animal_Power.pdf	Men and women are involved in crop transport from the field to homesteads and markets, though men use carts, bicycles o hired vehicles, whereas women do it on head and in small loads.	Reduced PH labour intensity and increased time availability for other duties.	
Figure 8 	Agricultural Market Development	Uganda http://pelumuganda.org/agricultural-market-development/	Promoting PHHandling, value-addition and marketing of agricultural products among smallholder farmers, enables them to access profitable markets. Yet, women still benefit less from these initiatives because they cannot travel long distances and are said not to be "good price negotiators" by men.	Joint women marketing groups, local trade fairs or other means can help women sell surplus crops, mainly those in polygamous marriages or other women head of households.	
Figure 9 	Rice Post-Harvest Processing and Marketing	Nigeria IC Net Limited http://icnetlimited.com/our-work/our-projects/agriculture/rice-post-harvest-processing-and-marketing/	Initiatives promoting Post-Harvest Processing and Marketing that improve the quality and reduce the post-harvest loss of grains help partially because women (even when in decision-making position at home) still are unable to reach bulk markets due to their multi-task nature.		

Table 4: Examples of innovations that can be used to promote gender and social equity in Post-Harvest management in Mozambique (Cont)

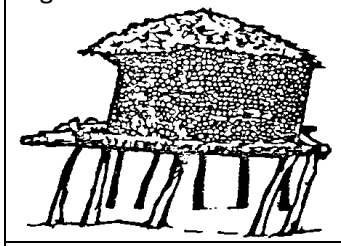
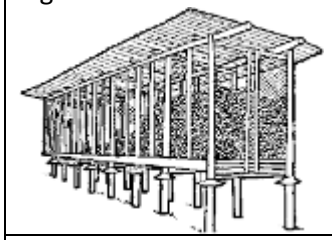
EQUIPMENT	NAME	SOURCE COUNTRY	USE	APPLICABILITY	
				WOMEN	MEN
Figure 10 	Traditional corn barn, Ghana	Ghana Improved Food and Drying Storage: A training manual http://www.nzdl.org/gsdl/collect/fnl2.2/archives/HASH01b3/33fb20b6.dir/p153a.gif	Good, wide, roof overhangs, raised high, rat guards and lots of ventilation. A crib this wide could be used to store maize only if it were field-dried or air-dried down to 13% moisture or less.	Women can benefit greatly from little technology improvements to this barn (roofing, rat guards) to store "*women´s crops*" and overcome the lack of space in the improved barns usually occupied by "*men´s crops*".	Can also benefit vulnerable men who cannot afford improved structures.
Figure 11 	Improved maize crib	Improved Food and Drying Storage: A training manual http://www.nzdl.org/gsdl/collect/fnl2.2/archives/HASH01b3/33fb20b6.dir/p153a.gif	Improved crop storage reduces post-harvest loss	Better crop drying can increase on-farm productivity and allow women to be involved in training and other self-promotional activities.	Better crop drying can increase on-farm productivity and increase bulk sales, allowing acquisition of assets.
Figure 12 	Postharvest - Rice	IRRI – Postharvest **http://irri.org/our-work/research/value-addedrice/postharvest.**	Reduced postharvest loss, up-dated equipment and adequate operator skills lead to increased quality and reduced contamination (for ex, by mycotoxins) of milled rice, thus increasing market price. Benefits also youth and children, usually involved in manual operations.	Mechanical threshing can reduce labour inputs, processing time and grain losses and increase on-farm production and productivity by allowing women to be involved in training and other self-promotional activities.	Mechanical threshing can increase on-farm productivity and increase bulk sales, allowing acquisition of assets.

Table 4: Examples of innovations that can be used to promote gender and social equity in Post-Harvest management in Mozambique (Cont)

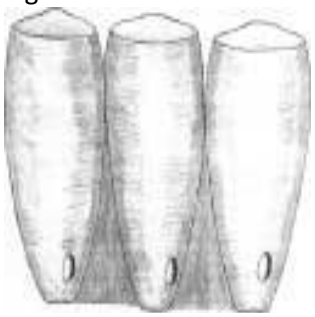
EQUIPMENT	NAME	SOURCE COUNTRY	USE	APPLICABILITY	
				WOMEN	MEN
Figure 13 	Traditional storage structures still going strong	Ghana http://www.agriculturesnetwork.org/magazines/india/3-post-harvest-management/traditional-storage-structures-still-going-strong/at_download/article_pdf	. Mud silos are very efficient for grain storage and used in Ghana to store grains for up to one year without significant damage. They have been developed and adapted over generations and are usually well suited to local conditions.	Since this technology represents a slight improvement to the traditional barns, it can be promoted to store "*women´s crops*" and overcome the lack of space in the improved barns usually occupied by "*men´s crops*".	Can also benefit vulnerable men who cannot afford improved structures.
Figure 14 		Eritrea http://www.agriculturesnetwork.org/magazines/india/3-post-harvest-management/traditional-storage-structures-still-going-strong/at_download/article_pdf	In Eritrea the main in-house grain storage structures in traditional houses are called koffa. These structures are oval shaped, 1.5-2 metres high, and made of cow dung and ash. More than one type of grain can be stored in them.	Since this technology represents a slight improvement to the traditional barns, it can be promoted to store "*women´s crops*" and overcome the lack of space in the improved barns usually occupied by "*men´s crops*". Ability to hold more than one crop suits the needs of women, who wish to keep various crops for food security.	
Figure 15 	The granary for cereals "Gorongosa Type"	Mozambique PRODEZA News http://postharvest.nri.org/images/documents/Gorongosa/Gorongoza_mud_silo_ppt_English.pdf	This granary can be adopted by larger numbers of farmers due to its low construction and maintenance costs, high durability, full protection against rats and insects, and also fire. It allows grain treatment with Phostoxin (aluminium phosphide), drives out residual humidity without condensation, secures grain conservation until next harvest and allows the farmer to wait for better market prices	Better crop conservation can increase on-farm productivity and allow women to be involved in training and other self-promotional activities. Perfect for women heads of households.	Better crop conservation can increase on-farm productivity and increase bulk sales, allowing acquisition of assets.

Table 4: Examples of innovations that can be used to promote gender and social equity in Post-Harvest management in Mozambique (Cont)

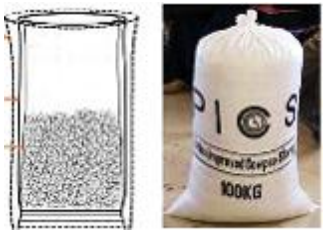
EQUIPMENT	NAME	SOURCE COUNTRY	USE	APPLICABILITY	
				WOMEN	MEN
Figure 16 	Awareness: A Key to Reducing Post-Harvest Loss in Africa - Discovering the Resources	The Rockefeller Foundation https://www.rockefellerfoundation.org/blog/awareness-key-reducing-post-harvest/	Purdue Improved Cowpea Storage (PICS) bags, are hermetic bags, or "triple bags," designed to prevent stored grains and cereals from pest attacks for up to nine months or a year. They are cheap and effective but many farmers do not know about them.	Perfect low cost for women in general, with focus to those heads of households. Better crop conservation can increase on-farm productivity and allow women to be involved in training and other self-promotional activities. Perfect to store smaller amounts of different crops.	Can also benefit vulnerable men who cannot afford improved structures.
Figure 17 	Farm Machinery and Equipment II – Lesson 14. Maize sheller: Types, components and working principles	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=125404	Hand shellers for small farmers, very helpful to ease the so strenuous hand shelling usually performed by women, the youth and children.	Perfect low cost for women in general, with focus to those heads of households. Perfect to process small amounts of maize. Turns shelling maize into a less uncomfortable task.	Can also benefit vulnerable men who cannot afford mechanical shellers.
Figure 18 	New postharvest storage technologies for Latin America	Latin America Events, MasAgro, South America http://blog.cimmyt.org/new-postharvest-storage-technologies-for-latin-america/	Airtight storage technologies can be used to ship, preserve and maintain the quality of food grains at smallholder level.	Perfect low cost for women in general, with focus to those heads of households. Better crop conservation can increase on-farm productivity and allow women to be involved in training and other self-promotional activities. Perfect to store smaller amounts of different crops.	Can also benefit vulnerable men who cannot afford improved structures.

Table 4: Examples of innovations that can be used to promote gender and social equity in Post-Harvest management in Mozambique (Cont)

EQUIPMENT	NAME	SOURCE COUNTRY	USE	APPLICABILITY	
				WOMEN	MEN
Figure 19 	Improved postharvest technologies for promoting food storage, processing and household nutrition in Tanzania		Metal silos and SGB GrainPro bags, are hermetic designed to prevent stored grains and cereals from pest attacks very effectively.	Metal silos are not so cheap and women are able to acquire them if they are in decision-making position. Otherwise, men tend to use them for storing income generation crops. If women can have access to them, can help increase on-farm productivity and allow women to be involved in training and other self-promotional activities.	Can also benefit vulnerable men who cannot afford improved structures.
Figure 20 	Yei Farmers´ group equipped with food processing machines	South Sudan http://www.gurtong.net/ECM/Editorial/tabid/124/ctl/ArticleView/mid/519/articleId/18265/Yei-Farmers-Group-Equipped-With-Food-Processing-Machines.aspx	Processing adds value to grain and supports better access to markets, both for men and women, who can then meet better prices.	Can release some duties from women as household labour division can be improved by increasing men´s participation in mechanized processing.	Increased bulk sales, allowing acquisition of assets.

Table 4: Examples of innovations that can be used to promote gender and social equity in Post-Harvest management in Mozambique (Concl)

EQUIPMENT	NAME	SOURCE COUNTRY	USE	APPLICABILITY	
				WOMEN	MEN
Figure 21 	Developing customised PHHS training posters in local languages	Training Manual for Improving Grain Postharvest Handling and Storage http://documents.wfp.org/stellent/groups/public/documents/reports/wfp250916.pdf	Improved quantity and quality grain can increase income earning opportunities and food security alternatives of learners' households. One way to doing so is equip farmers with knowledge in the language they know the best and using the best format possible to deliver its contents.	Very suited for women farmers who are relatively more illiterate than men.	Can also benefit vulnerable men who cannot afford improved structures.
Figure 22 	Using ICT to enable Agricultural Innovation Systems for Smallholders: ICT innovations	E-Agriculture http://www.fao.org/docrep/018/ar130e/ar130e.pdf	ICT can be used between farmers to support each other. SMS services and mobile payment systems that allow farmers to exchange capital, access to critical and targeted information on commodity prices, weather, disease outbreaks, etc., and helpline services providing key tips and real-time advice can be used in the field of PHM.	Very suited for women farmers who are relatively more illiterate than men and have difficulties in attending training activities due to their multi-task nature.	Because they have relatively higher literacy levels as compared to women, men farmers can take much advantage of the ICT potential to drive innovation on PHM leading to the greatest increase of their incomes

II.6. PHM INNOVATIONS, TOOLS OR MECHANISMS THAT ENHANCE GENDER BALANCE AND SOCIAL EQUITY WHICH CAN BE SCALED UP

General considerations regarding development and dissemination examples of innovations with potential to reduce PHM losses in Mozambique

This section will essentially deal with selected examples of PHM innovations, tools or mechanisms found as with potential to fit within the context of local practice and able to promote returns from agriculture. In common they have the fact that their characteristics make them gender- and social equity-sensitive. The tools are designed and tested to be used by women farmers, to be easy to assemble, relevant to the end-users including the youth, affordable, durable, do not require any kind of engines and with potential to be aligned with customs of the average Mozambican farmers.

According to World Bank (2011), examples of promising innovations ranged from (i) training on improved handling and storage hygiene (ii) using improved tools (e.g. hermetically sealed bags and household metal silos), supported by improved technical capabilities of local artisans around silo construction and maintenance. Costa (2014) based on a study-case from Uganda and Burkina Faso demonstrated the importance of improved post-harvest practices as a way to reduce PHLs. In fact, results showed that improved post-harvest management associated with new storage technologies reduced food losses by more than 98%, regardless of the crop and the duration of storage. These are clearly gender and social equity promotion mechanisms since they help women improve household food security, a role traditionally assigned to them, as well as improves access to food by the poorer farmers.

Training materials should be translated to vernacular languages and adjusted to the African context (Maize CRP, 2013). In Mozambique, where women illiteracy is of around 63%, translation tuition materials can improve their access to information otherwise they would hardly benefit from other forms of communication. By the way, with 40,3% overall illiterate farmers, almost half their number would not be reached by materials written in Portuguese.

For poorer smallholder farmers, who are unable to adopt innovative approaches, improvements in basic storage hygiene and good storage management practices are powerful tools, though very often not implemented by farmers (World Bank, 2011). As per Coulter and Schneider (2004) poorer producers can improve by including low-cost improvements to their existing structures and systems which will be easily adopted because it does relate to their culture and habits.

Relevant examples of innovations that can be scaled up to reduce PHM losses in Mozambique taking into account gender and social equity aspects

"*Compatible Technology International*" (CTI) has been developing tailored and affordable technologies to improve the lives of smallholder farmers in developing countries worldwide (Thilmany, 2011). Most of CTI technologies are gender- and social equity-sensitive, designed and tested to be used by women farmers, easy to assemble, affordable, durable and do not require any kind of engines (though one can be added). They can be used as en suite (thresher + stripper + winnower + grinder) e.g. for cooperatives or as stand-alone devices for individual households. This institution´s contact (www.compatibletechnology.org) is provided for reference and future contact in the event their tools and approaches can be mainstreamed in PHM projects and programmes in Mozambique.

According to Rugumamu (2009), apart from helping reduce the burden on women, improved technologies can also help increase men's participation in labour-demanding activities and thus promote better labour distribution. In his study-case, when improved technology was available to expedite shelling and to minimize grain damage, it was used by both men (75%) and women (22%).

The innovations listed below were selected not only on their potential technical fitness to the country´s context, but also to their potential for adaptation to the diverse community's cultural set-ups. CTI´s approach is the exact example of ways to go about promoting equity in agriculture development, mostly on PHM.

Adequate delivery mechanisms are to be used to deliver the innovations to farmers and bring about reduction of PHM losses. Using ICTs in agricultural Extension and Advisory Services was backed by Chapota (2015) as very relevant.

1. Shelling and threshing

The hardest part of harvesting is separating the grain from the chaff, an activity mainly carried out by women. For example, shelling of maize grains involves detaching grains from well dried cobs and is done by hand or simple tools. Locally designed craftsmanship to enhance shelling was developed and described by Rugumamu (2009). According to AGRA (2013), it is traditional the practice of shelling maize cobs by beating them inside sacks, practiced by poorer farmers. This practice results in cracking the grains, allowing them to be infected by fungi.

In the same line, after observing how Guatemalan women shelled corn, CTI researchers came up with a very simple, straightforward sheller. It consisted of a piece of wood with a hole in the middle. The corn is pushed through the hole, shaving the kernels from the cob. With tools, the yield can be increased to 92 percent and contamination is virtually eliminated. For example, with CTI tools, processing was 10 times faster than what could have been done by hand (Thilmany, 2011). This is the right example of small scale, simple, affordable and easy to implement technologies that can reduce the workload on women as well as improve access of marginalized

people to low-cost PHM technology that can help speed up processing and reduce exposure to loss risks.

2. Drying techniques and testing moisture levels

According to MAIZE CRP (2013), Kenyan and Malawian farmers use candles to deplete oxygen within sealed drums and glass bottles to determine grain dryness for safe storage. Such techniques and appropriate storage tools are of utmost importance to success of PHL reduction activities and can be easily made accessible to low-income farmers.

Different small scale drying devices are available at various complexity levels. Of course, simple and straightforward dryers can be promoted to further reduce PHLs considering that women have little time to participate in learning activities in order to understand complex operations as compared to their males who can afford to operate a little bit more complex tools and equipment because are much more exposed to new/improved technologies.

3. Storage utensils and infrastructures

The most frequently reported innovation introduced at family and community levels as per various reports are different models of granary silos (mud-brick, metal and plastic silos). Silos were referred to by World Bank (2011) as a powerful tool to protect stored grain from pests, rodents, birds, and fungi. Coupled with adequate postharvest management, silos can allow grains to be kept for long periods with no relevant loss of quality.

The adoption of metal silos has been recorded as a success story in Central America and in some few African countries but, their high cost and lack of incentives for cheaper local production in Mozambique and elsewhere, were repeatedly referred as their constraints. Maliro and Kandiwa (2015) informed that many individual people that bought those tools in Malawi were relatively rich urban part time farmers or farmer-relatives and NOT local poor farmers. As such, suitability of the metal silos technology in the context of gender and social equity is questionable.

According to FAO (2016), the Gorongosa improved barn, more affordable, could be a good alternative to the metal silo as it can last for up to 20 years, is impervious to fire and protects against rats, pests and diseases, retains the quality of the grain for up to ten months, it allows grain treatment with Phostoxin (aluminium phosphide) and drives out residual humidity without condensation. Since the Gorongosa barn is built to store one single crop and still costs a little higher than poorer households can pay at once (More than 50% of Mozambicans survive with less than USD1.5/day), alternatives that can potentially promote gender and social equity emerge, such as the hermetic storage (Super Grain Bag, able to hold 90 kg of grain and that does not require insecticide use, are environmentally friendly, and are 100% recyclable or the hermetic drums). The disadvantages of the bags are that they can be perforated by the larger grain borer and by rats but they are cheaper and can hold lower quantities of crops as compared to metal silos and the Gorongosa barns, ideal for poorer and vulnerable beneficiaries.

Goodhead and Glin (2015) reported that hermetic storage bags – triple-layered storage bags that protect grains from infestation – have successfully reduced food loss in parts of India. Some of the reasons linked to this success were that their use requires little training and farmers quickly see the economic benefit of storing grain at home and fetching at best prices. This seems to be one of the right technologies to be shared to women, who do not have much time available to participate in training events, mainly young women who are the most time constrained due to multiple tasks socially assigned to them that do not allow them to participate in information dissemination events.

4. Processing

This step is labour demanding and does involve health concerns, when it comes to winnowing or working under windy and sunny conditions. Dust masks are cheap and easy to be made available to female farmers, in order to protect their health.

Traditional storage devices of different formats and building materials are available in Mozambique, including cylindrical granaries on stilts, mud storage structures, woven baskets on erected stands, drums and jute bags (AGRA, 2013). Improvement to such methods and devices would benefit PHM in Mozambique.

5. Combating animal, pest and insect attacks

According to AGRA (2013), maize is susceptible to attacks by termites if left to dry in the field, as well as rats and infestation by pests. The same author states that rice is more affected by wild animal attacks (migrating bird – *Quelea quelea*) and livestock. Regarding sorghum and millet, losses are caused by pests, wild animals and livestock. Beans are more affected by pests, which infest grains before harvest, causing large losses if left for long storage periods (AGRA, 2013). Rodents represent a threat to all crops. Technologies suitable to promote gender and social equity in PHM to combat animal attacks include rat guards, rat killers and use of cats. Promotion of cat rising at family level is key, since mice will keep away from homes where their predators will be kept and is accessible to women and poorer households. Pesticides can be used to combat insect attacks.

6. Using Information and Communication Technologies in delivering agricultural extension and advisory services

Chapota (2015) stated that the processes used to disseminate and promote adoption of technology agricultural innovations are critical and that radio in association with other ICT media can play a major role. According to that author, radio is the most used medium to disseminate information for rural african audiences. It can reach remote areas where there are no phones or electricity, delivering vital information for people who cannot read and write but can listen in their vernacular languages. Even in the very poor communities, radio penetration is vast and people own radio devices or cellphones with radio function. This situation brings a perfect

solution for the characteristics of Mozambican farmers in the context of PHM, who are illiterate and cannot understand or speak Portuguese. Even poorer farmers can benefit from radio broadcasts by joining their neighbours or attending radio listening groups that can be organized at broadcasting times.

Chapota, (2015) recommends that use of radio services to disseminate agricultural contents can at times be enhanced by other ICTs such as mobile phones to allow interaction with listeners, who can provide feedback and demand on program contents to improve its efficacy. It demands that:

i) An appropriate broadcasting time be defined, usually between 6:00 and 7:00pm in Nampula and Zambezia provinces

ii) The duration is suitable – between 15 and 30 minutes per day

iii) It involves fellow farmers speaking (debates/interviews), telling their stories and experiences, instead of institutional officials who farmers think do not talk from own experience.

Other examples of ICT use can be SMS services and mobile payment systems that allow farmers to exchange capital, access to critical and targeted information on commodity prices, weather, disease outbreaks, etc., as well as helpline services providing key tips and real-time advice that can be used in the field of PHM.

For both uses of ICT (radio and electronic media), a degree of collaboration and cooperation between key stakeholders is necessary and demands a value chain approach.

II.7. GENERAL LESSONS ON THE PARTICIPATION OF WOMEN SMALLHOLDER FARMERS AND MARGINALIZED SOCIAL GROUPS IN PHM AND ON HOW TO ENHANCE INTEGRATION OF GENDER AND SOCIAL EQUITY INTO PHM

Gender and social equity

- Women and men have different perspectives because social labour division place different workloads to them according to their gender. As such, policies, programs, and projects designed to improve PHM must be developed auscultating both men and women.

- Men and women villagers need simple/medium level, time- and energy-saving PHM technologies. These technologies are an efficient vehicle to promote equitable division of labour between men and women in all activities because they promote more participation of men in roles culturally assigned to women (e.g. milling, de-husking, etc.);

- Providing income generating opportunities as standalone strategies for women empowerment may not yield the desired outcomes, unless men and women both change their attitudes regarding collaboration, cooperation and mutual respect of individual objectives. If a woman decides to get involved into a business opportunity to save food and make some money and starts making too

much money, than anticipated by the man, all of a sudden he can get involved and undercut any authority she may have been building for herself. There is a need for developing approaches that promote bargaining between both men and women about money and their traditions.

- To improve women´s bargaining power at household level specific areas where women can benefit directly from project activities to improve their bargaining power must be identified and promoted. As an example, since women control revenues from mid-season sales (that they can use to hire casual labour much later in the season), promoting mid-season sales would not have impact on the men's preference to sell grain soon after harvesting. However, care must be taken to understand that promoting mid-season sales by women may be an instrument for drudgery to vulnerable people.

- Structural modifications to granaries that benefit women by reducing grain store construction and maintenance requirements and allow them the ability to build separate stores where they can have more control over grain usage.

- Technology development for PHM needs to consider the cultural context in which it is to be used. Evidence from literature on PHM technologies, suggests that women's access and control of stored grain differs according to ethnic groups, so it is important to understand and mitigate such issues;

- The development and promotion of PHM tools requires gender sensitivity by the artisans, through appropriate gender mainstreaming training as to improve the level of awareness on difference in roles played by men and women farmers, design preferences for both men and women, and potential strategies for targeting the technologies;

- Specifically regarding the dissemination of metal silo technology, a deliberate attempt to target and train female artisans as well as target female-headed households to benefit from metal silo should be sought for.

PHL Reduction Technology

- Despite the successes reported by various authors for metal silos, high initial costs are a significant challenge for widespread adoption, constraining acquisition by many farmers unless they could obtain affordable credit. Failure of innovations to fit within the local context and practices and their inability to bring about attractive returns are other deterring factors. As such, for poorer farmers, dissemination of cheaper post-harvest tools, such as, for ex. hand threshers and grinders, triple bags, hermetic drums and implementation of improved grain handling practices or improvement of existing traditional storage structures against rat and insect attacks as well as to be efficient with the inadequate humidity levels of the grain at storage should be considered.

Policy issues on PHL Reduction

- A systematic long-term approach for disseminating PHM technologies must encompass i) technology transfer involving involve multi-institutional collaboration, ii) considerable time-investment for farmers to be able to evaluate and adopt new storage technologies, and iii) strong follow-up activities to ensure that the structures are being correctly made and used;

- There is need to increase awareness on the benefits of postharvest improvements at a wider scale (farmers, private sector and policy levels) and to work towards building the capacity to achieve such improvements by i) mainstreaming postharvest modules into the curriculum of agricultural colleges, ii) building farmer and private sector capacity through informal as and formal training and information and iii) harnessing the power of ICT´s (radio, newspaper, television, and video).

In such activities, gender and social equity considerations should play an important role.

II.8. CURRENT ON-GOING PHM DEVELOPMENT AND RESEARCH PROGRAMME INITIATIVES IN MOZAMBIQUE WHICH PROMOTE A ROBUST AND CONSISTENT PHM APPROACH THAT IS RESPONSIVE TO GENDER AND SOCIAL EQUITY

According to Gallina and Chidiamassamba (2010) targeting technology development and dissemination to women farmers is especially important in Mozambique because they are increasingly heading households (27,5% of the farmers were women-headed) and becoming keys for provision of most of the agricultural labour (52% of the population are women and 72% of the women are based in rural areas). Gallina and Chidiamassamba (2010) suggest that the development and dissemination of new technologies in the country does not take gender-specific characteristics and requirements into account, being an example the little investments in research to develop food processing technologies, predominantly undertaken by women farmers.

Participants to the Maputo Policy dialogue (July, 016) recommended that promising traditional PHM technologies suitable for poorer farmers in Mozambique should be systemized, researched and those proved to be better than no use of any PHM technology should be disseminated as alternatives to those scientifically developed, giving alternatives to poorer farmers. In line with this recommendation, traditional technologies tested and validated by HELVETAS in Cabo Delgado are to be disseminated.

Based on some practical examples in Mozambique, this section will give an overview of how PHM development and research programmes are being implemented under gender and social equity lens in Mozambique, taking in consideration experiences from elsewhere. Issues to be improved in line with gender and social equity improvement will be suggested where relevant.

Despite not having been found/reported indiscriminate examples of good practices, the trend regarding improvements in PHM of grains is as follows:

Catholic University Of Mozambique

The Catholic University of Mozambique is implementing a Food Engineering degree course in Manica, where some gender and social equity perspectives are being implemented in 2 topics:

a) Women´s Farmer Association promotion in Manica province

Training of women groups of 32 farmers each in 8 districts of Manica around correct grains conservation and processing practices for improved household food security and income generation for women. This activity was requested by GAPI, a financial institution, in the right direction of institutional integration.

b) Training of farmers on existing PHM practices

The university has an extension branch which, recognizing that post-harvest losses are mostly due to deficiencies regarding right maturity and dryness stages, these topics form the bulk of their intervention in outreach activities, training farmers. Regarding drying, emphasis is being on improving the traditional practice of sun drying, to semi-shade drying, based on nutritional lab information they deliver, demonstrating to what extent grains dried under the sun loses nutritional elements, information that is communicated to farmers.

c) University´s PHM technology level

The Catholic University is currently investing in a grain´s processing training lab where students will develop practical skills. The infrastructure is to be equipped with small scale dual mode operation systems (mechanical and manual) so as to equip graduates with practical skills relevant to the reality in the field and low-income farmers.

d) Issues to be improved

No mention was made for women empowerment activities around the women´s farmer association promotion and no information on which straightforward techniques were disseminated to help farmers with a practical advice on how to clearly identify the right grain maturity and dryness points in trainings on PHM practices. Regarding the university´s PHM technology level it was advanced that in future, students from their mechanical engineering course would have room to liaise with farmers in field activities so that they can develop an innovative mind set of developing simple prototypes that can be scaled-up to solve real field problems.

INGC - National Institute For Disasters Management

The National Institute for Disasters Management (INGC) is leading drought mitigation activities along with district stakeholders (SDAE-District organism that deals with agricultural and other

economic activities; NGO´s) in some of the country´s semi-arid regions. Post-harvest management is one of the pivotal activities, which is solely looking at disseminating Gorongosa type mud brick improved silos in some districts of Gaza and Inhambane provinces. Despite good intentions, this programme is to be improved in the following aspects:

a) Issues to improve

Only richer farmers qualify the requisite of "influent farmer" set to benefit from support to get a demonstration unit. The beneficiary must show own capacity to replicate the silo after the demonstration. There was a strong indication that gender and social equity issues were overlooked and only targeted numbers of improved silo were the main focus in the programme.

The programme on dissemination of improved silos concentrates solely on building the infrastructures. No mention was made as for PHM practical training activities to prepare the grains to be stored as well as on using pesticides inside the silo as well as on promotional activities based on demonstration of the silo´s effectiveness by comparing stored grain to that of the traditional stores.

Most potential artisans attending trainings do not have previous exposure to civil works professional experience (masons or bricklayers) and end up not becoming improved silo artisans because in a so short period of time they do not even develop the basic skills of using mason´s tools. Therefore, right skills should determine selection of potential improved silo artisans.

Considering the high vulnerability of populations in semi-arid areas, cheaper storage utensils are to be introduced as a mechanism to improve PHM in those regions. In the INGC experience, some larger-sized Gorongosa silos were seen empty for long periods of time due to unavailability of grains to be stored, meaning that for these areas, smaller and simpler models could accommodate both issues of availability of smaller quantities of grains to be stored and improvement of access to the poor.

IITA – International Institute for Tropical Agriculture

IITA, based in Nampula, reported some interesting PHM activities with soybeans and cowpeas, the first being grown as cash crop mainly benefiting men and the latter for household food security, mainly concerning women. The following gender and social equity promotion mechanisms were reported:

a) Dissemination of gender and social equity sensitive PHM tools

With soybeans, IITA´s strategy consists of identifying the most strenuous steps in PHM activities and act on them. As such, they are mainly concerned with introducing threshers that can reduce the burden on women for threshing soybeans. Threshing manually takes 1 week per ton but the machine takes 1 day per ton. Cleaning and winnowing threshed beans are still done manually.

As for cowpeas, since it is a food crop and harvesting is done for small quantities at a time and is a very sensitive commodity to pests during storage, IITA is promoting small, cheaper and effective storage utensils: the triple bags.

The threshers are owned by farmers who can afford them (petrol operated) but are also to be rented out to others in a mechanism that allows poorer farmers to have access to their services. In fact, because soy bean is a cash crop, fees for renting threshers can be paid after sale of produce – credit is given to poorer farmers – an effective mechanism to include socially disadvantaged members of the community.

Partial automation of PHM of soybeans acts not to disturb too much farmer´s social behaviour. In fact, if they wish so, women can still gather together to perform less strenuous steps of PHM of soybeans, while debating and exchanging experiences regarding their marriages, and family issues. This strategy seems to promote sustainability of introduced innovations in the traditional practices.

Another interesting mechanism to promote social inclusion of their PHM innovations is that threshers are mobile, going from farmer to farmer. In this way, it overcomes the difficulty some beneficiaries may find moving their produce. This concept should be carefully considered in similar or other functions of PHM in different crops.

b) Promotion of women´s Farmer Associations

To reduce the difficulties women face in getting access to better markets, IITA promotes women farmer associations through which any woman regardless if she is single, single mother, head of household, widow, etc. can get her produce into collection points where buyers or transporters pick them to better markets. This practice increases negotiation power of otherwise socially disadvantaged farmer groups when it comes to selling produce.

c) Promoting food processing

Recognizing the huge potential of soybeans to improve food security, mostly of poorer communities, IITA is involved with training their beneficiaries in soybeans processing to promote the use of such product as milk and porridge, because this is a difficult task to be performed. In this regard, beneficiaries are able to better use own produce to improve household food security.

IITA also acts to ensure that both men and women choose the cowpeas varieties of their preference. In this regard, since cooking time, taste and colour were important traits for women, IITA disseminated those varieties, along with the high yielding varieties requested for by the men.

d) Promoting local handicraftsmen

IITA introduced very simple machines that can be copied and replicated locally, which seems to be an important lesson regarding mechanisms for social inclusion in PHM in Mozambique. One

of the activities developed by this institution was to use an IITA engineer to train 5 local fabricators, one of whom was in turn given a contract to copy and replicate the imported threshers and other tools. IITA learned a lesson that the training conveyed to these fabricators should have included "business management skills and attitude subjects" since experience after training them showed that tis component was absent in the way they performed after training.

IIAM - Agricultural Research Institute Of Mozambique

The Agricultural Research Institute of Mozambique (IIAM) would be supposed to have a post-harvest management component in its research, but this has never been a very active area for many years. Current activities are restricted at disseminating food processing technologies developed elsewhere to farmers, with no clear indication of differences between research and extension as well as no research focus on the disseminated technologies.

a) Adaptive PHM research that can potentially benefit the poor

IIAM has conducted successful research on the use of wood ash, an ancient practice that has been used by the communities for grains storage. The research concluded that by using finely sieved ash in a 2 units ash: 1 unit grains proportion, this could act as a reliable organic pesticide. The news here was the improvement of a technology that had already being used by the farmers, but wrongly, with low effectiveness.

This same approach could be used to study and improve the existing traditional grains storage models

b) Lobbying for availability of smaller sachets of chemical pesticides in retail stores

IIAM has taken part in a long battle to convince retailers to sell pesticides to be used in family grains storage in smaller packages. As a result, some retailers (e.g. TECAP) have launched "*Actelic powder*" for protecting stored grains in 100gr sachets to the market. This achievement is worth to be mentioned because acts as a strong mechanism to promote inclusion of poor farmers

c) Potential mechanism for PHM research enforcement in agricultural research

The few activities reported for PHM research in Mozambique were part of a value chain approach research, i.e., research from seed development up to grains utilization. This seems to be a strong mechanism to mainstream PHM into IIAM research programmes, while simultaneously seeking for higher attention and resource allocation for PHM research at higher policy level of Mozambique.

d) Gender and improved nutrition mainstreaming in the agricultural research agenda

IIAM has a specific unit that is busy training agricultural scientists to develop their technologies with due consideration to gender equity as well as nutritional advantages of the new technologies. This approach can be used as a strong mechanism to promote gender and social equity in PHM.

e) Location of IIAM research sites in the countryside

Considering that location- and culture-specific gender/social equity PHM solutions are better developed if researchers live physically close to potential beneficiaries, the location of most of IIAM field sites should be regarded as an opportunity to help locate researchers able to observe closely and understand all the current dimensions of traditional PHM practices and help feed programmes to develop solutions to the identified problems with reference to gender and social equity relevance.

f) Issues to improve

Only one scientific staff was reported as being specialized in PHM research in the whole institute. This fact, coupled with lack of research focus on developing solutions to revert the trend of 30% plus post-harvest losses every year should be reflected upon by the institution. For the time being, no meaningful research is possible not even the research agenda can be elevated to the level of resource allocation to PHM issues due to lack of sensitiveness of entry points for improvement.

FAO – Food and Agriculture Organization

a) Supporting gender equality-related activities in PHM

FAO has been involved with strengthening decision-making capacity by women by improving collaboration within couples involved with maize production to supply a demand for high-standard produce for WFP (Local Purchases Programme). The idea is to ensure that women share the decision on where to use the revenues generated on these sales. Improved PHM tools such as the Gorongosa-type silos are also disseminated with preference to women-led families, including polygamous wives who tend to have full control and less interference by their husbands when it comes to using revenues generated by the sale of their produce.

The Farmers Field School methodology, which promotes both men and women to get used to talk and give opinions is presented as a great opportunity to drive change at community level because men learn that by letting women speak freely, many "quality ideas", such as their own (men´s ideas), come from women and tend to start looking for collaboration and cooperation at household level.

b) Promoting local handicraftsmen

Identification of handicraftsmen to be trained for manufacturing PHM tools or building PHM infrastructures starts with a careful selection of local people who have already been doing the business of producing metal tools or masons who are responsible for building houses locally. In this way, this activity (producing PHM tools/infrastructures) is not the only source of revenue from "*handcraftsmanship*", but rather one of most other activities.

According to the interviewee, the following approaches should be promoted:

The late PAPIR (Project for the Support of Rural Small-Scale Industry), that used to train tinsmiths, smiths, bricklayers, etc. in Sofala province in the 90´s, seems to be an experience to be rescued and adjusted to current reality and could be used to contribute to move the PHM agenda ahead;

The Technical basic schools (escolas básicas) should have a strong focus on solutions for PHM

c) Issues to be improved

Development initiatives related with PHM should ally to universities that have campus in the field and find ways of using their students to implement activities, while, besides learning, they may also be thinking solutions to real field problems and prepare themselves to be future good professionals.

There is a need for a "one-stop shop" solution on PHM with a vast buffet menu of different options in terms of PHM solutions that can be used by development agencies.

FAEF and FAENG/UEM – Faculty of Agronomy and Forestry Engineering and Faculty of Engineering /Eduardo Mondlane University

Although some notions of gender equality are lectured in the various course contents at FAEF, this topic seems not to be as deeply focused as it should in order to allow graduates to have strong skills to handle gender and social equity considerations in post-harvest management activities. At FAENG, no social sciences are lectured since their main clients are large industrial and commercial companies. The following activities are being undertaken in this field:

a) Adaptive PHM research that can potentially benefit the poor

FAEF is undertaking adaptive research to determine effectiveness of the triple bag technology in grains storage in Maputo, Manica and Gaza provinces, based on imported samples. The idea is to recommend local manufacturers (Plastex) to produce such bags and hence, promote this technology to increase access of storage tools as well as give solutions to communities who practice shifting cultivation. In the same context, plastic drums are also being tested as alternative hermetic storage tools.

FAENG has been involved by the Chemistry Engineering Faculty in PHM tools development as a result of practical issues identified during internships in rural areas. For example, 5 BSc students stayed for 3 months in a village (Nhacoongo - Inhambane), setting, operationalizing, testing and training farmers on use of a locally built cassava solar drier.

FAENG has been involved in a trilateral agreement with IITA, as supplier of PHM machinery prototypes for adaptation and transfer of technology to a reputed local mechanic/blacksmith (Mr Paindane). After this collaboration, Mr Paindane is delivering orders for low-cost, small scale PHM tools to NGO´s or individual farmers. As a result "Josina Machel" association, from Nhacoongo, has been delivering dried cassava chips obtained using cassava graters built by Mr Paindane. This example, although from a commodity that is not core to this study, can illustrate opportunities that can be explored in the context of grains.

b) Adjustment of the university curriculum towards supporting PHM

There is a decision to implement a post-harvest management MSc course. Currently, another MSc course (Agriculture and Rural Development) is running, but with no particular focus on PHM. The same happens to BSc Agronomy graduates specialized in Rural Engineering, who has a semester subject on PHM, part of which for grains. A good practice that was mentioned by the interviewee was the "Master Course on Chemistry and Processing of Local Resources" being conveyed by the Sciences Faculty of UEM, which focus on the specific issue of local fruits, vegetables, roots and tubers.

c) Issues to be improved

FAEF students, apart from visiting farmers and factories during practical classes and internships, do not have opportunities of living in a village with farmers for some time, in order to understand and learn on farmer´s hardships and be in a good position to think and implement solutions, as per UNILURIO´s practice, in Nampula province. "…*Some of our students state during classes that they have never seen a traditional silo…*" stated Sandra Chemane, lecturer at FAEF/UEM.

During the on-farm phase for testing the innovations being currently adapted, FAEF should involve women on their own, so that resulting storage model is sensitive to their needs.

FAENG students do not have the annual leave activities ("Actividades de Julho/Actividades de Janeiro"). As such, their practical experience-building opportunities are shrinked and future capacity to devise solutions for practical problems reduced. FAENG should reflect further and reintroduce the annual leave activities and use them to promote identification of problems and development of solutions relevant to agriculture in general and PHM in particular.

Currently, estimates of 60 to 70% of FAENG of dissertations (Tivana, 2015, personal communication) are theoretical and not directed at solving practical problems. If a practice observed in ISUTC, where dissertations for solving country´s real problems get bonus marks, there seems to be a room for promoting local innovation, some of which could benefit the poor.

The only link between FAEF and the private sector/industry is when seeking opportunities for practical classes. There seems not to be medium-long-term collaboration programmes, where, for example, FAEF would identify a need to be responded to by developing a tool, the private sector would develop prototypes to respond to such need, which would then be tested by FAEF during their community outreach activities and if found relevant, be brought back to the industry with suggestions for improvement and mass production. Other collaboration mechanisms, for example, would be to expose students to village internships and then to local industries, with the objective of them trying to influence the industry´s manufacturing processes towards solving the problems found to be in top priority line, using accessible and straightforward technologies, rather than most of those that are widely sold by retailers which seem to mostly be bought by development partners, not by farmers themselves.

There was no clarity as per contents of the curriculum of the Post-Harvest Management training course being planned by UEM. According to findings during this study, the MSc graduates, amongst other skills, must be equipped with knowledge on approaches to mainstream social equity and gender mainstreaming in PHM. Likewise, such topics should be a strong component in the PHM subject in all the other courses (BSc and MSc). Lastly, considering that almost half of grains produced are wasted due to PH loss, FAEF could be mandated to find encouragement mechanisms for their post-graduate staff to write their thesis developing solutions to local problems.

III. CONCLUSIONS AND RECOMMENDATIONS

GENDER AND SOCIAL EQUITY CONSIDERATIONS

- Most technologies developed and introduced to support women's productive activities are not specifically targeted to women. As such, development and dissemination of new technologies in Mozambique must include gender-specific characteristics and social equity requirements.

- Investing in selected segments of PHM value chains, where technology can reduce workload usually left to women, children and the youth using mobile, easy to copy, petrol-powered machines, bought in instalments by richer farmers, with the mandate of being used both on cash and credit terms (as per IITA´s project on threshers for soybeans) is a powerful gender and social inclusion initiative that can be considered a "best practice" from within the country - Nampula. Partial automation of the process leaves room for community socialization and improves the chances of social acceptance of the innovation.

- "Best practices", from overseas, by "*Compatible Technology International*", is the design of technologies that are gender- and social equity-sensitive, tools that are designed and tested to be used by women farmers, easy to assemble and relevant to the end-users including the youth (49,9% Mozambican farms headed by farmers aged 10 to 39 years old/youth). Such technologies are affordable, durable, aligned with local customs and do not require any kind

of engines. If replicated by the concerned local engineering universities or if implemented in a project-format, many local fabricators can be trained to be enabled to develop novel solutions to community problems or to copy/replicate simple, affordable and straightforward tools that can ease PHM tasks.

- Improvement of the efficiency of transportation to minimize costs and improve access by women and vulnerable people can be achieved through joint marketing groups, where everyone delivers their harvests to collection points and buyers or transporters pick them to better markets, has a huge potential to increase negotiation power of otherwise socially disadvantaged farmer groups when it comes to selling produce.

- Introduction and dissemination of PHM tools is a key strategy to increase men participation in labour-demanding activities and thus promote better labour distribution at household level. Dissemination of PHM equipment and tools that are easy to copy and training of local fabricators in their local fabrication can be a good practice provided the training includes "business management skills and attitude" subjects. Involving women artisans along with adequate training environment and considering women´s interests in the manufactured tools are keys to promote gender equity.

- Lobbying for the sake of the poorer farmers, who cannot afford to buy full packages of grain pesticides promote social equity (Ex. the Mozambican company TECAP,L.da, launched to the local market 100gr Actelic sachets because local R&D institutions promoted this) and can be seen as a strong mechanism to increase access of marginalized farmers to improved technology.

- Implementation of activities of gender and better nutrition mainstreaming in research and academic institutions (ex. IIAM) can promote due consideration to gender and food security as key issues during planning, implementation and evaluation of future research and development activities.

- Alternative PHM technologies that can help improve livelihoods of women and of other disadvantaged people include mass dissemination of improved handling and storage hygiene, good storage management practices, use of cheaper improved tools (e.g. hermetically sealed bags/drums) and low cost improvements to their existing structures and systems. In the technology development process, taking gender considerations into account is crucial for the relevance of the innovations to all concerned people.

- Promoting participation of women in decision-making at household level is a titanic effort. FAO and UNAC are achieving this objective by improving collaboration between men and women, using work methodologies that awaken men´s minds for the potential of good ideas/thoughts that can emerge from women if they are let to express them freely. The Farmers Field School methodology presents as a great opportunity to drive change at community level.

- Women participation in decision-making at household level is critical for the success of income generating opportunities. Unless men and women both change their attitudes regarding collaboration, cooperation and mutual respect of individual objectives, no success can be foreseen in standalone women empowerment initiatives.
- Due to their main role in all stages of PHM, women farmers are the most suitable actors to be prioritized in PHM training and empowerment initiatives. Training should however not overlook the need to involve both men and women to improve their ability of collaborating and working together.
- ICT´s are being used everywhere in Mozambique, even by disadvantaged farmer communities. Capacity building and information sharing interventions can greatly benefit from them.

PHL REDUCTION TECHNOLOGY ISSUES

- "*Compatible Technology International*" (CTI) (www.compatibletechnology.org) has been identified in this study as one of the best references for PHL reduction technology development tailored at women and disadvantaged people for developing countries worldwide. Their approaches are recommended as reference for technology development and dissemination in the area.
- The use of some traditional methods for grains conservation has been scientifically proved after adjustments for effectiveness and scientific validation. Such technologies have higher potential adoption rates due to their higher cultural acceptance levels because they increase the opportunities for identification of low cost improvements to farmer´s current structures and handling systems.

POLICY AND INSTITUTIONAL ARRANGEMENT ISSUES

- The on-going decentralization process of agriculture research activities by IIAM and some universities can be used as a good entry point for a better linkage between research and farmers by allowing researchers and/or university students to be physically closer to beneficiaries for a better understanding of all the dimensions of traditional PHM practices and help develop solutions to the identified problems with reference to gender and social equity relevance.
- Intensification of advocacy towards elevation of PHM to the higher agenda of GoM is critical to stimulate action at various operational levels. A key message to be disseminated would be raising awareness on the cost-effectiveness and environmental sustainability of promoting PHL reduction, rather than increasing production to corresponding levels.
- Financial incentives and a long term implementation approach supported by consistent M&E are key and should be budgeted for in agricultural development projects. For this change to be

possible, the agricultural policies and strategies and the gender policy in the agricultural sector should reflect very clearly priorities regarding lowering PH losses, for which a share of the 10% national budget to be committed to agriculture should be used for PHM issues and detailed budget expenditures reflect specifically on PHM actions.

- Some achievements in PHM improvements in Mozambique have been made and were reported in Mozambique, in Africa and in Central America. Experience sharing involving farmer change-agents and representatives of the academy, policy-makers, private sector and R&D institutions can speed up the process of implementing desired changes for Mozambique.
- Using ICTs can be a very powerful way to accelerate dissemination of information regarding PHM in Mozambique by using the network of around 100 radio stations that can reach around 60% of the Mozambican population. Appropriate multi-institutional partnerships to develop and deliver the contents must be established.

CULTURAL ISSUES

- Simplicity matters for culture and sustainability. Farmers need simple solutions with clear benefits. For example, hermetic storage bags – triple-layered storage bags that protect grains from infestation have been used with little training, allowing farmers to quickly see the economic benefits of storing grains at home for selling at the highest possible price. As such, innovations must align and be adapted to community's existing culture to promote effective adoption.
- Polygamy can be used as an opportunity to promote PHM activities, since women in polygamous marriages have full control and less interference by their husbands when it comes to selling harvests and using generated revenues, for example, to invest in improved PHM tools**.**

IV. REFERENCES

- **AGRA - (2013)** - Establishing the status of postharvest losses and storage for major staple crops in eleven African countries (Phase I). Alliance for a Green Revolution in Africa: Nairobi, Kenya.
- **AGRA - (2014)** - Establishing the status of postharvest losses and storage for major staple crops in eleven African countries (Phase II). Alliance for a Green Revolution in Africa: Nairobi, Kenya.
- **APHLIS** - African Postharvest Losses Information System - http://www.aphlis.net
- **ARNALDO, C (2004)** African Population Studies vol. 19 n°1/Etude de la population africaine vol. 19 n° 1.

- **BOHAEN, S. (2015)**, personal communication

- **CDIA (2007)** Estratégia da Revolução Verde em Moçambique, Centro de Documentação e Informação Agrária, Ministério da Agricultura, Maputo, Moçambique

- **CERNANSKY, R. (2015)** Empowering women in order to save the harvest Empowering women in order to save the harvest. http://news.mongabay.com/2015/04/empowering-women-in-order-to-save-the-harvest/

- **CHAPOTA, R (2015)** Rapid Assessment on the Use of Radio in Extension and Advisory Services in Mozambique. *Consultancy report*, Modernizing Extension and Advisory Services Project – USAID

- **CHINGARANDE, S.D; GUTI, E AND KANDIWA, V. (2015)** - Gender Analysis of Maize Post-Harvest Management in Zimbabwe: A Case Study of Shamva District, Swiss Agency for Development and Cooperation (SDC) (https://www.shareweb.ch/site/Agriculture-and-Food-Security/focusareas/Documents/phm_sdc_egsp_gender_analysis_zimbabwe.pdf)

- **CIMMYT (2013)** New postharvest storage technologies for Latin America http://blog.cimmyt.org/new-postharvest-storage-technologies-for-latin-america/

- **COMITÉ DE CONSELHEIROS (2003)** – Agenda 2025 – Visão e Estratégias da Nação, Maputo, Moçambique.

- **COSTA, S.J. (2014)** - Reducing Food Losses in Sub-Saharan Africa (Improving Post-Harvest Management and Storage Technologies of Smallholder Farmers.). An 'Action Research' evaluation trial from Uganda and Burkina Faso World Food Programme, Kampala, Uganda.

- **COULTER, J. and SCHNEIDER, K. (2004)** - Feasibility Study of Post-harvest Project in Mozambique and Tanzania. Natural Resources Institute and Helvetas Inter cooperation.

- **CUGALA, D; TOSTÃO, E.; AFFOGNON, H AND MUTUNGI, C (2012)** Postharvest losses in Africa – Analytical review and synthesis: the case of Mozambique. ResearchGate, Technical Report, December 2012

- **DAVID, S. (2010)** Producing bean seed: handbooks for small-scale bean producers, 2nd edition. Handbook 1. Network on Bean Research in Africa, Occasional Publications Series, CIAT, Kampala, Uganda.

- **FAO (2016)** Improved post-harvest handling means improved livelihoods for farmers - http://www.fao.org/mozambique/programmes-and-projects/success-stories/gorongosa-silos/en/.

- **FANRPAN (2014)** - Towards a specific post-harvest loss management policy and strategy for Mozambique. FANRPAN Policy Brief.

- **GALLINA, A. AND CHIDIAMASSAMBA, C. (2010)** Gender Aware Approaches in Agricultural Programmes, Mozambique Country Report – UTV Working paper 2010 http://www.sida.se/publications.
- **GOLOB, P. (2009) –** On-Farm post-harvest management of food grains – A manual for extension workers with general reference to Africa. FAO – Agricultural and Food Engineering Training and Resource Materials. Rome.
- **GoM (2011)** – Poverty Reduction Action Plan 2011-2014, approved at the 15th Regular Session of the Council of Ministers of the government of Mozambique.
- **GoM (2014)** – National Development Strategy 2015-2035.
- **GOODHEAD, G. AND GLIN, C.D. (2015)** From India to Africa: a quest to reduce food loss - Leader´squest - http://www.leadersquest.org/journal/from-india-to-africa-a-quest-to-reduce-food-loss
- **HODGES, R.J, (2012)** – Postharvest weight losses of cereal grains in Sub-Saharan Africa. African Postharvest Losses Information System
- **INE (2011) –** Censo Agro-Pecuário 2009-2010: Resultados Definitivos - Moçambique. Instituto Nacional de Estatística.
- **IMPRENSA NACIONAL DE MOÇAMBIQUE (2015)** – Programa Quinquenal do Governo 2015-2019, Boletim da República, Série I, Nr 29, 2º Suplemento, Maputo, Mozambique.
- **MAIZE CRP (2013)** - Affordable and Effective Crop Storage Solutions for Smallholder Farmers – Annual Report http://annualreport2013.maize.org/affordable-and-effective-crop-storage-solutions-for-smallholder-farmers/
- **MALIRO, D.D. and KANDIWA, V (2015)** - Gender Analysis of Maize Post-Harvest Management in Malawi: A Case Study of Lilongwe and Mchinji districts, Swiss Agency for Development and Cooperation (SDC), https://www.shareweb.ch/site/Agriculture-and-Food-Security/focusareas/Documents/phm_sdc_egsp_gender_analysis_malawi.pdf
- **MANDA, J. Æ MVUMI, B. (2010)** Gender relations in household grain storage management and marketing: the case of Binga District, Zimbabwe. Agric Hum Values (2010) 27:85–103, DOI 10.1007/s10460-008-9171-8
- **MINAG (2005)** - Estratégia de Género do Sector Agrário. Maputo, Moçambique.
- **MINAG (2010)** – Plano Estratégico para o Desenvolvimento do Sector Agrário - PEDSA. Maputo, Moçambique.

- **MINISTRY of AGRICULTURE and ANIMAL RESOURCES of RWANDA (2011)** - National Post-Harvest Staple Crop Strategy.

- **MOZAMBIQUE DEMOGRAPHICS PROFILE (2014)** - http://www.indexmundi.com/mozambique/demographics_profile.html

- **MULUNGA, M.M. and KANDIWA, V (2015)** Gender Analysis of Maize Post-Harvest management in Zambia: A Case Study of Chipata and Katete Districts, Swiss Agency for Development and Cooperation (SDC), https://www.shareweb.ch/site/Agriculture-and-Food-Security/focusareas/Documents/phm_sdc_egsp_gender_analysis_malawi.pdf

- **PRODEZA NEWS (2015)** The granary for cereals "Gorongosa Type" http://postharvest.nri.org/images/documents/Gorongosa/Gorongoza_mud_silo_ppt_English.pdf

- **REMBOLD, F.; HODGES,R.; BERNARD, M.; KNIPSCHILD, H. and LÉO, O. (2011)** - The African Postharvest Losses Information System (APHLIS), JRC Scientific and Technical Reports. http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/15877/1/lbna24712enc.pdf

- **RUGUMAMU, C.P. (2009)** - Assessment of post-harvest technologies and gender relations in maize loss reduction in Pangawe village eastern Tanzania -. Department of Zoology and Wildlife Conservation, College of Natural and Applied Sciences, University of Dar Es Salaam. P.O. Box 35064 Dar Es Salaam. Email: wrugu@udsm.ac.tz. *Tanz. J. Sci. Vol. 35 2009*

- **THILMANY, J. (2011)** Out of Their Design Comfort Zone - Progressive Engineer - http://www.progressiveengineer.com/features/cti.htm

- **TIVANA, L.D.; CHAMBULE, A.C.; MADZARA, M. and MONJANE, I. (2014)** - Post-harvest Management Policy and Strategies in Mozambique and Sub-Saharan Africa. FANRPAN.

- **TIVANA, L.D. (2015) –** Personal communication

- **SETSAN (2007)** Estratégia e Plano de Acção de Segurança Alimentar e Nutricional 2008-2015. Maputo, Moçambique.

- **UN (2010)** Comprehensive Framework For Action high-level task force on the global food security crisis- www.Fao.Org/Fileadmin/User_Upload/Isfp/Ucfa_Final.Pdf

- **WFP (2010) –** Mozambique Comprehensive Food Security and Vulnerability Analysis. Mozambique office, Maputo, Mozambique.

- **WORLD BANK (2011)** - Missing Food: The case of postharvest grain losses in Sub-Saharan Africa. Report number 60371-Afr

- **ZAVALE, H. (2014)** – Post-harvest Management (PHM) and Climate Smart Agriculture (CSA) Policy Studies. Validation workshop, Maputo.

- **ZVOMUYA, F. (2014) -** Weak post-harvest policies in Mozambique major cause of food insecurity. http://africagreenmedia.co.za/weak-post-harvest-policies-in-mozambique-major-cause-of-food-insecurity/