Republic of Mozambique

Report of Barriers Analysis and Enabling Environment for transfer and diffusion of Agriculture Sector technologies in Mozambique

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List of Abreviations

Acronym	Long Name
CA	Conservation Agriculture
CARE	American Organization
CLUSA	Cooperative League of the United States of America
FAO	Food and Agriculture Organization
DARIDAS	Ditectorate for Arid and semi arid zones
DARN	Directorate for Agriculture and Natural Resources
DINAS	National Directorate for Agriculture and Silviculture
DNEA	National Directorate for Agrarian Extension
DNRH	National Directorate for Water Resources
DPCI	Directorate for Planing andInternationa Cooperation
FAEF	Faculty of Agronomy and Forestry Engineering
IIAM	Agrarian Research Institute of Mozambique
INE	National Institute for Statistics
INGC	National Institute for Disaster Management
INIR	National Institute of Irrigation
MASA	Ministry of Agriculture and Food Security
MICOA	Ministry of Coordination of Environmental Actions
MINAG	Ministry of Agriculture
MOPHRH	Ministry of Public Works, Housing and Water Resources
NGO	Non- Governamental Organization
PEDSA	Strategic Plan for Agriculture Development
PROMAC	Promotion of Conservation Agriculture
RWHC	Rainwater harvesting and conservation
TNA	Technology Need Assessment
UEM	Eduardo Mondlane University

Executive Summary

Agriculture in Mozambique is dominated by smallholder farmers who produce mostly food crops for their livelihood and income but climate change, manifested mostly through climate extreme weather events has been affecting their livelihood and incomes strategies leading to food and nutrition insecurity and poverty. To ensure smallholder adaptation to climate change impacts, the barriers hindering the transfer and diffusion of three technologies were identified and analysed and the measure for removing the barriers identified. In addition, the enabling environment for successful transfer was also identified. The three selected and prioritized technologies are: (1) conservation agriculture, (2) rainwater harvesting and conservation through small to mediums dams and small reservoirs and, (3) seed production and promotion of low-cost storage systems (super bags, metal silo and polyethylene silo) of seed and grain.

Conservation agriculture can help smallholder farmers to be resiliente to drought by reducing evaporation, increasing moisture retention and organic matter in the soil. Rainwater harvesting will contribute to resilience through capturing and use of excess surface runoff water to ensure crop production and livestock watering particularly in arid and semi-arid areas of Mozambique where crop production and livestock breeding is increasingly becoming impossible due to the prevalence of drought. The transfer and diffusion of CA and RWHC is aimed to target at least 60% of smallholder farmers located in semi-arid and arid areas of Mozambique which are the most prone to drought. Seed production can contribute to resilience of smallholder farmers and their families to drought, floods and cyclones by ensuring quick recover and restart of crop production after these events have taken place. Low-cost storage systems for seed and grain can contribute to the resilience of smallholder farmers by ensuring food availability soon after extreme events have taken place and through rapid recovery and restart of agricultural production using the stored seed. The transfer and difussion of seed production and improved low-cost storage systems is aimed to target at least 75% of smallholder farmers in entire country to make Mozambique resiliente to climate change.

The process for conducting barrier analysis was the following: (1) Setting up preliminary targets for technology transfer and diffusion; (2) Identification and prioritization of barriers using bilateral meetings, brainstorming and the Logical Problem Analysis involving root causes analysis; (3) Identification, analysis and categorization of possible measures; (4) Identification of enabling environment to enhance the uptake of the technologies.

The barriers hindering the transfer and diffusion of conservation agriculture are: high cost of its implementation exhacerbated by the high cost of implements and lack of financial capacity of farmers; limited information and awareness on CA due to limited government and donor investiment in research and demonstrations of the technology and on contracting and training of technical and extension staff; inadequate technical support to farmers due to inadequate extension and research support and limited means and financial resources to assist farmers; and weak collaboration among stakeholders due to lack of strong coordinating institution and lack of awareness of effectiveness of collective action.

The barreiers hindering the transfer and diffusion of rainwater harvesting and conservation are: high preparation and implementation costs associated to lack of expertise and reduced number of suppliers in the country; limited information and awareness due to limited government and donnors investment in promotion, demonstrations and research; insufficient technical capacity for research, promotion and demonstrations due to limited training and training institutions; and weak collaboration among stakeholders.

The barriers hindering the transfer and diffusion of seed production are: high production and transation costs due to lack of efficiency of the seed companies associated to lack of financial capacity of the seed companies; lack of farmers awareness on value or advantage of using improved seed; and malfunctioning of the seed value chain due to seed market distortion resulting from government subsidies and lack of technical and financial capacity of MASA to conduct seed quality control and certification and to promote, coordinate and monitor the development of the seed sub-sector. The transfer and diffusion of low-cost improved storage systems (super bags, metal silo and polyethylene silo) is hindered by lack of financial capacity of farmers to purchase storage systems, low production and productivity to justify acquiring storage systems; lack of market for agricultural production to provide incentive for acquiring storage systems; and lack of awareness of some of the improved storage systems such as super bag and metal and polyethylene silos.

The measures to overcome the barriers include increased government and international donnors investment in capacity building of institutions and people, on research and technology demonstration to enhance public awareness; improved coordination, communication and collaboration; and design and implementation of policy and regulation.

1. Barrier analysis and identification of enabling environment to ensure the adoption of technologies in Mozambique

The report of Technology Need Assessment for the agriculture sector in Mozambique (Government of Mozambique, 2017) identified three technologies that can help the sector to adapt to climate change, which are: (1) conservation agriculture, (2) rainwater harvesting and conservation and (3) seed production and promotion of low cost improved storage systems of grain and seed (super bags, metal silo and polyethylene silo). These technologies were used to identify the barriers that hinder their transfer, diffusion and adoption and to identify measures for the removal of identified barriers. After the identification of barriers and measures, the enabling environment that can ensure the transfer and dissemination of technology to the technology beneficiaries was described.

The report has two sub-chapters. In sub-chapter 1 the preliminary targets of technology transfer and diffusion are indicated and in sub-chapter 2 the barriers are analysed and the measures for removing the barriers for transfer and diffusion of the 3 priority technologies are identified. Before the identification of barriers, an overview of the technology is provided. The barriers are broadly categorized into economic and financial and nonfinancial. Similarly, measures are also categorized into economic and financial and nonfinancial. The report concludes presenting the links between the barriers identified and the enabling environment to overcome the barriers for technology transfer and diffusion in agriculture sector in Mozambique.

1.1 Preliminary targets for technology transfer and diffusion

Agriculture in Mozambique plays an important role for socio-economic growth and development because it provides employment for more than 80% of the economically active population and food, nutrition and income for more than 70% of Mozambican population composed mostly by smallholder farmers (MINAG, 2010). Agriculture contributes about 23% to the gross domestic product (INE, 2011) and 20% for exports (FAO, 2007). This makes agriculture to have significant contribution to economic growth and development and poverty reduction in the country. Agriculture is predominantly practiced by smallholder farmers who account for 96.7% of the total cultivated area under annual crops and by male-headed households which represent 73.0%. The contribution of production made by the family sector to the gross domestic product generated by agriculture is about 95% (FAO, 2007) which makes this sub-sector one of the most important contributors to economic growth.

However, climate change manifested mainly through increase in temperature, reduction of rainfall and its high variability and in the form of extreme weather events such as droughts, floods and cyclones are the main threats to the growth and development of the agriculture sector by causing destruction of crops, animals and or reducing their production and productivity.

As part of strategies to support the resilience of the country to climate change, a technology need assessment (TNA) project is being conducted in the agriculture sector. The TNA project is being implemented in three phases, namely, (1) technology prioritization; (2) barriers analysis and description of enabling environment; and (3) development of action plan for prioritized technologies. In the first phase, 3 priority technologies were identified from a set of 14 technologies initially identified. The three priority technologies are: (1) conservation agriculture, (2) rainwater harvesting and conservation, and (3) seed production and promotion of low-cost improved storage systems for seed and grain (Government of Moçambique, 2017).

Conservation agriculture is governed by three principles, permanent soil cover, minimum soil disturbance and rotation or intercropping. Conservation agriculture contributes to adaptation to climate changes and particularly to drought by increasing the water storage capacity of the soil since the permanent soil cover and minimum soil disturbance increase rainwater infiltration and retention which contributes to reduce runoff and erosion. The permanent soil cover also increases incorporation of organic matter and nitrogen content in the soil which contributes to increased microbiological activity of the soil. That contributes to increased crop yields and stability, increased production and consequent improvement in food and nutritional security, increase household income and improved well-being. The technology is targeted to smallholder farmers in the arid and semi-arid areas and or areas prone to soil erosion in Mozambique. People living in these areas are cyclically exposed to droughts, floods and erosion. As a result they cyclically face problems of food insecurity due to the low production and productivity. The ambition is to upscale the technology to cover at least 60% of smallholder farmers in semi-arid and arid areas to enhance their resilience to drought drought and erosion.

Rainwater harvesting and conservation will contribute greatly to resilience to drought by providing water for irrigation of crops and livestock watering during the time of lack of rain or in areas with little rain and or irregular. On a small scale, rainwater harvesting and conservation can contribute to resilience to flood because it helps to reduce runoff of excess rainfall water. The

implementation of this technology will contribute to the increase in production and productivity, diversification of crop production and therefore to improvement of food and nutritional security, increase household income and improve the welfare. The proposed ambition is to introduce the technology where is not existing and to upscale to cover at least 60% of smallholder farmers in arid and semi-arid areas of Mozambique which have been cyclically affected by water shortage for crop production and livestock watering.

The seed production will contribute to the resilience to climate change because it will ensure the availability of seed to ensure quick recovery and restart of production after crop losses due to drought, flood or cyclones. The promotion of low-cost storage systems enables adaptation to climate change by conserving the grain keeping it in quantity and quality to ensure food availability to people and seed to restart production after the bad harvest or crop losses due to drought, flood or cyclones. The availability of seed to restart production after drought, floods and cyclones or food availability after these events will contribute to increased food security and to income generation for the families since they can make sales in moments where there is shortage of food. The ambition is to upscale seed production and promote low-cost storage systems throughout the country. In first place, the technology transfer and diffusion is targeting to cover at least 75% of smallholder farmers in the country.

Therefore, the transfer and diffusion of the three technologies is extremely important to adapt the country to climate change because its adoption will contribute to improve food and nutritional security and well-being of most of the Mozambican population that depends on agriculture to access food, nutrition and income. In addition, it will contribute to the growth and economic development and for capturing foreign currency taking into account the large contribution of agriculture to the gross domestic product and exports.

1.2 Description of the process for barrier analysis and identification of measures to overcome the barriers

The barrier analysis consisted of identification of barriers followed by their analysis. The identification of barriers was based on desktop review and bilateral discussion meetings. Desktop review consisted on reviewing relevant documents such as research publications, reports and police documents. From that process an extensive list of barriers was produced. Through bilateral discussion meetings the list of barriers was supplemented and improved. Bilateral meetings were conducted between the consultant and researchers from the Agrarian Research Institute of Mozambique (IIAM) and Eduardo Mondlane University, staff from NGOs, FAO and from the Ministry of Agriculture and Food Security (MASA) which included staff from the National Directorate of Agrarian Extension (DNEA), National Directorate of Agriculture and silviculture (DINAS), Seed Department of MASA, National Institute for Irrigation (INIR), staff from the Ministry of Ministry of Public Works, Housing and Water Resources (MOPHRH) (National Directorate of Water Resources and Regional Administrations of Water) and National Institute for Disasters Management (INGC). After an improved list of barriers was produced, the consultant categorized the barriers into economic and financial and non-financial (market conditions, legal and regulatory, network, Institutional and organizational capacity, human skills, social, cultural and behavioral, information and awareness and technical).

For conducting the analysis, a workshop involving technology working groups (group of conservation agriculture, rainwater harvesting and conservation and seed production and promotion of low cost storage systems) was organized. Workshop participants from the 3 technology working groups came from institutions involved in bilateral meetings. Through brainstorming the the technology group set-up the preliminary target of technology transfer and diffusion and then conducted the screening of barriers to select the priority ones. The process ended with Logical Problem Analysis involving root causes analysis.

The identification of possible measures to remove the barriers was also done during the workshop by the technology working group. For each category of barriers, a set of potencial measures were identified and analysed. The process ended after an agreement about the measures for removing the barriers was reached.

1.3 Analysis of barriers and measures for conservation agriculture

In this section a general description of conservation agriculture is given, followed by the identification of barriers and their categorization into economic and financial and not financial. Following the analysis of barriers, the measures for the removing the identified barriers are identified and also categorized into economic and financial and not financial.

1.3.1 General description of conservation agriculture

Conservation agriculture (CA) is an agricultural system that seeks to conserve soil and water, precisely; the concept refers the conservation of soil organic matter, increased soil water retention and reduced soil erosion and pollution. CA combines three principles: minimum soil disturbance, permanent soil cover (cover crops or cover with residues) and crop rotation or intercropping.

The CA is a technology suitable for arid and semi-arid areas where soils are low in organic matter and are prone to desertification. The technology leads to reduced use of machinery and fuel and time savings in operations. However, the CA requires specialized machinery for sowing, large areas for crop rotation and maintenance of the residues in the field to maintain fertility.

Conservation agriculture contributes significantly to resilience to drought but it can also contribute to the resilience to flooding. This can be done by reducing evaporation, increase the retention of moisture and organic matter in the soil. CA also contributes to the reduction of greenhouse gases because the soil is not disturbed. CA contributes to the reduction of flooding by improving water retention and reducing runoff. CA also contributes to increased nutrient use efficiency, increased biodiversity of the soil and reducing desertification. CA provides an opportunity to improve the welfare of people in arid and semi-arid regions of Mozambique. Conservation agriculture is not a technology market.

1.3.2 Identification of barriers for conservation agriculture

The barriers that hinder the transfer and diffusion of conservation agriculture are related to high initial costs for farmers due to the cost of implements (rippers and planters) associated to their lack of financial capacity; limited information and awareness due to limited researcah and demonstrations and inadequate extension support; and lack of collaboration due to lack of string coordinating institution and lack of awareness of effectiveness of collective action (Annex 1A). These barriers are categorized into economic and financial and nonfinancial barriers as detailed below.

1.3.2.1 Economic and financial barriers of Conservation agriculture

The key economic and financial barriers for transfer and diffusion of conservation agriculture are related to the cost of technology implementation and limited financial capacity of government to invest in research and promotion of technology to farmers. The initial cost of implementing CA is high because farmers have to purchase implements such as rippers and planters which are costly. That is exhacerbated by their lack of financial capacity which is further complicated by the fact that they lack access to credit due to lack of collaterals and high interest rates.

The lack of financial capacity by the government limits investment in research to identify techniques and practices appropriate for different farming contexts, for conducting socio economic studies to assess perceptions and preferences of techniques and practices, for hiring and training extension sfatt and for conducting demonstrations of the technology and assistance to farmers.

1.3.2.2 Nonfinancial barriers to conservation agriculture

Nonfinancial barriers are categorized into political and regulatory, lack of human capabilities, market failures, lack of information and awareness, institutional and organizational capacity, socio-cultural and technical.

a) Human capacities

The barriers of human capacities are related to limited number of technical staff to conduct research and to demonstrate and assist farmers in the process of transfer and diffusion of CA. Due to limited government and international donnors investiment in agriculture sector, the number of technical staff is limited to ensure adequate research, technology demonstration and appropriate assistance of farmers. In addition, the existing technical staff (agronomists and extension officers) lacks technical and communication skills to ensure research and promotion of CA in the country. Training is a mechanism to improve human capacity. However, the courses being offered in most agricultural training institutions still don't include contents of conservation agriculture. Non-degree training are generally undertaken to extension staff by different institutions promoting CA but these training generally do not include practical lessons. As a results, the extension staff lack of practical skills and experience on how to conduct demonstration plots for promoting CA.

b) Market

Due to limited number of adopters of CA, the suppliers of implements used for CA are too reduced because of reduced demand of these implements. On the other hand, the promotion of cover crops which are not used as food limits interest in seed companies to produce seed of these crops. That is exacerbated by the fact that most of cover crops are not widely cultivated in the country.

c) Information and awareness

Farmers in most cases are not aware about CA. The lack of awareness is due to limited research on appropriate techniques and practices for different farmers' contexts and lack of demonstrations of techniques and practices identified as well as lack of communication of research results to potential beneficiaries. In case the research was conducted, there was no involvement of potential beneficiaries of the technology. Therefore, few farmers are informed and aware about technology and its potential benefits.

d) Institutional and organizational capacity

The coordination of research activities, technology dissemination, establishment of linkage between research, extension and producers and the overall coordination of actions conducted by different stakeholder in the country on conservation agriculture should be led by the Ministry of Agriculture and Food Security (MASA) in Mozambique. This institution lacks capacity in financial, human resources and skills to ensure adequate transfer and diffusion of the technology. MASA has also limited capacity to lead the coordination and establishment of linkages between research, extension and producers, as a result the extension doesn't make full use of the research results and consequently, the producers doesn't make use of results generated by the research and there is no coordination of who does what, where and when (different institutions working on CA are not coordinated and there is no information on what they are doing, where and when). The limited financial and technical capacity of MASA particularly, limits the capacity to provide continuous technical support to producers.

Other barriers to transfer and diffusion of CA is the lack of full integration of Local Adaptation Plans (where promotion of CA activities should be planned) in the District Development Plan. This has been due to lack of Lack of continuous technical support

e) Social and cultural

Due to lack of awareness because of weak linkages between research, extension and farmers and lack of involvement of farmers in research process, farmers do not realize the advantages of using CA. Another barriers to CA adoption by farmers is related to the fact that some CA practices are labour intensive (e.g. transportation of crop residues to the site for implementing CA) and farmers still don't perceive the advantage of CA over conventional agriculture due to the fact that the yields obtained using CA in first 3 years are lower than those obtained using conventional agriculture. For permanent soil cover, there has been a promotion of crop residues use; the competition for the crop residues between application of conservation agriculture and livestock feeding is another barrier to adoption of CA.

f) Technical

Yield performance under CA in first 3 years is low compared to conventional agriculture which makes people not to appreciate CA. The promotion of techniques and practices not suitable to farmer's needs and conditions has been blocking the transfer and adoption of CA. This has been due to lack of socio-economic analysis of the process of technology promotion. For instances, the use of mulching has been a problems in sites which problems with termites. On other hand, the use of non-food cover crops has been resulting in lack of interest by the farmers and seed companies on seed production of these crops.

1.3.3 Identification of measures for conservation agriculture

Like the barriers, the measures were also categorized into economic and financial and non-financial.

1.3.3.1 Economic and financial measures for conservation agriculture

To enhance the transfer and diffusion of CA there should be substantial investments in research for identifying techniques and practices appropriate for different farming contexts, demonstration of techniques and practices that work well, investment for hiring and training technical staff that will conduct research, demonstration and assist farmers. The investment will also be directed to support the extension services, training of producers and awareness of farmers and society about the CA through introduction of CA in syllabus. Parallel to investment, there should be incentives to farmers through

creating subsidized loans to acquire implements and to companies importing the implements or raw materials and spare parts to make implements through tax breaks. Another measure to help enhance transfer and diffusion of CA can be through allocation of a proportion of the total institutional budget to target CA activities (for implementation, coordination and monitoring of activities).

1.3.3.2 Nonfinancial measures of conservation agriculture

Nonfinancial measures were categorized into political and regulatory, development of research capacities, research and participatory training of farmers, education, training and knowledge transfer, institutional collaboration and communication and awareness.

a) Political and regulatory

The use of cover crop for permanent soil cover seems more feasible than using crop residues because of termites in certain locations, competition with animal feeding in others and labour intensiveness of transporting crop residues from one place to another. Hence, it is recommended to use as cover crop the one can have multi-purpose (more purposes than being only cover crop) and there should be incentives to promote seed production of the cover crop to ensure its availability and accessibility. These incentives can be through the granting subsidized loans, facilitating the importation of inputs at free taxes.

Another measure can enhance transfer and diffusion of CA is through integration of CA in national policies (environmental policy, agricultural extension policy, land policy and education policy) to promote the adoption and ensure sustainable agriculture development.

b) Research capacity development

Given the limited human and technical capacities for development and promotion of CA, there is a need to develop a capacity building program for human resources to strengthen and improve scientific and technical competences to create local experts in CA who will be involved in research for assessing perceptions about technologies and practices appropriate for each context and testing of these techniques and practices for adaptability to the farmers context. For that to happen there should be a continuous investment to support research. The research should also include the identification and promotion of cover crops for multiple use, production of evidence of the advantages of CA over the conventional agriculture and development of technological packages of CA.

The CA is a public good; however, the private sector should be encouraged to invest in capacity building as well as in research and development (R & D) to identify techniques and practices appropriate to the local context, identification of best cover crops and in seed production of the cover crops.

b) Research and participatory training of farmers

Since research is driven by farmer's needs, there is a need to use the research and participatory training approach to bridge the gap between research and implementation of CA by farmers. The participatory research and training approach enables to promote methods that integrate traditional and scientific knowledge and enhances the perception of the ecological and economic principles to enable farmers to develop the ability to make informed decisions. With this approach farmers are involved in all phases of the process of defining the research agenda and experimental treatments, in conducting observations and in discussion and interpretation of results. Thus, farmers improve their knowledge in relation to ecological principles and become partners of research and extension institutions. This approach allows researchers to assess the knowledge of farmers in relation to ecological principles of crop management and thereby improve their perception of how to address the social and behavioural obstacles CA adoption.

c) Education, training and knowledge transfer

Researchers and extension agents should receive appropriate training to improve their knowledge in technical and ecological principles of CA in order to make informed decisions about how to do research and transfer of techniques and practices looking at each context. Extension services should adopt appropriate technology transfer approaches for each context involving participatory methods. This participation should include research institutions, NGOs and farmers organized in associations or not. The participatory approach should allow all stakeholders to participate in the decision making process, analysing problems and generating solutions. Hence the need to have an expert extension agent closely linked to farmers through CA demonstration projects and adult participatory learning methods to improve knowledge about the technology and CA techniques to increase farmers' confidence about the technology.

Increased awareness of the producers and the public on climate change can help overcome personal attitudes and misconceptions related to the barriers of CA adoption. Furthermore, collaboration between public research institutions, universities, private sector, extension services, farmers and experts

should be promoted and strengthened to improve the transfer and diffusion of technology and knowledge. Education and capacity building should also include the development of curricula in secondary education, technical and in High Education Institutions that teach agriculture.

d) Institutional colaboration

The CA platform should be institutionalized and strengthened to ensure coordination, liaison and collaboration between all stakeholders involved in agricultural development for the successful implementation of CA. The stakeholders include the Ministry of Agriculture and Food Security, The Agrarian Research Institute of Mozambique, The High Education Institutions working on CA, the NGOs (CARE, CLUSA-PROMAC, etc), the National Institute for Disaster Management, FAO, farmers organizations (UNAC).

e) Communication and awareness

There is a need to develop effective dissemination programs with clear messages and more objective content using demonstration plots (CDRs), farmer field school (FFS) approaches and integrated program of agricultural technology transfer, including the development of manuals, technical notes. There is also a need to design programs and strategies CA upscaling throughout the country.

1.4 Analysis barriers and possible measures to overcome barriers for rainwater harvesting and conservation

This section provides a general description of rainwater harvesting and conservation and the identification of barriers and their categorization into economic and financial and not financial. Following the analysis of barriers, the measures for the removing the identified barriers are identified and also categorized in economic and financial and not financial.

1.4.1 General description of rainwater harvesting and conservation

Rainwater harvesting is a method for collecting, storing and conserving water from roof top and surface runoff from rain for household consumption and agriculture in arid and semi-arid regions. Rainwater harvesting could be achieved from roof top ground surface (roads) that constitutes the catchment area where the rainfall or water runoff is initially captured. Surface water flowing along the ground during rain is usually diverted toward a reservoir below the surface. Rainwater harvesting can be categorized according to the type of catchment surface used, and by implication the scale of activity. Rainwater harvesting represents an adaptation strategy to climate change for people living with high rainfall variability, both for domestic supply and to enhance crop, livestock and other forms of agriculture.

The equipment needed to implement this technology include: drainage canals, settling pond where collected water is settled for sedimentation; collection pond, recommended to collect water in earth made pond, otherwise from concrete material; pump which is only needed if the collected water should to be pumped to the upstream areas.

Maintenance is required for the cleaning of the reservoir and inspection of the gutters, pipes and taps and typically consists of the removal of dirt, leaves and other accumulated materials. Such cleaning should take place annually before the start of the major rainfall season with regular inspections. In regions with unpredictable rainfall, more regular maintenance and cleaning will be required to ensure that the equipment is maintained in good working order. Cracks in the storage reservoirs can create major problems and should be repaired immediately to avoid water loss. Maintenance of the catchment area to avoid damage by people and animals and to keep it free from vegetation is required. Running costs of RWHC system are relatively low. The construction, operation and maintenance do not intensively use hand labour. The collected water is of acceptable quality for agricultural purposes.

The reservoirs can be medium to large size when for community use and small when for farmers individual use since the water is harvested is collected from a private road or terrain or roof tops. The RWHC can be done in oven, especially on coastal and mountainous areas where there is sufficient rainfall for the use of this technology.

The RWHC can contribute to increased crop yields and encourage farmers to diversify production, increase production, choose more profitable crops, to acquire large animals or invest in use of improved inputs to improve fertility and in management of pests and diseases as well as to invest in the acquisition of irrigation infrastructure. RWHC contributes to adaptation to climate change at the farm level mainly through diversification of water supply for agriculture, reduce the risk of water quality degradation and reduce pressure on surface and groundwater and support management of water resources. The RWHC is not a technology market.

1.4.2 Identifying barriers of rainwater harvesting and conservation

The barriers that hinder the transfer, diffusion and adoption of rainwater harvesting and conservation are related to high costs of preparation, construction and maintenance; limited information and awareness due to limited promotion, research and demonstration; inadequate technical capacity to promote RWHC due to limited training and training institutions and reduced number of technical staff; and weak collaboration (Annex 1B). The barriers are categorized into economic and financial and nonfinancial as detailed below.

1.4.2.1 Economic and financial barriers of RWH

The transfer and diffusion of RWHC is generally done by government and in most cases in collaboration with development agencies particularly for large RWHC systems such as dams. For small systems such as small reservoirs farmers can cover his costs of construction and maintenance. The barriers limiting the transfer and diffusion of large RWHC are related to the high costs of preparation, installation and maintenance while for small systems are related to high costs of installation and maintenance. The high costs associated to the limited financial capacity of government to promote the transfer and diffusion as well as of farmers to implement the systems hinders the transfer of RWHC. The cost of installation and maintenance of tarpaulins, sheets, and cement in some cases, taps and piping pipes, panels for pumping water can be high for farmers limiting the adoption of the technology by farmers. The government in most cases depends on development agencies to conduct mapping,

construction and maintenance for the large systems which also depend of the objectives and interest of the development agencies. The limited olviment of private sector in this technology is also a major contributing barrier to limited adoption by farmers.

1.4.2.2 Nonfinancial barriers of RWH

a) human capacities

To conduct mapping, construction and maintenance of large RWHC systems requires highly skilled and qualified people which are not presently available in the country. The limited number of skilled human resources is due to the fact that very few national institutions are offering training containing these skills. In addition, at the implementation sites there are no skilled personnel for management and maintenance of these systems. Even for construction and maintenance of small RWHC, there are still limited human resources skilled.

b) information and awareness

In Mozambique, awareness campaigns about climate change and possible solutions to address climate change have been limited to floods and tropical cyclones. Hence, different groups and farmers are not well informed or aware about the RWHC as possible solution to adapt to drought. Other reason leading to lack of information and awareness has been the lack of community involvement in decision-making. In addition, the involvement of mass media in dissemination of this type of technologies is another reason for the lack of information and awareness of RWHC technology.

c) Institutional collaboration and organizational capacity

The construction of medium to large RWHC systems is generally planned at central level and sometimes with less involvement and coordination with districts and province. In some cases the plan is made at MASA with less involvement of MOPHRH and vice-versa. The lack of joint planning and community involvement has been limiting the adoption of this type of technology. The lack of community involvement limits the community's appropriation of technology. The other barrier that hinders the transfer and diffusion of this technology in Mozambique is limited investment by the private sector.

1.4.3 Identification measures for RWHC

The measures necessary to remove barriers to transfer, diffusion and adoption of RWHC are categorized into economic and financial and nonfinancial. In each category, the measures were identified.

1.4.3.1 Economic and financial measures

The government should invest and or negotiate with development and funding agencies to fund actions of mapping of potential areas for implementation of RWHC, construction and maintenance of RWHC systems as well as for obtaining cheap bank loans to support the construction and maintenance of small RWHC systems by farmers. Similarly, the government should encourage private investment in RWHC through establishing infraestruture to encourage private sector penetration in rural areas to provide all necessary equipments for construction of small and medium RWHC systems. Government should also negociate with financial institution to provide cheap loans to farmers for constructing small RWHC systems.

1.4.3.2 Nonfinancial measures

a) **Political and regulatory**

Creating incentives for private investment in RWHC such as tax incentives to importers of hydraulic components and local production of some components

b) **capacity building**

There is need to empowering the society through inclusion the RHWC issues in curricula at different levels of education as drought resilience adaptation. The implementation of the training program should include practical lessons of how to build some RWHC systems. In addition, farmers and communities should be trained on construction, management and maintenance of RWHC systems.

c) **Collaboration**

There is need to improve the coordination and collaboration among the institutions involved in the transfer and diffusion of RWHC (MASA, MOPHRH, INGC) at local, provincial and central levels

d) **Communication and awareness**

Design and implement awareness campaigns related to climate change impacts and adaptation strategies. The implementation of these campaigns should involve mass media in its diffusion.

1.5 Barrier analysis and possible measures to remove barriers for seed production and promotion of low cost storage systems

In this section an overview of the seed production and promotion of low-cost improved storage systems and identifying barriers is made. The identified barriers are categorized into economic and financial and nonfinancial. Subsequently, the measures for removing the barriers categorized into economic and financial and nonfinancial were identified.

1.5.1 Overview of seed production and promotion of low-cost storage systems

Seed production is key to the attainment of household food security among resource poor farmers in developing countries (Wambugu et al, 2009). Seed production is an action or activity that can contribute to resilience of communities to climate change because it ensures the availability of good quality seed that will enable rapid recovery and restart of production after crop losses due to drought, floods or cyclones. In addition, good quality seed has vigor that allows it to withstand some level of stresses caused by the limited availability of water and high temperatures in addition to resisting the attack of pests and diseases.

While considerable losses can occur in the field, both before and during harvest, the greatest losses usually occur during storage. Therefore the basic objective of good storage is to create environmental conditions that protect the product and maintain its quality and quantity, thus reducing product and financial loss. There are two reasons for food storage: domestic security and maintaining value prior to sale. Farmers may not accept improvements which incur costs when storing primarily for home consumption because an improvement in quality of a food produced for home consumption does not achieve a higher monetary value for the farmer.

To reduce food insecurity, appropriate production technologies and good storage environment is needed. Appropriate production technologies can increase productivity and quality while good storage environment can contribute to lower the (1) biological damage by insects, rodents and micro-organisms; (2) chemical damage through acidity development and flavor

changes and (3) physical damage through crushing and breaking. Good storage involves controlling temperature, moisture, light, pests and hygiene.

The establishment of safe, long-term storage facilities ensures that grain supplies are available during times of drought (UNEP, 2010). It is important to be able to store food after harvest so as not to be compelled to sell at low prices. Appropriate storing techniques can prolong the life of foodstuffs, and/or protect the quality, thereby preserving stocks year-round. The adoption of new storage methods by the low-income farmers will be possible if they are to assist with basic literacy and numeracy, and possibly some kind of training group.

Grain storage has been established to prepare for droughts, hunger and malnutrition (UNEP, 2010). Grain storage provides an adaptation strategy for climate change adaptation by ensuring feed is available for livestock and seed stock is available in the event of poor harvests due to drought (UNEP, 2010). Efficient harvesting can reduce post-harvest losses and preserve food quantity, quality and the nutritional value of the product (FAO, 2010). Innovations for addressing climate change include technologies for reducing waste of agricultural produce (BIAC, 2009). In fact, the establishment of safe storage for seeds and reserves of food and agricultural inputs are used as indicators of adaptive capacity in the agriculture sector (CARE, 2010).

The low-cost improved storage systems which are object of barriers analysis are super bag, metal silo and polyethylene silos. These technologies were investigated and found to be appropriate for grain and seed storage in Mozambique.

1.5.2 Barriers identification for seed production and promotion of low-cost storage systems

The barriers that hinder the transfer and diffusion of seed production are highly related high production and transation costs due to high inefficiency of seed companies; lack of financial capacity by seed companies and farmers to limited access to credit; lack of awareness of the value or advantage of using improved seed by farmers and malfunctioning of the seed value chain due to market distortion by the government and lack of technical and financial capacity to coordinate, monitor and promote the development of seed sector development by MASA as well as lack of capacity to conduct quality control and seed certifications (Annex 1c).

The barriers hindering the transfer of low-cost improved storage systems are associated to lack of financial capacity pf farmers to acquire storage systems; exhacerbated by the lack of markets for agriculture production which can give incentives for farmers to store and sell the production when the price is attractive and low production and productivities which which in most of cases does not justify for acquiring storage systems; and lack of awareness about the improved storage systems due to lack of demonstrations and promotion (Annex 1D). These barriers are categorized into economic and financial and nonfinancial as indicated below.

1.5.2.1 Economic and financial barriers

The economic and financial barriers hindering the transfer and diffusion of seed production are associated to high production and transation costs due to high inefficiency resulting to lack of skills and lack of financial capacity of seed companies. Other is related to lack of financial capacity of farmes to acquire improved seed due to the fact that they depend on agriculture to generate income and they generally have low production and productivity, lack access to market and credit due to lack of collaterals and high interest rates.

Similarly to the seed production, the transfer and diffusion of low-cost improved storage systems is hindered mostly by the lack of financial capacity by farmers to acquire storage systems. The low production and productivity is one of the major disincentives for adoptions of improved systems because in most cases the low production doenst need storage system. The lack of market for agricultural produce to create incentive for storing the production to sell when the price is attractive is another barrier for adoption of improved storage systems. The lack of access to credit is another barrier to adoption of improved storage systems.

1.5.2.2 Nonfinancial barriers

a) Political and regulatory

In Mozambique there is still no apropriate seed policy and legislative intruments that could address many of the gaps in the seed value chain. The design and implementation of seed police and regulation will contribute to improve the effectiveness of MASA conduct seed quality control and certification and to promote, coordinate and monitor the development of the seed sub-sector.

b) Socio-cultural

FAO implemented a project to promote Gorongosa silo but the adoption has been very low. The cost for constructing the silo (cost with cement and wires) and the fact that it enables to store only one commodity at a time and low crop productivity are among the caused for low adoption. Given that farmers produce multiple crops, they prefer storage system that enables storing different commodities at same time and not single crop storage as the case of Gorongosa silo. The size of the storage system in situation where productivity are very low limit the adoption. Gorongosa silo is designed to store up to 1,000kg which most farmers do not produce.

c) information and awareness

In Mozambique the use of improved seed still at 10% for Maize and 1.8% for rice and for other crops is still very low. The lack of awareness about the benefits of using improved seed is a major barrier because there have been less demonstration of advantage of improved seed over the recycled seed currently being used for crop production. With regard the storage systems, farmers still not informed and aware about some of the storage systems such as the super bag and its advantages over the storage systems currently being used by farmers. The promotion of these technologies (seed and storage systems) should be anticipated by the demonstration of their best performance over the systems currently being used.

d) Institutional and organizational capacity

The major barriers hindering the seed production is the malfunctioning of the seed value chain due to market distortion caused by Government seed distribution programs and lack of technical and financial capacity of MASA to coordinate, monitor and promote the development of seed sector development as well as to conduct quality control and certification. Presently, there are three laboratories conducting seed quality control, one in North, one in central and one in South. These laboratories have difficult to respond to the demand on seed quality control for the entire country on time. The limited staff in number and quality to perform seed inspection and certification further complicates the production of good quality seed.

Other barriers that hinder transfer and adoption of seed production is the fact that there is still little opening for guaranteed seed production. The weak support mechanisms to producers to increase production and areas to promote the search for seed and storage systems is another blocking barrier to seed production and adoption of storage systems. Associated to these

barriers, there is lack of systematic extension approaches to promotion and dissemination storage technologies and lack of systematic performance evaluation of the storage technologies to inform the needs for technology improvements to respond to farmers need and preferences.

f) market

The poor distribution network is one of the market barriers that limits the transfer and diffusion of seed production. The weak market development for agricultural products is another barrier hindering seed production because with well-developed market for agriculture products farmers will need to increase their production and for that they will need improved seed.

The market barriers for promotion of storage systems is related to unavailability of materials for the construction of metal silos and lack of suppliers for super bag in the country.

g) Technical

The basic seed used to produce certified seed is generally of low quality. That results in low quality of certified seed produced leading to low production and productivity of marketed seed. The low availability of improved varieties for some crops is also another barrier that hinders seed production

1.5.3 Identification of measures for seed production and promotion of low cost storage systems

The measures to remove the barriers to transfer, diffusion and adoption of seed production and promotion of low cost storage systems were categorized onto economic and financial and nonfinancial. In each category, the measures were identified.

1.5.3.1 Economic and financial measures

Given that the barriers hindering the transfer and diffusion of seed production and promotion of low-cost storage systems are associated to the cost and lack of financial capacity it is recommended to:

- Liaise with financial institutions to provide cheap loans to: seed companies to cover the costs for transportation, processing and administrative which are very high; community and farmers to conduct seed production particularly of food security crops where seed companies generally doesn't have interest in seed production
- Provide Tax incentives through reducing or eliminating taxes in importation of raw materials for manufacturing storage systems
- Create an enabling environment for local artisans to have access to loans cheap loans for them to manufacture low-cost storage systems at local level.

1.5.3.2 Nonfinancial measures

a) Political, legal and regulatory

The seed policy and legislation should be created to help improve the development of the seed sub-sector by improving the seed business environment through supporting MASA institutions to be more effective in promoting, coordinating and monitoring the development of the seed sub-sector, in implementing the seed legislation and in delivering services to the seed industry and also to assist MASA and seed sub-sector stakeholders in monitoring the implementation of seed policies and legislation. Some of the aims of the seed police and legislation should be to help create sustainable seed maket by removing market distortion cause by Governments subsidy programmes

b) Socio-cultural

The social and cultural barriers hindering the adoption of improved seed production and storage systems can be addressed through enhanced access

to improved inputs in order to increase production. With enhanced production farmers will demand for storage systems o store production as well as for improved seed to maintain high production. Other measures should be to manufacture small sizes of storage systems to enable storage of small quantities of different crops that they produce.

c) Technical

To ensure increased seed production, there is a need to expand and increase seed inspection in the field and the quality control of the seed after processing. The effective realization of seed inspection and quality control will contribute to raise awareness about the value or advantage of the use of improved seed because improved seed will have better performance than recycled seed and will lead to increased production and productivity. That in turn this will contribute to increased demand for improved seed and hence increased seed production. On the other hand, increased seed production will contribute to seed affordability given that increased production leads to increased availability.

One of the factors contributing to low adoption of improved storage systems is low production and productivity. Increased production and productivity will also contribute to increased demand for storage systems once the market for agricultural production has been established. Other measure to be considered is to make available storage systems of different sizes to suit different types of farmers and levels of production and productivity, where small size of the same type of storage system will be appropriate for farmers producing small quantities of grain or seed.

c) Information and awareness

Very few farmers are aware of the value or advantage of using improved. Therefore, there should intensification of demonstration plots for demonstrating the performance of improved seed compared to recycled seed to enable farmers to seed the advantage of improved seed. These demonstrations should be conducted using different approaches including the farmer field schools to ensure covering large number of farmers.

d) Institutional and organizational capacity

There a set of measures on institutional and organizational capacity that needs to be taken in consideration to enhance seed production in Mozambique. These include:

- Improve extension network, their skills and in means for more effective assistance to farmers on community seed production or on agricultural production
- Improve the entire production chain in order to encourage producers to increase production which will contribute to increase the demand for improved seed and storage systems to store the increased production.
- Improve or expand the network of inspectors and seed laboratories to ensure availability of improved seed and increase awareness about improved seed.
- Institutionalize and strengthen the quality control services at various levels
- Improve local infrastructure for entire seed supply chain
- Improve coordination between seed production and inspection institutions and streamline the inspection process or remove bureaucracy.

e) Market

Market for agricultural production can be a major drive for adoption of seed production as well as for storage systems. Market availability can contribute for increased production because farmers will be sure to sell all production that can make. On the other hand, increase production can contribute to acquisition of storage systems to ensure storing the production for the time the price for agricultural production is high. To ensure market establishment and development, there is a need improve roads and create associations to aggregate production and facilitate its transport and or attract potential buyers. On the buyers' side, there is a need to create incentives to ensure Economic agents to improve the network of seed distribution of seeds. These incentives can be access to cheap loans to get involved in commercialization.

f) **Human capacities**

To increase seed production it is necessary to train extension officers and farmers on seed production, handling and conservation. That will enable farmers to get involved in seed production in contract farming with seed companies or conduct their own production individually on in groups. Training extension officers will ensure availability of expertise to assist farmers on seed production.

On the other hand to promote low-cost storage systems, there is a need to train local artisans if manufacturing some of the storage systems such as metal silos.

1.6 Links between the barriers identified

From the analysis of the three technologies for adaptation, it was found that there are common barriers for the three technologies. The common barriers were grouped into: (1) low investment in research and extension, (2) limited technical and institutional capacity, (3) poor communication, coordination and collaboration among institutions, and (4) lack policies and regulations.

1.6.1 Little investment in research and extension

Research and extension are key to the adoption of technologies. The investment in research will enable the identification of appropriate technologies for each context while the extension will enable the demonstration and promotion of appropriate technologies for specific farmers or farmer's groups context. The lack of investment in research and extension makes difficult to identify technologies suitable to each context and demonstration of technology performance to farmers. Therefore, it is necessary to increase investment in research to identify technologies suitable to specific context of farmers before starting its diffusion.

1.6.2 Limited technical and institutional capacity

The limited financial capacity of the institutions, the reduced number of technical staff and the lack of technical knowledge will hinder the transfer and diffusion of technologies for adaptation. The limited technical capacity may hinder the testing and identification of technologies suitable for each specific context and conducting demonstrations of technology. Therefore, hiring new extension workers and conducting permanently and continuously training is key for ensuring dissemination and potential adoption of the technologies. For example, the adoption of conservation agriculture will be improved by

identifying the most appropriate techniques for each context, its understanding by extension to ensure its dissemination to producers, conducting tests that show advantage of CA over conventional agriculture and using appropriate dissemination approaches. On other hand, the limited availability of funds for mapping areas with potential for rainwater harvesting and conservation, the reduced number of technical capacity to train communities in techniques for rainwater harvesting and conservation, the reduced number people trained to maintain the rainwater harvesting and conservation systems will also hinder the adoption of rainwater harvesting and conservation. The upscaling of seed production also goes through a massive training of technical staff and farmers in seed production techniques, increasing the availability of seed inspectors for quality assurance that will encourage producers to adopt improved seeds. In this context, it is necessary to improve the availability of funds to increase the number of technicians and ensure their training and empowerment.

1.6.3 Poor communication, coordination and collaboration

The lack of coordination and poor collaboration between different actors working with one of the three technologies for adaptation has been referred to as one of the major barriers to the transfer and diffusion of technologies for adaptation. There is a poor collaboration between the various actors working in conservation agriculture, there is a poor collaboration between research and extension, there is poor collaboration between institutions working in the rainwater harvesting and conservation at the central level and at different levels (national to the provincial and local). There is no clarity about who is coordinating the transfer activities of conservation agriculture. There is also lack of collaboration between the different actors working in the seed sector and post-harvest management. Coordination, collaboration and communication between and among actors can improve the mobilization of resources, attracting international financing, the exchange of information on what approaches and techniques work best for each context among others. Therefore, improving the adoption of these technologies will also require improvements in communication, coordination and collaboration between the actors working in technology transfer and diffusion.

1.6.4 Policy and regulation

Lack of a national policy for seeds and post-harvest management has hindered the development of actions for growth and development of the seed sector and the improvement of post-harvest management in the country. Likewise, the lack of policy or regulation that encourages the private sector to import equipment used in conservation agriculture has also contributed to the limited adoption of this technology. The development of seed and post-harvest management police and policy or regulations that may create incentives for private investment in the seed sector, post-harvest management and in conservation agriculture should be considered to ensure wide adoption of the three prioritized technologies.

1.7 Enabling environment to overcome the barriers in the agricultural sector

The enabling environment to address common barriers to transfer and dissemination of the three technologies includes increased investment in research and extension; training and development of human and institutional capacities; strengthening collaboration, coordination and communication between the institutions and actors; creation of appropriate policies that will encourage investment and the application of laws.

1.7.1 Enabling environment to address the barriers of conservation agriculture

The necessary conditions to ensure the adoption of conservation agriculture are as follows:

- Provision of financial resources to fund research and extension
- Training highly qualified technical staff to conduct research and extension of the CA
- Upscaling demonstration plots to show the performance of the technology to producers
- Improve the coordination, collaboration and communication mechanisms between research, extension, farmers and the different actors to increase the successful transfer of technology
- Strengthen collaboration and information sharing between different actors (research, extension, government, NGOs, development agencies, etc.)
- Improve technical support to producers to improve the implementation of conservation agriculture

- Hire more technicians to help in research and upscaling massive dissemination of conservation agriculture
- Strengthen research capacity to identify appropriate technologies for each specific context and to conduct socio-economic studies on adaptation technologies and perceptions about the technologies
- Create market incentives to promote investment in seed production of cover crops
- Establish political support to promote private investment in equipment used in AC and the adoption of AC techniques through tax incentives and access to subsidized loans
- Awareness of farmers on climate change and the benefits of conservation agriculture as adaptation technology

- Improved access to: agricultural inputs, credit and market for their products to be able to promote the adoption of technology
- Establish demonstration plots strategic areas to expose the technology to a large number of farmers
- Availability extra land for expansion of farming area with view to implementation of crop rotation
- There is a need to ensure the availability of accessories

1.7.2 Enabling environment to address the barriers for rainwater harvesting and conservation

The conditions necessary to ensure the adoption of rainwater harvesting and conservation are as follows:

- There should be awareness raising for communities and producers about climate change and the benefits of rainwater harvesting and conservation as adaptation strategy
- To promote the adoption of rainwater harvesting and conservation, the access to agricultural inputs, loans, market for their products as well as the promotion of high income crops such as vegetables that require a lot of water should be guaranteed
- A favorable environment must be created for the suppliers of parts to operate
- Technical capacity must be created to ensure the transfer and diffusion of technology
- Farmers must be organized into groups or associations of infrastructure users in the case of dams to ensure its management and maintenance

- Coordination and inter-institutional collaboration should be strengthened and improved to improve the transfer and diffusion of rainwater harvesting and conservation
- Adequate human and financial resources should be provided to plan and implement the technology
- Government should consider increasing investment through private public partnerships for the installation of rainwater harvesting and conservation infrastructures to improve access to water for irrigation and stocking of livestock as a priority

1.7.3 Enabling environment to address the barriers of seed production and promotion of low-cost storage systems

The conditions necessary to ensure the adoption of seed production and promotion of low-cost storage systems are as follows:

- There should be a seed policy and postharvest management to promote the use of improved seed and storage systems

- To promote the adoption of seed production and promotion of low-cost storage systems, the access to agricultural inputs, loans, market for their products should be guaranteed
- Access to seed and storage systems should be improved through subsidized credits, lower prices
- should be improving the quality control system by increasing the number of seed inspectors, lab technicians and labs for seed quality control

- Demonstration plots of improved seed should be established in strategic areas to expose the seed a large number of farmers
- Coordination and inter-institutional collaboration should be strengthened and improved to improve the transfer and diffusion of rainwater harvesting and conservation
- Food production should be intensified to promote the use of improved seeds and storage infrastructures

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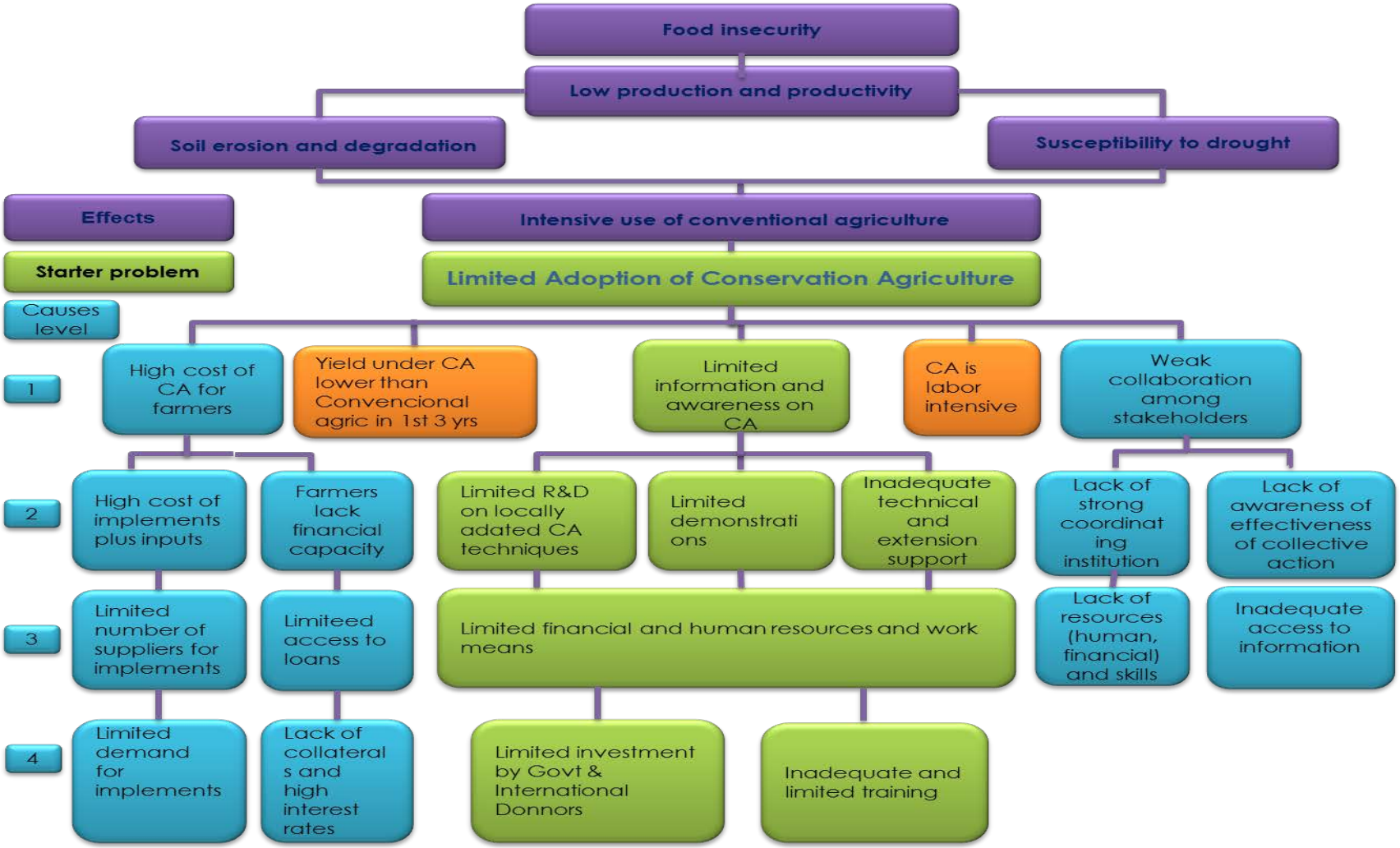
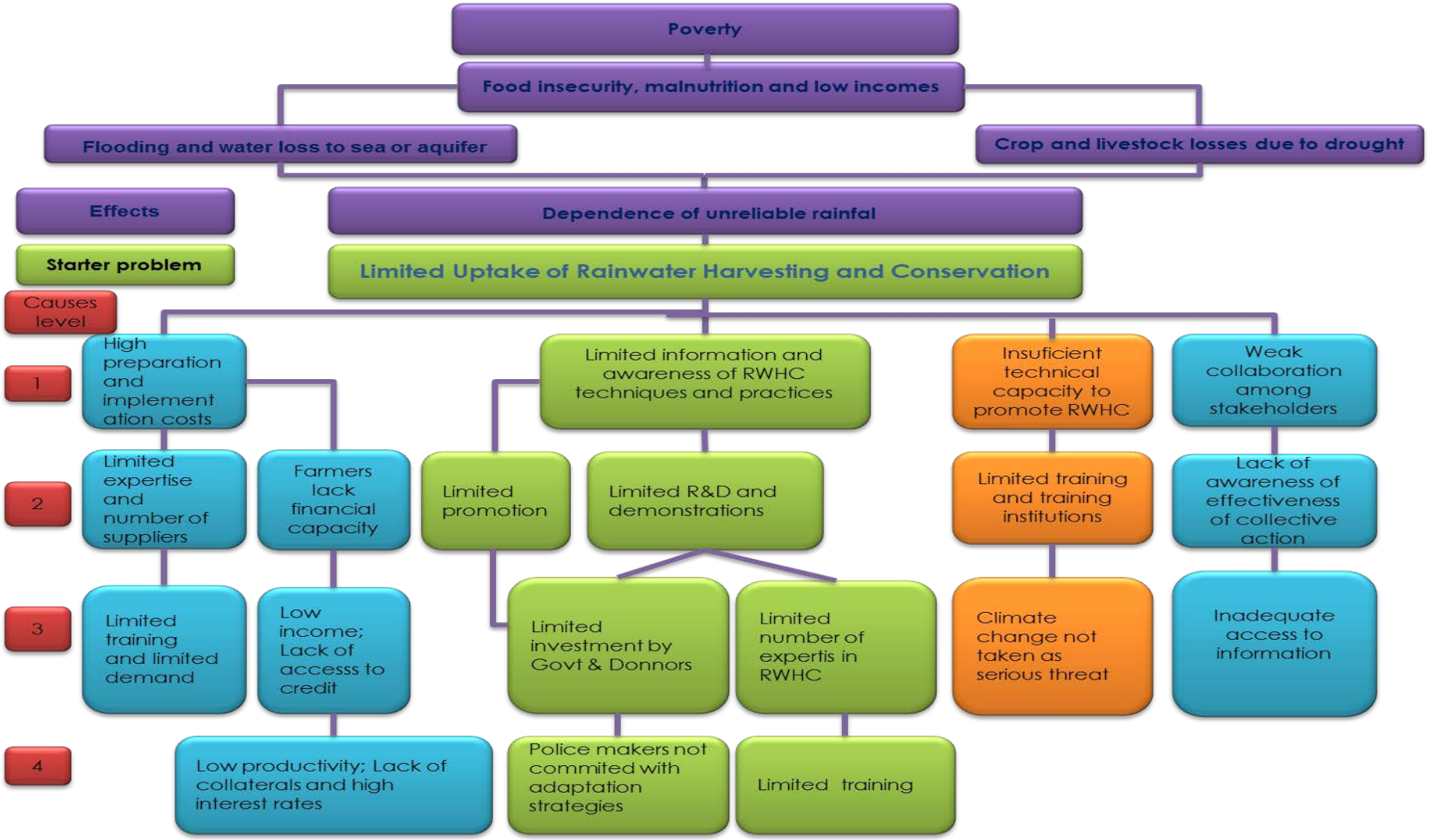
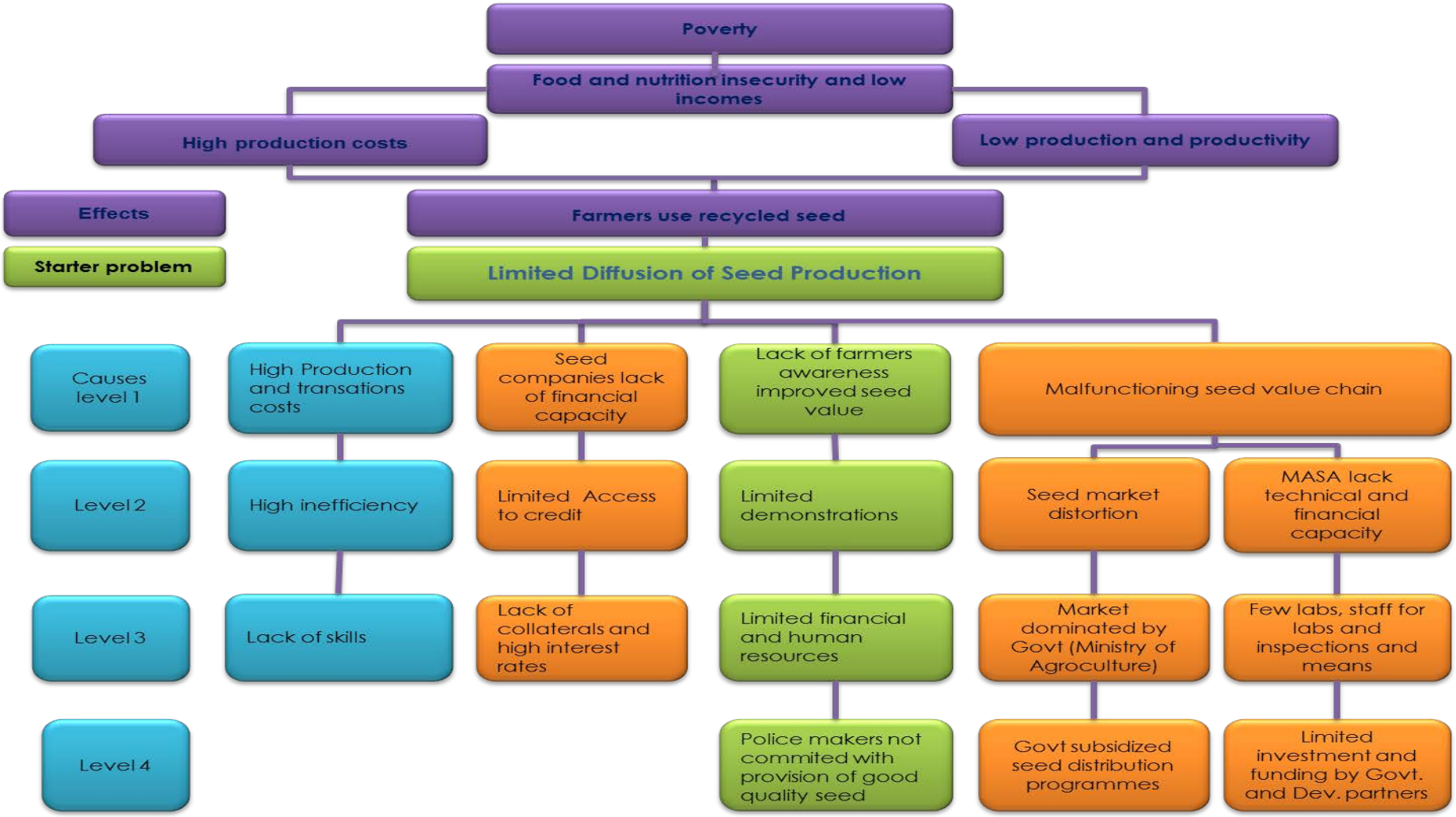
Annex 1A: Problem tree for Conservation agriculture



Annex 1B: Problem tree for Rainwater Harvesting nd Conservation



Annex 1c: Problem tree for Seed Production



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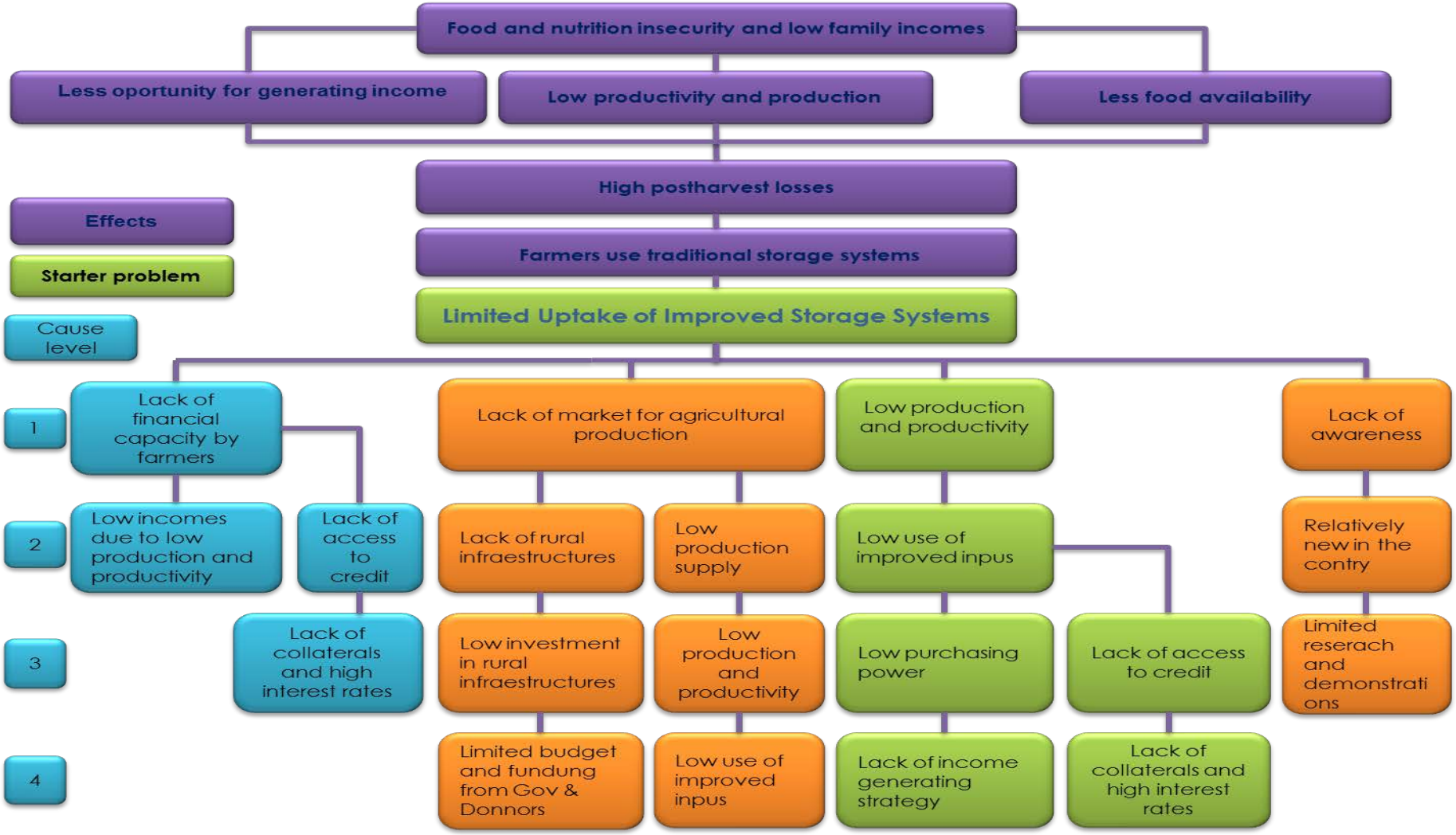
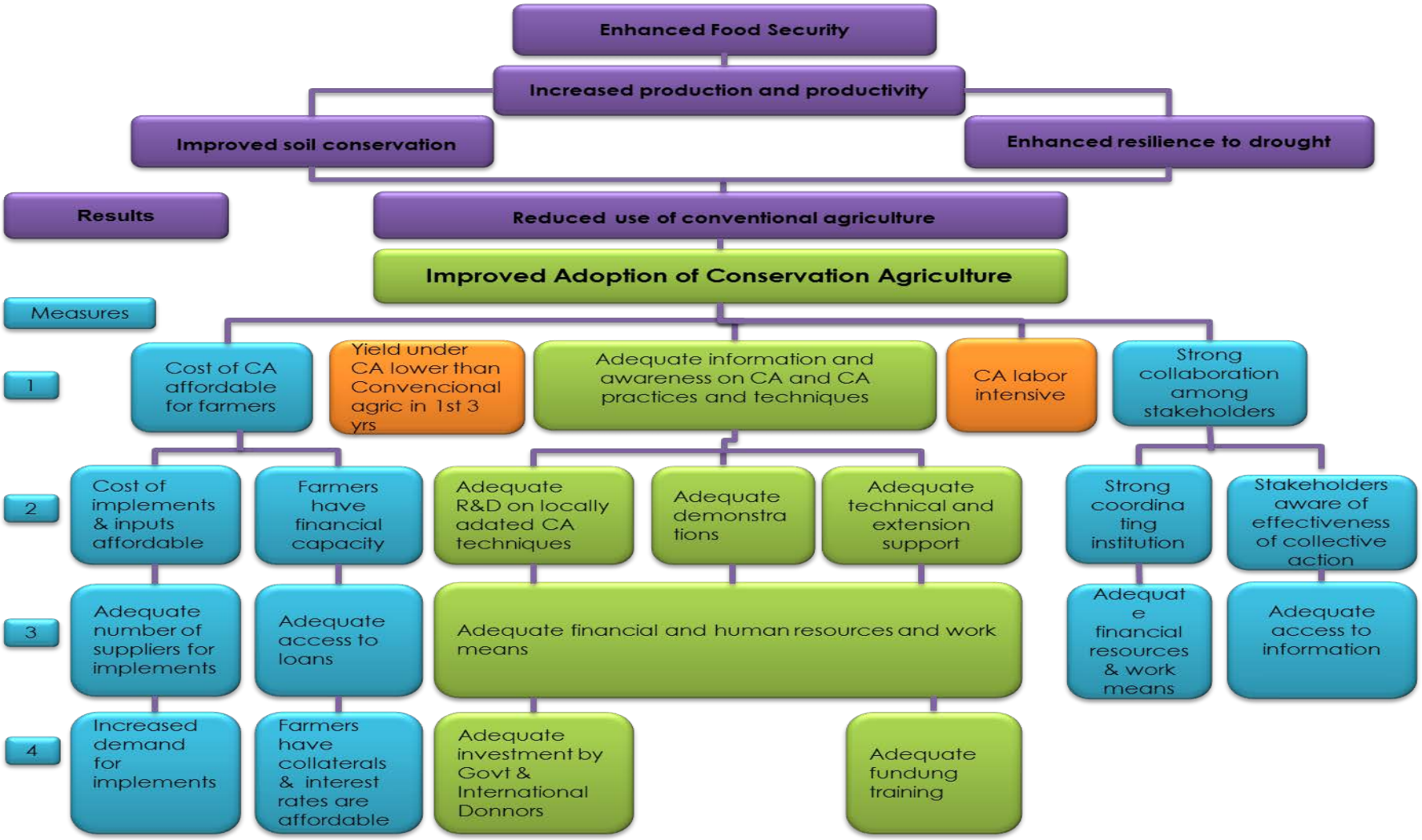
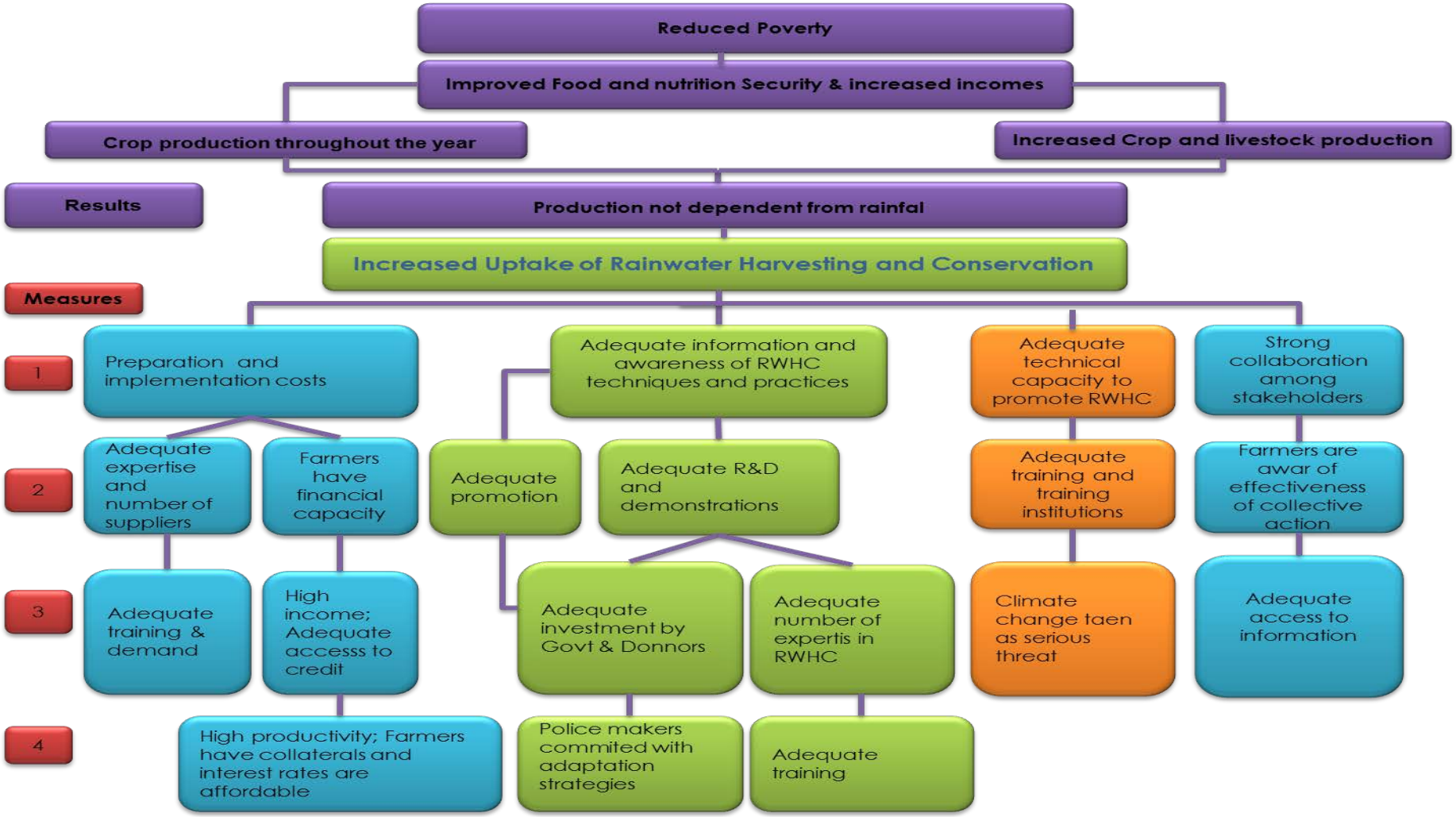
Annex 1D: Problem tree for Storage Systems



Annex 2A: Objective tree for Conservation Agriculture



Annex 2B: Objective tree for Rainwater Harvesting and Conservation



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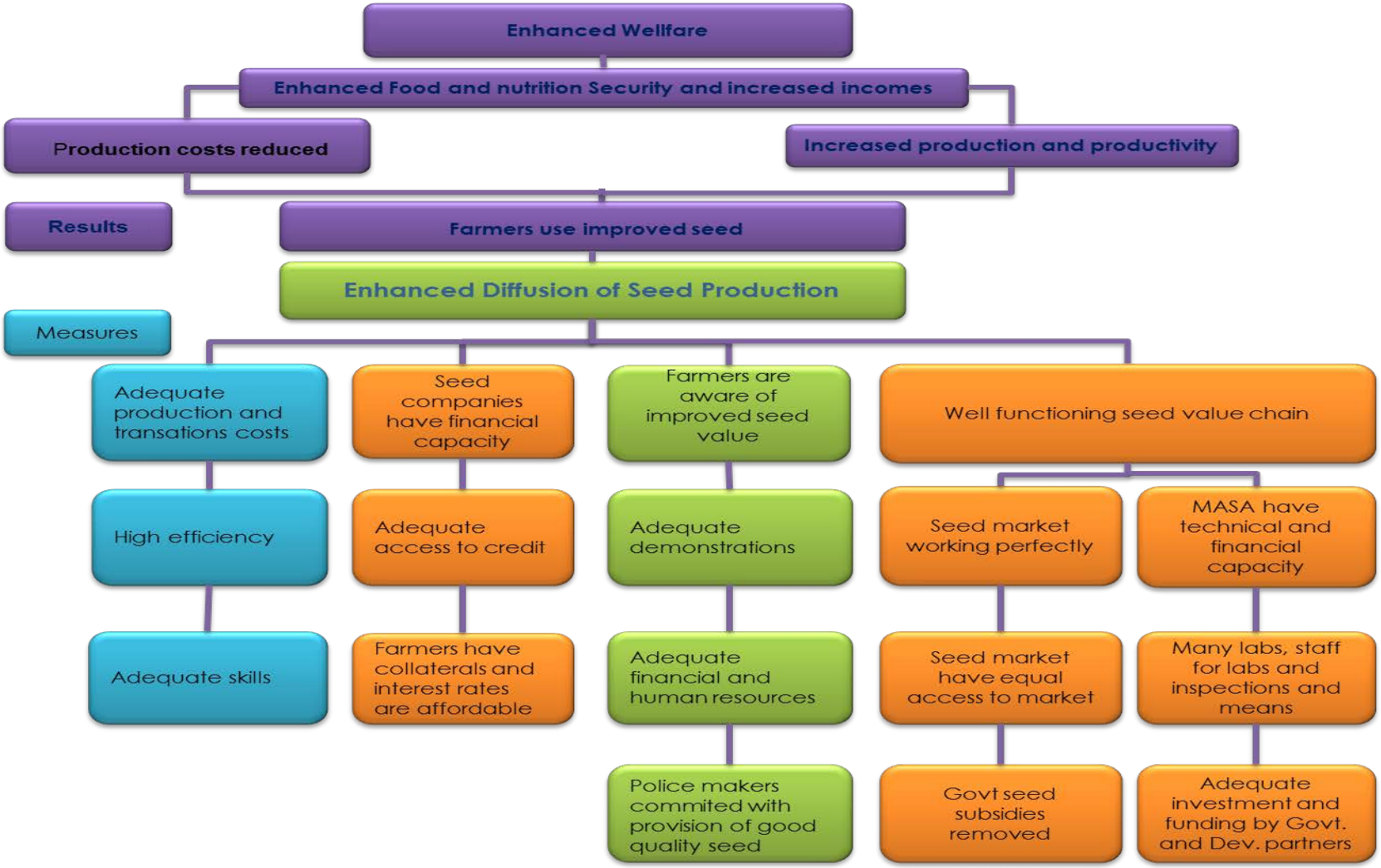
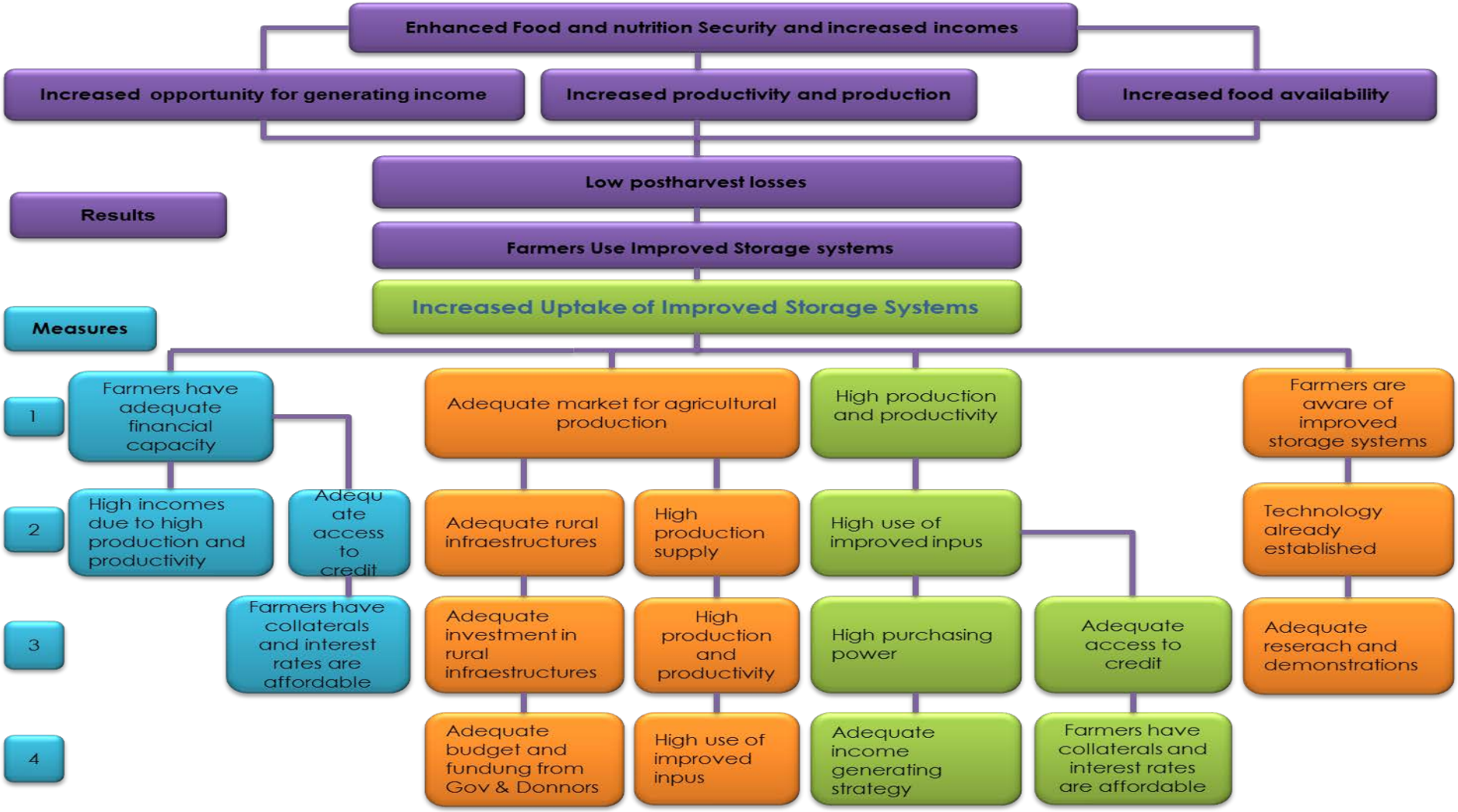
Annex 2C: Objective tree for Seed Production



Annex 2D: Objective tree for Low-Cost Storage Systems



Annex 3: List of participants

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Annex 4: Cost Benefit Analysis for conservation Agriculture

Cost benefit analysis for Conservation Agriculture
COST= investment in R&D + demonstration cost+ training cost + additonal cost of CA implementation + cost of public awareness
BENEFITS= Benefit from increase in crop yield and quality +

Item	Unit	Quantity
Total area under production	ha	
Target area under CA (60%)	ha	
Area under CA per year	ha/yr	
Cost of investment in R&D	USD/yr	
Cost of technical support to CA	USD/yr	
Cost of demnstrations	USD/yr	
Cost of training	USD/yr	
Cost of public awareness	USD/yr	
Additional investment cost	USD/yr	
Timeframe of the project	years	10
Crop productivity per year	t/ha/yr	

Annex 5: Cost Benefit Analysis for Rainwater harvesting and conservation

Cost benefit analysis for Conservation Agriculture
COST= investment in R&D + demonstration cost+ training cost + additonal cost of CA implementation + cost of public awareness
BENEFITS= Benefit from increase in crop yield and quality +

Item	Unit	Quantity
Total area under production	ha	
Target area under CA (60%)	ha	
Area under CA per year	ha/yr	
Cost of investment in R&D	USD/yr	
Cost of technical support to CA	USD/yr	
Cost of demnstrations	USD/yr	

Cost of training	USD/yr	
Cost of public awareness	USD/yr	
Additional investment cost	USD/yr	
Timeframe of the project	years	10
Crop productivity per year	t/ha/yr	

Annex 6: Cost Benefit Analysis for seed production

Cost benefit analysis for Conservation Agriculture

COST= investment in R&D + demonstration cost+ training cost + additonal cost of CA implementation + cost of public awareness
BENEFITS= Benefit from increase in crop yield and quality +

Item	Unit	Quantity
Total area under production	ha	
Target area under CA (60%)	ha	
Area under CA per year	ha/yr	
Cost of investment in R&D	USD/yr	
Cost of technical support to CA	USD/yr	
Cost of demnstrations	USD/yr	
Cost of training	USD/yr	
Cost of public awareness	USD/yr	
Additional investment cost	USD/yr	
Timeframe of the project	years	10
Crop productivity per year	t/ha/yr	

Annex 7: Cost Benefit Analysis for low-cost improved storage systems

Cost benefit analysis for Conservation Agriculture
COST= investment in R&D + demonstration cost+ training cost + additonal cost of CA implementation + cost of public awareness
BENEFITS= Benefit from increase in crop yield and quality +

Item	Unit	Quantity
Total area under production	ha	
Target area under CA (60%)	ha	

N

Area under CA per year	ha/yr	
Cost of investment in R&D	USD/yr	
Cost of technical support to CA	USD/yr	
Cost of demnstrations	USD/yr	
Cost of training	USD/yr	
Cost of public awareness	USD/yr	
Additional investment cost	USD/yr	
Timeframe of the project	years	10
Crop productivity per year	t/ha/yr	