Food and Agriculture Organization
of the United Nations

Annex 2

Appendix 1 – Ecosystem based Adaptation

For the GCF-FAO Project "Ecosystems-based Adaptation for resilient Watersheds and Communities in Malawi (EbAM)"

1. Ecosystem-Based Adaptation (EbA) involves use of biodiversity and ecosystem services to assist people to adapt to climate change.[1] Interventions according to EbA are comprised of actions to restore and strengthen ecosystems so that biodiversity and ecosystem services are maximized and climate-change adaptation is most effective. Hence, EbA for watersheds means restoring and strengthening their ecosystems, or managing watershed vegetation, soil and water regime in a sustainable manner, which is the overall goal of the project. Agriculture constitutes major uses of watershed lands, which may negatively affect the surrounding ecosystems that provide services indispensable to humans and agriculture itself – clean water in a regulated manner, organisms that control pest insects, habitats for crop pollinators, soil fertility and so on.[2] EbA in agriculture, thus, aims at creating an assemblage of crops and livestock to resemble ecosystems in functions and biodiversity as well as minimizing disturbances that are damaging to the nearby ecosystems (Components 1 and 2). Agroecology has been widely accepted as a means of climate change adaptation based on ecosystems in agriculture.[3]

2. Ecosystem-based adaptation is aligned with Malawi's Updated Nationally Determined Contributions (NDC), 2021.[4] Among many actions for climate change adaptation, the NDC 2021 proposes: development of adaptation planning tools; ecosystem-based adaptation; integrated watershed management; crop diversification; sustainable soil and water management; afforestation; agroforestry; sustainable forest management; and riparian restoration. The strategic adaptation actions mentioned in the NDC 2021 follow the National Adaptation Plan mandates, but also adds: development of adaptation planning tools for vulnerable communities; development of methodologies to assess risks and identify community-based adaptation options; and elaboration of adaptation priority actions, using nature-based solutions and ecosystem-based adaptation. Under *"accessible and harmless water*," the NDC lists integrated watershed management. The long list of actions on agriculture, livestock and fisheries includes promotion of: farm-based disaster risk reduction and management practices (crop and diet diversification, integrated pest management, etc.); soil and diet improving crops; farmer managed natural regeneration; drought resilient water, soil and catchment conservation; climate adaptation capacity among smallholder farmers; reforestation; community participation in seed selection, storage and management; rainwater harvesting; drought resilient and early maturing crop varieties; and soil fertility improvement. These actions are some of the well-known EbA interventions, which are mentioned in *Malawi National Guidelines: Integrated Catchment Management and Rural Infrastructure 2015*[5], *the Forest Landscape Restoration Opportunities Assessment for Malawi 2017*[6], as well as *the National Forest Landscape Restoration Strategy 2017*.

3. Ecosystem-based management of watersheds is a paradigm-shifting pathway listed in the Green Climate Fund Sectoral Guide on Ecosystems and Ecosystem Services.[7] The project (EbAM) proposes to invest in ecosystem-based management of watersheds, one of the two paradigm-shifting pathways defined by the GCF Sectorial Guide on Ecosystems and Ecosystem Services. The project aims at enhancing ecosystem functions at a watershed scale large enough to facilitate climate change adaptation in a sustainable manner. Watershed management plans under EbAM will combine ecosystem and socioeconomic perspectives by adopting a landscape approach to maximize biodiversity and provision of ecosystem services and to support livelihoods and socio-economic development. In the framework of Malawi's water resources management, the plans will be Village Level Action Plans (VLAPs), specified by the Ministry of Agriculture, Irrigation and Water Development. The planning and implementation processes will be inclusive; meaningful participation of vulnerable groups (e.g., women, youth, the poorest) will be ensured through their capacity building and examination of decision-making power sharing at household and community levels. Local/traditional knowledge in ecosystem management will be

incorporated, which the government of Malawi aspires to do, but has not been able to satisfactorily on the ground.

4. The project promotes resilient agroecology, the first paradigm-shifting pathway of the GCF Sectorial Guide on Agriculture and Food Security.[8] Ecosystem-like farms surrounded by well-functioning ecosystems bring improvements in soil biodiversity, soil organic matter and soil structure, which are continuously deteriorating under conventional agriculture due to greatly diminished biodiversity, especially underground. Improved soil organic matter and soil structure increase soil water holding capacity, and hence lead to reduced risks of climate hazards, such as droughts and floods. Higher biomass achieved by agroecology means elevated transpiration and hence smaller ambient temperature fluctuations. Farms are resilient when strengthened as ecosystems; soil biodiversity assures fertility, while agrobiodiversity greatly mitigates proliferation of pests, diseases and weeds and provide food and nutrition security. A meta-analysis of 57 developing countries has shown that agroecology can increase yield up to 80%.[9] In Malawi, it has been shown that agroecology generates higher benefits in agriculture, environment, livelihood, food and nutrition compared to conventional agriculture.[10] Due to the context specific nature of agroecology, its precise effects are subject to socioeconomic, cultural and environmental factors of each farm. Climate resilient plant varieties will be sought, propagated and shared by EbAM through seed banking and nurseries. As an innovation, a wide range of adaptation options will be offered to the participating farmers. Their diversity in needs and strengths is more than often overlooked by extension workers; adoption of new practices will be higher and sustainable when the farmers are given the opportunity to choose what best meets their needs and takes advantages of their strengths. For EbA agricultural practices (or agroecology) to be appropriate for smallholders, they must: (i) increase food security of smallholder households; (ii) increase income generation of smallholder households and diversify its sources; (iii) take advantage of local/traditional knowledge of smallholder farmers; (iv) use local, available and renewable inputs rather than external inputs; (v) be affordable in terms of cost and labor to smallholder farmers.[11] .

5. Ecosystems provide various services – provisioning, regulating, cultural and supporting[12] – which EbAM sets out to strengthen. Various functions of ecosystems are essential to the existence of humans, and hence called ecosystem services. Four types of them have been distinguished: (i) provisioning services (provision of food, water, timber and fiber); (ii) regulating services (regulation of climate, floods, disease, wastes and water quality); (iii) cultural services (provision of recreational, aesthetic and spiritual benefits); and (iv) supporting services (soil formation, photosynthesis and nutrient cycling).[13] Climate change threatens the supply of such services, which EbA will counter by restoring and strengthening ecosystems and creating ecosystem-like agriculture. It has been asserted that EbA could be characterized as generation of services to ecosystems: (i) ecosystem protecting services (habitat/species protection through management or cultural rules; weeding/culling of species determent to ecosystems; resources overexploitation limited by rituals); (ii) ecosystem enhancing services (cultivation, domestication, trait selection, translocation, range spreading to improve biodiversity; pruning for improving plant health; fertilizing; and nutrient cycling); (iii) ecosystem restoring services (improving soil/water/air quality; habitat/niche construction; nutrient conversion into forms suitable for plant uptake; increase in plant biomass; and revitalization of cultural harvesting); and (iv) ecosystem supporting services (cultural-ecological integrity and symbiosis).[14]

6. Ecosystem-based adaptation allows holistic solutions for holistic benefits and is superior to other climate-change adaptation strategies in many aspects. Examples of EbA include: agroecology; vegetation and soil management of forests, grasslands and rangelands; and water regime management of river basins, flood plains, wetlands and aquifers. EbA boosts ecological resilience[15] through restoring, strengthening and sustainably managing ecosystems.[16] Resilient

ecosystems are equipped with self-healing and adapting capabilities, which render EbA measures effective in a wider range of climate situations than other adaptation strategies. EbA generates short- and long-term term benefits[17] and is applicable at regional, national and local levels.[18] It is considered more cost effective in climate change adaptation than grey infrastructure when economic, social and environmental benefits are included.[19] When local/traditional knowledge (holistic socio-ecological knowledge, practices and beliefs)[20] is integrated, EbA has good chances of avoiding maladaptation.[21] Agriculture can cope well with climate variability when it resembles ecosystems and minimizes its damage to existing ecosystems. Other characteristics of EbA in agriculture include: resilience against pests and weeds[22] (expected to increase due to CC); preservation of soil health; improvement in nutrient cycling; reduced use of external inputs (which is often detrimental to both the source and to the recipient ecosystems); improvement in food and nutritional security; and diversification in income generating goods and services. With native and landrace varieties and breeds, climate resilience of the agricultural system can be maximized. High agrobiodiversity can translate into year-around availability of cash and subsistence crops, leading to uninterrupted cash income flow and food and nutritional security. EbA management of forests, grasslands and rangelands restores and strengthens the ecosystems involved and secures water resources, preserves soil microbiome and health, regulates floods and droughts (which are expected to increase in frequency and intensity due to climate change), enhances agricultural production and improves health and sanitation. Water regime management with a focus on river basins, flood plains, wetlands and aquifers can: provide water storage capacity; regulate floods and droughts; enhance agricultural production; and contribute to better health and sanitation. The three examples above are pertinent to EbA watershed management.

7. Native species play critical roles in resilient ecosystems, and hence in EbA. Climate change weakens ecosystems and facilitates establishment of invasive species, which further lowers ecosystem resilience. Despite the importance of native species in climate resilient agriculture, many are neglected and underutilized. By the sheer fact that native species evolved in the local environment for over thousands of years or more, they tend to thrive with less inputs than exotic species and are much more adept at maintaining local ecology and biodiversity, and hence, landscapes and culture unique to locality.[23] Robust and healthy ecosystems are the foundation of EbA, and it is the native species that confer such characteristics the most. In other words, they are key to preventing maladaptation[24] and building ecological resilience against extreme weather events.[25] Some exotic species may appear useful in addressing various environmental problems, such as deforestation and soil erosion, thanks to their fast and reliable establishment and growth. Such traits are demonstrations of their aggressiveness, which often allow them to outcompete native species and to replace them. Climate change weakens ecosystems and eases establishment of invasive exotic species.[26] The resultant low biodiversity creates environments more favorable to invasive species, leading to further reduced resilience to climate change and to invasive species.[27] The readily available genetic diversity needed for climate change adaptation is higher for native species than for an exotic species introduced, whose genetic cousins are found in their own native range. Hybrids perform very well provided that the required external inputs are available and that the seeds are purchased every year from a qualified seed supplier. These characteristics deprive farmers of opportunities to select seeds more adapted to the changing climate and also create financial dependence. Thus, the most preferred species from the EbA point of view are the native (including endemic) species.

8. EbA protects native wild edible plants, which carry the genetic diversity needed for climate change adaptation and provide food and nutritional security. Agroecology as an EbA approach relies on agrobiodiversity and use of native agricultural species, but both have been in decline around the world,[28] resulting in: cultivation and consumption of a very small portion of known edible organisms; and neglect and underutilization of native crops. The African continent has been

known for its high intra- and inter-seasonal climate variability, even prior to the current anthropogenic climate change;[29] the native species are likely to possess higher capacities than the exotics to cope with the changing climate. The potential resilience of native crops has been noted in sub-Saharan Africa in face of increasing aridity (one of the projected changes in Malawi), in addition to their superior nutritional diversity compared to non-native crops in cultivation.[30] Many of the neglected and underutilized crops likely exist more outside the agricultural fields than within. It is also the wild relatives of domesticated crops which harbour most of genetic diversity needed for climate change adaptation; the highest diversity is found among the natives than among the exotics due to their much longer history. Wild products also supplement local diet during normal times and save lives in times of famine. Some weeds participate in agriculture as intercrops, reducing the need for pesticides or fertilizers.[31] It is critical to consider the role of native wild products in agricultural and food systems for their contribution to food and nutritional security and also to a diversified set of income-generating goods and services.

9. Landraces are varieties diverged sufficiently from the original species to adjust to the local conditions; landrace of exotic origin will be part of recommended species. Varieties that have locally developed and existed without negatively disturbing the local ecosystems often have high capacities to tolerate biotic and abiotic stress specific to the location. Such varieties with recognizable differences from the original species are called landraces; they could be of native or non-native origin. Landraces are usually highly valued by local farmers and play an important role in their socioeconomic lives. While EbAM promotes agrobiodiversity with emphasis on native species for higher ecological integrity of watersheds, higher climate resilience[32] and lower input requirements, it includes landraces in the recommended types of organisms to be used for ecosystem-based adaptation of agriculture. Some cash crops of foreign origin with well-established markets may be supported by EbAM for livelihood purposes, while the country transitions into EbA. Beyond agriculture, EbAM species will be the native ones, as their contribution to ecological resilience is superior to exotic species, including their landraces. Table 1 summarizes the EbA characteristics of native and exotic plant species (landrace, non-invasive and invasive): suitability to local environmental conditions;[33] inputs required for establishment and maintenance;[34] rate of response to climate change;[35] provision of habitat for native fauna;[36] maintenance of local ecology and biodiversity;[37] maintenance of landscapes[38] and culture unique to locality; contribution to ecological resilience against extreme weather events;[39] and prevention of maladaptation.[40]

Table 1: Ecosystem-Based Adaptation and Native/Exotic Flora

Characteristics	Native Species (including their landraces)	Exotic Species		
		Landrace	Non Invasive	Invasive
Suitability to Local Environmental Conditions	**Very Good**	Close to native species.	May or may not be good, but very seldom as good as native species	 Grows fast and outcompetes native species

Characteristics	Native Species (including their landraces)	Exotic Species		
		Landrace	Non Invasive	Invasive
Inputs Required for Establishment and Maintenance	**Little**	As above	As above	 Grows very well without any/little aid; control is difficult once established
Rate of Response to Climate Change	Slower than invasive species	Slower than invasive species	Slower than invasive species	 Expected fastest.
Provision of Habitat for Native Fauna	**Very Good**	Close to native species, but seldom as good.	As above	Deprivation or none to little provision
Maintenance of Local Ecology and Biodiversity	**Very Good**	As above	As above	Destructive
Maintenance of Landscapes and Culture Unique to Locality	**Very Good**	As above	As above	Destructive
Contribution to Ecological Resilience against Extreme Weather Events	**Very Good**	As above	As above	Deprivation or none to little contribution
Prevention of Maladaptation	**Very Good**	As above	As above	None or little

10. The word *indigenous* appears to designate all crops that the Malawians see in their environment. The national awareness is low on invasive species. Scientifically, native species are synonymous with indigenous species, but "indigenous" vegetables most commonly cited by Malawians include exotic and invasive *Bidens pilosa* (Blackjack)[41] and *Amaranthus* spp., a genus that includes exotic and highly invasive *Amaranthus palmeri* (Palmer amaranth) [42] and *Amaranthus spinosus* (Spiny amaranth),[43] potentially invasive *Amaranthus muricatus*[44] and so on. The common grasses and trees promoted in the country for reforestation and fuel supply are:[45] giant bamboo, which could be any of the several species named as such[46] (All are of Asian origin, except for one that is native to Madagascar. Among them, at least *Bambusa vulgaris*[47] and *Dendrocalamus strictus*[48] are potentially invasive in Africa.); *Gliricidia sepium* (Central American origin and mildly or potentially invasive in Africa); Tephrosia (*Tephrosia volgeii*[49] and *Tephrosia caerulea*[50] are native to Malawi. *Tephrosia purpurea* is of Indian origin.[51] *Tephrosia candida* is from South and Southeast Asia and potentially invasive in Africa.[52]); Sesbania (*Sesbania punicea* is native to South America[53] and a Category 1 invasive plant in South Africa; it may not be cultivated, sold or transported between regions.[54] It is prohibited in Australia.[55] *Sesbania bispinosa* most likely originated in India,[56] and *Sesbania sebana* is native to Malawi.[57]); Calliandra calothyrsus (*Calliandra houstoniana* var. *calothyrsus* is native to Central America, very aggressive

and reported invasive in Uganda.[58]); and *Senna* spp. (*Senna spectabilis* originated in tropical America and is reported invasive in Uganda.[59] *Senna siamea* is native to Southeast Asia, with potentially of significant invasion risk in already cultivated areas.[60] *Senna septemtrionalis* is native to Central America and has been reported invasive in many countries, including Malawi.[61] *Senna marilandica* is native to North America.[62]). Neither the advantages of natives species nor disadvantages of exotic species, especially those invasive, are not appreciated fully by the local population or donors in the country.

Box 1: Bamboo and Ecosystem-Based Adaptation

Bamboo is a hardy, perennial grass, which can grow in a wide variety of soil types and water availability unsuited to other plants.[63] The plant can grow rapidly in hot and humid rainforests and also in cold climates with temperatures as low as −20°C.[64] It is prized for its fast growth as well as for rhizome and root system that prevent soil erosion.[65] Two main types of bamboo rhizome exist: (a) monopodial (running) and (b) sympodial (clumping).[66] The rhizomes of running bamboo spread horizontally and often quickly. It is hence considered more invasive than the clumping bamboo,[67] but a global review of bamboo has suggested that invasiveness does not depend on particular inherent characteristics of the plant, such as rhizome types, but more on native plant diversity and specifically low native bamboo diversity of the host location.[68] The review also found that the species with larger native range tended to be more invasive.[69]

Bamboo belongs to the Poaceae family, spreading over several genera: Bambusa; Dendrocalamus; Gigantochloa; Oxytenanthera; Phyllostachys and so on. The most introduced species in the world are from the genera Bambusa and Phyllostachys, which contain species prized for fastest growth and most of the listed invasive species.[70] The two genera are largely Asian in origin.[71] There are four African bamboos originated in Africa, a continent marked by low bamboo biodiversity.[72] *Oxytenanthera abyssinica* (common name: Lowland bamboo,[73] Bindura bamboo[74]) is the only known bamboo native to Malawi.[75]

Lowland bamboo possesses the desirable characteristics typical of a bamboo: fast growth; high soil conservation potential; multiple use; and adaptability to low quality sites.[76] However, due to its growth rate inferior to that of the Asian relatives, which are the fastest growing in the world, lowland bamboo is not included in the group of bamboos promoted in Malawi.[77] The low number of native bamboo species in the country makes it quite suited for invasion by bamboo species that are most widely introduced. Awareness on exotic and invasive species is weak in the country, and promotion of lowland bamboo would most likely have the unintended consequences of encouraging more planting of invasive bamboo. Although *Oxytenanthera abyssinica* could be used for EbA in Malawi, the project takes the precautionary approach of not recommending it as part of EbA.

11. Biodiversity and ecosystem services cannot be established through application of a single technique. Agroecology – EbA for agriculture – is a holistic and integrated approach,[78] not an application of isolated agroecological techniques, simple input substitution or compliance with certificate requirements.[79] It cannot be formulated as recipes; what is most appropriate depends on each agricultural field's livelihood needs, aspirations and constraints, in addition to surrounding ecosystems and their conditions.[80] The same holds for EbA in general. The techniques promoted

by the project can be categorized according to their role in restoring and strengthening ecosystems and endowing agricultural systems more of ecosystem-like features (Table 2).

Table 2: Ecosystem Management and Main Ecosystem-Based Adaptation Techniques

Ecosystem Management	Technique
Establishing Ecosystem-like Agriculture or Agroecology *Crop Land Management*	
Assembling living elements for resilience 	Use of Native Plants and Animals Diversification of Crops Conservation of Pollinator Ecosystems
Aiding in nutrient cycling 	Use of Bio-inputs/ biofertilizer
Ensuring efficient use of water 	Mulching Flood Recession Cropping Pit Planting/Negarim/Zaï/Tassa
Protecting soil and its fertility 	Diversification of Crops Cover Crops Integration of Perennial Crops Minimum Tillage/Conservation Tillage Contour Cropping

Ecosystem Management	Technique
Selecting living elements for beneficial interactions 	Crop Rotation/Intercropping/Companion Cropping Integrated Crop and Livestock Cultivation Integrated Rice and Aquatic Animal Cultivation Agroforestry Other Biological Pest Controls Physical Pest Controls
Protecting and strengthening ecosystems 	Forest Farming
Aiding agriculture with living elements 	Windbreak/Hedge/Hedgerow/Shelter Belt/ Vegetative Barrier/Wind Barrier/Living Fence
Vegetation and Soil Management for Well-Functioning Ecosystems *Forest Management and Grassland/Rangeland Management*	
Protecting and strengthening ecosystems 	Natural Forest Protection Use of Native Forest Plants and Animals in Forest Regeneration Assisted Natural Regeneration/Farmer Managed Natural Regeneration Use of Wild Products and Non-Timber Forest Products for Livelihood Purposes Forest Farming

Ecosystem Management	Technique
	Use of Native Plants and Animals in Grassland/Rangeland Management
Protecting soil and its fertility 	Cover Crops [Rangelands] Minimum Tillage/Conservation Tillage [Rangelands] Rotational Grazing
Assembling living elements for resilience 	Diversification of Forage Plants Integrated Crop and Livestock Cultivation Silvo-Pastoralism
Enhancing ecosystem resilience with living elements 	Windbreak/Hedge/Hedgerow/Shelter Belt/ Vegetative Barrier/Wind Barrier/Living Fence [Rangelands]
Watershed Management for Well-Functioning Ecosystems *Water Regime management*	

Ecosystem Management	Technique
Protecting and strengthening ecosystems 	Conservation of Riparian Buffer Zone and Floodplain Conservation of Wetland Use of Native Plants and Animals
Protecting soil and its fertility 	Contour Bunding/Contour Ridging/ Contour Trenching/Diversion Ditch/Contour Vegetation Strip/Contour Hedgerow Brush Fill/Brush Plug Gully Plug/Check Dam/Check Wall
Ensuring efficient use of water 	Water Harvesting

12. By considering climatic events in the forms experienced by ecosystems, historical and projected changes in climate variables informed the EbA interventions of EbAM. The historical and projected changes in climate variables are linked to how EbAM addresses them through viewing the changes as future climatic events as experienced by ecosystems (Table 3). What each climatic event means to ecosystems determines the adaptation intervention required ("Ecosystem Boosting Measures" in Table 4) as well as the EbA techniques in the field to be adopted ("Corresponding Techniques in the Field" in Table 4). The benefits of addressing climatic events are also described in Table 4. Since every element is related to all others in ecosystems, at least indirectly, one positive turn usually leads *ad infinitum* to another, and another. The "Primary Benefits" column of Table 4 contains the major initial effects of such long chain of reactions.

13. EbAM shoulders the initial investment required for adoption of each technique *chosen by each watershed community*. The major items of watershed management financed by the project are: management planning process (which involves discussions on EbA technique selection); sensitization and training; provision of seeds and seedlings; establishment of seed and seedling nursery; material for gully plugs, check dams and other infrastructure; required but missing tools; and technical advice for plan implementation. The project encourages the beneficiaries to plan watershed management according to a landscape approach (Component 1); the resultant plan may well include livestock and edible aquatic organisms, and EbAM equips the beneficiaries with the capacity to raise the needed funds for such activities and manage their financial resources for the long term. Sensitization on EbA techniques involving livestock and edible aquatic organisms will be carried out, but training or material will *not* be provided by EbAM. The description of techniques, their variations and their feasibility in the EbAM areas are presented in Table 5. The detailed characteristics of each technique follow.

Table 3: Climate Change[81] and Climatic Events as Experienced by Ecosystems in Malawi

Climate Variable		**Historical Trend (1961-2020)**	**Future Trend (in comparison with 1961-2020)**	**Future Climatic Events**
		Overall: Marked by variation on small spatial scales.	**Overall: Marked by higher variation on small spatial scales.**	
Temperature		Increase in mean annual temperature of 0.04°C/decade since 1971	Accelerated temperature rise. Maximum monthly temperature to increase by 0.3-3°C/ more than 4°C in end-century[82] under RCP 4.5/8.5.	Higher frequency and intensity of: Extreme heat.
Rainfall	Rainy Season Onset	Delays of 8-14 days in 1991-2020 compared to 1961-1990	Delays of at least 10-12 days in near century[83] under RCP4.5.	Higher frequency and intensity of: Extreme heat; Droughts/Aridity; Floods; Other disruptions in water cycle.
	Rainy Season Cessation	Mostly advanced (up to 14 days) but delayed in a few Districts.	Advances of 2-5 days by mid century under RCP 4.5.[84]	Higher frequency and intensity of: Extreme heat; Droughts/Aridity; Other disruptions in water cycle.
	Variability	Increase in spatial, inter and multi-annual variability.	Further increase in spatial, inter and multi-annual variability in near century.[85]	Higher frequency and intensity of: Droughts/Aridity; Floods; Other disruptions in water cycle.
	Tropical Cyclones/Storms	Increase in frequency and intensity.	Further increase in frequency and intensity.	Higher frequency and intensity of: Droughts/Aridity; Floods; Other disruptions in water cycle; Strong winds.
Future Climatic Event as Experienced by Ecosystems			Higher frequency and intensity of: Elevated plant/animal stress; Increased soil erosion; Decline in soil fertility; Further deforestation and degradation of watersheds; Intensified incidence of pests, diseases and weeds; Inconsistent water supply	

Table 4: Climatic Events, Ecosystem Based Adaptation and Benefits

Climatic Events as Experienced by Ecosystems	Ecosystem based Adaptation Intervention		Primary Benefits
	Ecosystem Boosting Measures	**Corresponding Techniques in the Field[86]**	
Elevated plant/animal stress *Contributing Climatic Events:* *Extreme heat* *Droughts/Aridity* *Floods* *Other disruptions in water cycle* *Strong winds*	• Increase aboveground biomass - Plants' evapotranspiration lowers ambient temperature. - Higher albedo reduces surface heat absorption and increases soil moisture retention. - Plants' evapotranspiration localizes and balances water cycle (instead of making it large and unbalanced, resulting in droughts/floods). • Physically intercept rain, sunlight and winds - If done by living vegetation, they contribute to the above ("Increase aboveground biomass"). • Give preference to native plants/animals - Native plants/animals are more adapted to the local ecosystems/climate even under climate change.	<u>Agricultural land restoration</u>, including: • Increase aboveground biomass ✓ Diversification of Crops (including forage plants) ▪ Cover Crops ▪ Crop Rotation/Intercropping/ Companion Cropping ✓ Rotational Grazing ✓ Conservation of Ecosystems • Physically intercept rain, sunlight and winds ✓ Mulching ✓ Cover Crops ✓ Pit Planting/Negarim/Zaï/Tassa ✓ Windbreak/Hedge/Hedgerow/Sheter Blet/Vegetative Barrier/Wind Barrier/Living Fence • Give preference to native plants/animals ✓ Use of Native Plants and Animals	• Higher farm productivity from reduced plant/animal stress due to climate change, more consistent water supply and increased soil fertility • Lower plant/animal stress • Reduced deforestation and degradation of watersheds - From reduced conversion into agricultural fields. • Lower ambient temperature (climate change mitigation) - From increased aboveground biomass • Higher biodiversity - From increased aboveground biomass - From preference given to native plants/animals • Higher soil carbon (climate change mitigation) - From increased aboveground biomass • More consistent water supply - From increased soil carbon. • Higher soil fertility - From increased soil carbon and soil biodiversity • Less incidence of pests, diseases and weeds From lower plant/animal stress and higher biodiversity
Increased soil erosion *Contributing Climatic Events:*	• Increase aboveground biomass - Biomass acts as obstacles and slows down runoffs. - Rain has smaller impact on soil, and hence smaller probability of being carried away.	<u>Soil and water conservation</u>, including: • Reinforce slopes with living/non-living material ✓ Mulching ✓ Contour Cropping	• Reduced soil erosion • Reduced decline in soil fertility - From reduced soil erosion • Reduced deforestation and degradation of watersheds - From reduced conversion into agricultural fields.

Climatic Events as Experienced by Ecosystems	Ecosystem based Adaptation Intervention		Primary Benefits
	Ecosystem Boosting Measures	**Corresponding Techniques in the Field[86]**	
Extreme heat *Droughts/Aridity* *Floods* *Other disruptions in water cycle* *Strong winds*	- Including plants of higher height will further reduce the impacts and probability of erosion. • Increase soil biodiversity - Soil organisms decompose soil organic matter and bond soil particles. - Improvement in soil biodiversity leads to higher levels of soil organic matter and bonding of soil particles. • Reinforce slopes with living/non-living material • Increase aboveground biomass diversity - Different plants are hosts to different soil organisms, which in turn improves biodiversity - Hence it also contributes to the above ("Increase soil biodiversity"). • Give preference to native plants/ animals - Native plants/animals are more adapted to the local ecosystems/climate even under climate change.	✓ Contour Bunding/Contour Riding/Contour Trenching/Diversion Ditch/Contour Vegetation Strip/Contour Hedgerow ✓ Brush Fill/Brush Plug ✓ Gully Plug/Check Dam/ Check Wall <u>Agricultural land restoration</u>, including: • Increase aboveground biomass ✓ Cover Crops ✓ Crop Rotation/Intercropping ✓ Conservation of Pollinator Ecosystems • Increase soil biodiversity ✓ Diversification of Crops and Forage Plants ✓ Integration of Perennial Crops ✓ Minimum Tillage/Conservation Tillage • Give preference to native plants/animals ✓ Use of Native Plants and Animals	• Lower ambient temperature (climate change mitigation) - From increased aboveground biomass • Higher soil biodiversity - From increased aboveground biomass - From preference given to native plants/animals • Higher soil carbon (climate change mitigation) - From reduced soil erosion. • Higher biodiversity - From increased aboveground biomass - From increased soil biodiversity • More consistent water supply - From increased soil carbon • Higher soil fertility - From increased soil carbon and soil biodiversity • Higher farm productivity - From reduced soil erosion (which brings more consistent water supply and increased soil fertility)
Decline in soil fertility *Contributing Climatic Events:* *Extreme heat* *Droughts/Aridity* *Floods* *Other disruptions in water cycle* *Strong winds*	• Increase aboveground biomass - Carbon captured by aboveground biomass will be exuded underground to feed soil organisms. - Higher soil biodiversity means higher nutrient diversity and soil fertility. • Increase soil biodiversity - Minimize physical soil disturbance, which leads to loss of large soil organisms. • Reinforce slopes with living/non-living material • Increase aboveground biomass diversity	<u>Soil and water conservation,</u> including: • Reinforce slopes with living/non-living material ✓ Contour Cropping ✓ Contour Bunding/Contour Riding/Contour Trenching/Diversion Ditch/Contour Vegetation Strip/Contour Hedgerow ✓ Bush Fill/Brush Plug ✓ Gully Plug/Check Dam/ Check Wall <u>Agricultural land restoration</u>, including • Increase aboveground biomass ✓ Cover Crops	• Higher farm productivity - From reduced decline in soil fertility (which brings more consistent water supply) • Reduced decline in soil fertility • Lower plant stress - From reduced decline in soil fertility • Reduced deforestation and degradation of watersheds - From reduced conversion into agricultural fields. • Less incidence of pests, diseases and weeds

Climatic Events as Experienced by Ecosystems	Ecosystem based Adaptation Intervention		Primary Benefits
	Ecosystem Boosting Measures	**Corresponding Techniques in the Field[86]**	
	- Different plants are hosts to different soil organisms, which in turn make different nutrients available for plants. - Hence it also contributes to the above ("Increase soil biodiversity"). • Enhance nutrient cycling - Nutrient cycling is enhanced with integration of other elements in food production (e.g., manure/feces from animals). - Livestock can incorporate cover crops into soil. - Biological wastewater contains nutrients. • Give preference to native plants/animals - Native plants/animals are more adapted to the local ecosystems/climate even under climate change.	✓ Crop Rotation/Intercropping/ Companion Cropping ✓ Conservation of Pollinator Ecosystems • Increase soil biodiversity ✓ Cover Crops ✓ Diversification of Crops and Forage Plants ✓ Integration of Perennial Crops ✓ Minimum Tillage/Conservation Tillage • Increase aboveground biomass diversity ✓ Diversification of Crops and Forage Plants ✓ Cover Crops ✓ Integration of Perennial Crops ✓ Minimum Tillage/Conservation Tillage ✓ Contour Cropping • Enhance nutrient cycling ✓ Integrated Crop and Livestock/aquatic Cultivation ✓ Agroforestry ✓ Silvo-Pastoralism ✓ Solid/Liquid Biological Waste Application Techniques to Increase aboveground biomass diversity are also applicable. • Give preference to native plants/animals ✓ Use of Native Plants and Animals	- From healthier plants and animals • Lower ambient temperature - From increased aboveground biomass • Higher soil biodiversity - From increased aboveground biomass - From preference given to native plants/animals • Higher soil carbon - From reduced decline in soil fertility. • Higher biodiversity - From increased aboveground biomass - From increased soil biodiversity • More consistent water supply - From increased soil carbon
Further deforestation and degradation of watersheds *Contributing Climatic Events:*	• Protect non-plantation forests. • Prevent soil erosion and soil fertility decline. - Less forests are cleared for agriculture. EbA mechanisms against "Increased soil erosion" and "Decline in soil fertility" are applicable.	<u>Community forest and woodlot restoration; forest management; river and stream bank restoration.</u> These include: • Protect non-plantation forests. ✓ Natural forest protection (Establish woodlots for fuelwood and charcoal) ✓ Agroforestry	• Reduced deforestation and degradation of watersheds • Reduced soil erosion • Reduced decline in soil fertility • Lower plant/animal stress - From reduced decline in soil fertility • Less incidence of pests, diseases and weeds

Climatic Events as Experienced by Ecosystems	Ecosystem based Adaptation Intervention		Primary Benefits
	Ecosystem Boosting Measures	**Corresponding Techniques in the Field[86]**	
Extreme heat *Droughts/Aridity* *Floods* *Other disruptions in water cycle* *Strong winds*	• Connect forest conservation to economic activities. - Farmers are incentivized to keep forest ecosystems in good health. • Control fire - Livestock can control fire through browsing and grazing, thus protect forests and grasslands. • Give preference to native plants/animals - Native plants/animals are more adapted to the local ecosystems/climate even under climate change.	✓ Use of native forest plants in forest regeneration ✓ Assisted Natural Regeneration/ farmer managed natural regeneration ✓ Forest Farming ✓ Conservation of riparian buffer zone and floodplan (revetment, deformable bankline; degradable/ deformable toe • Prevent soil erosion and soil fertility decline (see techniques to remedy "Increased soil erosion," "Decline in soil fertility.") • Promote cash income from NTFP. ✓ Use of Wild Products and Non-Timber Forest Products for Livelihood Purposes • Promote simple Payment for Ecosystem (PES) schemes (e.g. of bee-keeping). • Control fire: ✓ Firebreak (as part of Assisted Natural Regeneration/Farmer Managed Natural Regeneration) ✓ Integrated Crop and Livestock Cultivation • Give preference to native plants/animals ✓ Use of Native Plants and Animals	- From healthier plants and animals • Lower ambient temperature (climate change mitigation) - From increased aboveground biomass • Higher soil biodiversity - From increased aboveground biomass - From preference given to native plants/animals • Higher soil carbon - From reduced soil erosion. - From reduced decline in soil fertility. • Higher biodiversity - From increased aboveground biomass - From increased soil biodiversity - From controlled fire. • More consistent water supply - From increased soil carbon • Higher farm productivity From reduced soil erosion (which brings reduced decline in soil fertility and more consistent water supply)
Intensified incidence of pests, diseases and weeds *Contributing Climatic Events:* *Extreme heat* *Droughts/Aridity* *Floods*	• Increase aboveground biomass diversity - Diversity prevents outbreak of pests, diseases and weeds by limiting their access to hosts. - Diversity is also preventive thanks to plants' robust health, which owes to soil biodiversity created by their own diversity. • Cultivate plants that repel pests and disease-causing fungi/bacteria in the vicinity of (or in sequence with) the main crop.	<u>Agricultural land restoration</u>, including • Increase aboveground biomass diversity ✓ Diversification of Crops and Forage Plants ✓ Cover Crops ✓ Integration of Perennial Crops ✓ Minimum Tillage/Conservation Tillage ✓ Contour Cropping	• Less incidence of pests, diseases and weeds • Higher biodiversity • Lower plant/animal stress - From less incidence of pests, diseases and weeds • Higher soil biodiversity - From preference given to native plants/animals • Higher soil carbon - From reduced soil erosion.

Climatic Events as Experienced by Ecosystems	Ecosystem based Adaptation Intervention		Primary Benefits
	Ecosystem Boosting Measures	**Corresponding Techniques in the Field[86]**	
Disruptions in water cycle	• Maintain biodiversity (and large enough habitats for various organisms) to keep ecosystems in good health. - Degraded ecosystems are prone to pest/disease attacks and invasion by weeds. • Give preference to native plants/animals - Native plants/animals are more adapted to the local ecosystems/climate even under climate change. • Pest control by other methods that do not interfere with ecosystem services	• Cultivate plants that repel pests and disease-causing fungi/bacteria in the vicinity of (or in sequence with) the main crop. ✓ Crop Rotation/Intercropping/ Companion Cropping <u>Community forest and woodlot restoration; forest management, including:</u> • Maintain biodiversity (and large enough habitats for various organisms) to keep ecosystems in good health. ✓ Natural Forest Protection ✓ Use of Native Forests Plants and Animals in Forest Regeneration ✓ Assisted Natural Regeneration/Farmer Managed Natural Regeneration ✓ Conservation of Riparian Buffer Zones and Floodplain ✓ Conservation of Wetland ✓ Use of Wild Products and Non-Timber Forest Products for Livelihood Purposes ✓ Forest Farming • Give preference to native plants/animals ✓ Use of Native Plants and Animals • Pest control by other methods that do not interfere with ecosystem services ✓ Other Biological Control (e.g., application or organic chemicals) ✓ Physical Pest Control (e.g., nets)	- From reduced decline in soil fertility. • More consistent water supply - From increased soil carbon • Higher soil fertility - From increased soil carbon and soil biodiversity • Higher farm productivity - From higher plant/animal productivity
Inconsistent water supply *Contributing Climatic Events: Extreme heat*	• Increase soil organic matter - Higher soil organic matter leads to higher water holding capacity of soil. - Higher water holding capacity means soil acts as moisture reservoir. • Increase aboveground biomass	<u>Soil and water conservation interventions</u>, including: • Increase soil organic matter See techniques to remedy “Increased soil erosion” and “Decline in soil fertility.” • Increase aboveground biomass ✓ Cover Crops	• More consistent water supply • Higher soil organic matter (climate change mitigation) • Lower plant/animal stress - From more consistent water supply • Reduced deforestation and degradation of watersheds

Climatic Events as Experienced by Ecosystems	Ecosystem based Adaptation Intervention		Primary Benefits
	Ecosystem Boosting Measures	**Corresponding Techniques in the Field[86]**	
Droughts/Aridity *Floods* *Disruptions in water cycle*	- Biomass acts as obstacles and slows down runoffs, allowing higher soil absorption of runoffs. - Rain has smaller impact on soil, and hence smaller probability of being carried away. - Including plants of higher height will further reduce the impacts and increases the probability of soil's absorption of rainwater. - Plants' evapotranspiration localizes and balances water cycle (instead of making it large and unbalanced, resulting in droughts/floods). • Give preference to native plants/animals - Native plants/animals are more adapted to the local ecosystems/climate even under climate change. • Ensure efficient use of water	✓ Crop Rotation/Intercropping/ Companion Cropping ✓ Conservation of Pollinator Ecosystems • Give preference to native plants/animals ✓ Use of Native Plants and Animals • Ensure efficient use of water ✓ Mulching ✓ Flood Recession Cropping ✓ Pit Planting/Negraim/Zaï/Tassa ✓ Drinking and Bating Water Protection ✓ Water Harvesting ✓ Gully Plug/Check Dam/Check Wall	- From more consistent water supply • Less incidence of pests, diseases and weeds - From more consistent water supply • Lower ambient temperature (climate change mitigation) - From increased aboveground biomass • Higher biodiversity - From increased aboveground biomass - From preference given to native plants/animals • Higher soil fertility - From increased soil carbon and soil biodiversity • Higher farm productivity - From more consistent water supply and higher soil fertility

Table 5: Ecosystem-Based Adaptation Techniques: Descriptions, Variations and Feasibility

Below are examples of possible interventions to be promoted under VLAPs, SCMPs and FFS. *These additional details complement was is presented in the main text of the Feasibility Study. For more technical details on some of the techniques, the reader is invited to consult* Malawi National Guidelines: Integrated Catchment Management and Rural Infrastructure 2015 (Volume II)[87].

Technique	Description	Technical Feasibility
Establishing Ecosystem-like Agriculture or Agroecology *Crop Land Management*		
Use of Native Plants and Animals	Cultivation of **native** plants and animals to benefit from their **suitability** to the local environment and **adaptability** to its changes. - Aids in **restoring local ecosystems**.	EbAM provides: - Sensitization and training. - Native seeds/saplings. - Native plant nurseries. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material inputs for daily care of crops and animals. - Reduced labor and material inputs for caring against diseases and extreme weather. - Reduced external input requirement (e.g., water, nutrient supplements, chemical products against pests/diseases for proper growth).

Technique	Description	Technical Feasibility
Diversification of Crops	Cultivation of **various** crops that are of **sufficient botanical difference** to benefit from their different abilities in modifying biochemical and physical properties of soil and other elements of microenvironment. - Prevents creation of an environment suited to uncontrollable proliferation of pests and weeds. - Varied resilience of crops to climate change improves overall resilience of farm. - **Variations** include: mulching with living plants; crop rotation/intercropping/companion cropping (excepting relay planting); forest farming; agroforestry; and strip cropping.	EbAM provides: - Sensitization and training. - Seeds for diversification, including landraces, drought resistant crops, native food crops, including lost crops. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material inputs for daily care of crops. - Higher labor input per area because of higher diversity of crops.
Conservation of Pollinator Ecosystems	Conservation of **nesting and foraging** sources and improvement in **habitat heterogeneity** to support pollinator **species richness**, including those for **non-crop plants** and of **various taxa** (insects and vertebrates). - Nesting sources include: shrubs, trees, pesticide and vegetation-free soil. - Habitat heterogeneity is linked to creation and maintenance of niche microenvironments.	EbAM provides: - Sensitization and training. - Specific material needed for each conservation measure. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material for daily care of crops. - Reduced labor and material for caring against diseases and extreme weather.
Use of bio-inputs/ biofertilizer	Recovery and use of **nutrients** in **solid biological waste**, **including animal waste and sewage**, to **reuse** in agricultural field production. - **Variations** include: composted material application to crop lands, including Bokashi composting and vermicomposting.	EbAM provides: - Sensitization and training. - Equipment and material for demonstrations (strings/pegs, shovel/hoe, bucket, tarp material (hay, wood, etc.). Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Solid biological waste free of antibiotic substances as much as possible, feed additives and other chemicals toxic to ecosystems. - Higher labor input for waste collection, treatment and application.

Technique	Description	Technical Feasibility
Mulching	Application of natural or artificial **material on soil surface** to cover and improve biochemical and physical properties of soil. - **Variations** include: cover crop and green manure.	EbAM provides: - Sensitization and training. - Materials and equipment (e.g. slasher). - [Cover Crop/Green Manure] Hoe and seeds. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - [Mulch] Material (wood chips, straw, leaves, seeds for cover crops, etc.). - Increased labor for mulch application. - Reduced labor and material input for pest and weed suppression. - [Cover Crop/Green Manure] Reduced labor and material for compost/fertilizer. - Reduced labor and material input for pest and weed suppression. - [Cover Crop] Additional land for cultivation of cover crops.
Flood Recession Cropping	Cropping in floodplains and on river/lake banks to make use of **soil moisture** after **flood recession**.	EbAM provides: - Sensitization and training. - Materials and equipment (e.g. hoe). Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material input for pest and weed suppression.
Pit Planting/ Negarim/Zaï/ Tassa	**Planting** of crops **in pits** whose **dug out material** is place around or downhill of each pit to form a **berm** to **break hard pan** and **reduce sheet soil erosion.** - **Manure/compost** may be applied to pits.	EbAM provides: - Sensitization and training. - Materials and equipment (e.g. hand hoe, string and pegs). Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - [Optional] Manure/compost. - Higher labor input for pit creation. - Higher input and material for weed control.

Technique	Description	Technical Feasibility
Integration of Perennial Crops	Cultivation of higher proportion of **perennial crop plants** for soil conservation.	EbAM provides: - Sensitization and training. - Seeds of perennial plants (including landraces, drought resistant crops, native crops). Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material for replanting.
Minimum Tillage/ Conservation Tillage	**Minimum disturbance** of **soil** to improve biochemical and physical properties of soil, including no burning or little removal of crop residue. - Conservation tillage may designate any method of soil cultivation that leaves crop residue before and after planting the next crop. - **Variations** include: no (or zero) tillage, direct seedling; strip tillage/zone tillage; and ridge tillage.	EbAM provides: - Sensitization and training. - Material and equipment (slasher and hoe, material required for weed suppression and rill erosion control, contour gauge/A-frame, hoe and material for contour marking etc.) Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and costs for tilling. - Reduced labor and material for compost/fertilizer. - Reduced labor and material for pest suppression. - Higher labor and material input for weed suppression (which requires crop rotation or cover crops). - Higher labor and material input for rill erosion control (which requires cover crops, contour cropping, strip cropping, mulching, planting of deep-root/perennial crops and/or grass waterways). - [Ridge Tillage] Higher labor and material input for constructing ridges across contour lines to minimize erosion on slopes. - [Ridge Tillage] Higher labor input for ridge construction and maintenance.

Technique	Description	Technical Feasibility
Contour Cropping	Planting of crops along **contour lines** to intercept **water flow**, encourage water **infiltration** and discourage soil **erosion** by water. - **Variations** include: contour bunding/contour ridging/marker ridging/contour trenching; strip cropping; terracing; and Slope Agriculture Land Technology (SALT, or contour hedgerow intercropping).	EbAM provides: - Sensitization and training. - Contour gauge/A-frame, hoe and material for contour marking. - [Contour Bunding/Contour Ridging/Marker Ridging/Contour Trenching/Terracing] Pegs, hammer, spade and wheelbarrow. - [SALT] Shovel/spade, digging bar and tree seeds/saplings. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Higher labor input for construction of runoff outlets, e.g., grassed waterways. - Higher labor input for contour marking in the first year. - [Terracing] Higher labor input for terrace construction in the first year and maintenance (removing debris from outlets, smoothing silt bars in channels, rebuilding terrace ridges, etc.). - [SALT] Reduced labor and material for compost/fertilizer. - [SALT] Reduced labor and material for pest and weed suppression. - [SALT] Higher labor input for contour marking and hedgerow making in the first year. - [SALT] Higher labor input per area because of higher diversity of crops. - [SALT] Reduced labor input because of high proportion of perennial plants (if they yield agricultural products).

Technique	Description	Technical Feasibility
Crop Rotation/ Intercropping/ Companion Cropping	Cultivation **across time/space** of **crops** that are of **sufficient botanical difference** to benefit from their different abilities in modifying biochemical and physical properties of soil and other elements of microenvironment (e.g., reduced pest presence, higher pollinator availability). - Most **common** secondary crops are legumes for **nitrogen fixing** in soil. - **Variations** include: replay planting; mixed intercropping; row intercropping; strip intercropping; alley intercropping; vegetable/legume cultivation during rice fallow; trap cropping; weed control intercropping; repellent intercropping; and pull-push/stimulo-deterrent-diversionary intercropping	EbAM provides: - Sensitization and training. - Hoe. - Seeds (e.g. landraces, drought-resistant, native, including lost crops) for additional crops. - [Crop rotation] Seeds uniform in fixed input requirements (e.g., sunlight, structure such as trellis, soil depth). - If involving trees, shovel/spade, digging bar and tree seeds/saplings. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - [Crop rotation] Land uniform in fixed input requirements (e.g., sunlight, structure such as trellis, soil depth). - Reduced labor and material for compost/fertilizer. - Reduced labor and material for pest and weed suppression. - Higher labor input per area because of higher diversity of crops. - [Strip Cropping] Possibility of reduced labor input, due to higher suitability to powered equipment than mixed/row intercropping. For vegetable/legume cultivation during rice fallow, Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Drained rice fields and vegetable/legume seeds (and in some cases rice straw). - Reduced labor and costs for tilling. - Reduced labor and material for rice stubble clearance. - Reduced labor and material for fallow crop land preparation. - Reduced labor and material for compost/fertilizer for rice and fallow crop. - Reduced labor and material for pest suppression. - Reduced labor and material input for weed suppression (if rice straws are applied). For alley cropping, see Agroforestry below.

Technique	Description	Technical Feasibility
Integrated Crop and Livestock Cultivation	Cultivation of **forage, other crops** and small **livestock** which **forages *in situ***.	EbAM provides: - Sensitization and capacity building on planning. - Materials and equipment (e.g. Hoe). Beneficiaries provide: - Time and interest for sensitization. - Local/traditional knowledge and labor for technique implementation. - Small livestock. - Reduced labor and material for crop residue clearance. - Reduced labor and material for land preparation for crops.
Integrated crop and Aquatic Animal Cultivation	Cultivation of crops (e.g. flooded rice) with aquatic animals, such as **fish**, **shellfish**, **crustaceans**, **waterfowls**, etc.	EbAM provides: - Sensitization and capacity building on technical production aspects and planning. Beneficiaries provide: - Time and interest for sensitization.
Agroforestry	An alternative name for **intercropping/companion cropping** with **trees**. - **Variations** include: alley cropping; food forest/guild; silvo-pastoralism; and slope agriculture land technology (SALT). - Occasionally include forest farming.	EbAM provides: - Sensitization and training. - Material and equipment: [Silvo-Pastoralism] Hoe (if introducing grass/forage to woodland/forest); shovel/spade, digging bar and tree seeds/saplings (if introducing trees to pastures) Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material for compost/fertilizer. - Reduced labor and material for pest and weed suppression. - Higher labor input per area because of higher diversity of plants. - Reduced labor input because of high proportion of perennial plants (if they yield agricultural products).

Technique	Description	Technical Feasibility
Other Biological Pest Controls	**Removal/repelling of pests** by employing **predatory insects/birds**, **parasitic insects and parasitoids** (supplemental release, or boosting/conserving naturally occurring population in the environment).	EbAM provides: - Sensitization and capacity building on planning. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Organisms required for control. - Reduced labor and material for pest suppression.
Physical Pest Controls	**Removal/repelling of pests** by physical means. - Examples are: handpicking; hand nets and bag nets; beating and hooking; shaking; sieving and winnowing; mechanical exclusion (e.g., use of adhesive/no-traction material, screen, trench, red lights); mechanical traps (light trap, air suction trap, electric trap); burning; crushing and grinding; sounds; rope dragging in rice fields; fruit bagging; tin collars on stems, etc. - Applicable only at small scale.	EbAM provides: - Sensitization and capacity building on planning. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Tools required for control. - Reduced labor and material for pest application. - High and repeated input of labor.
Forest Farming	Planting of crops in **understory** of **existing natural forest** without clearing forest trees.	EbAM provides: - Sensitization and training. - Materials and equipment (e.g. hoe). Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material for crop maintenance.
Windbreak/Hedge/ Hedgerow/Shelter Belt/Vegetative Barrier/ Wind Barrier/Living Fence	Planting of **trees and shrubs** to **reduce wind force**.	EbAM provides: - Sensitization and training. - Materials and equipment (e.g. shovel/spade, digging bar) - Tree seeds/saplings. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor inputs and costs to repair damage caused by wind and cyclone.
Vegetation and Soil Management for Well-Functioning Ecosystems		

Technique	Description	Technical Feasibility
Forest Management		
Natural Forest Protection	**Prevention** of **degradation** and destruction of **natural forests** through their **ecologically and economically** efficient management to satisfy energy and other **human needs**. - **Techniques** include: plantation management/ woodlot management; efficient use of fuelwood (improved charcoal production, use of fuel efficient cooking stove); and solar power generation/wind power generation.	EbAM provides: - Sensitization. Training for natural forest protection and plantation management/woodlot management, improved charcoal production. - Capacity building on planning for other techniques. - Equipment and materials: [Plantation Management/Woodlot Management] Hoe, shovel/spade, digging bar; - Tree seeds/saplings. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material inputs for daily care of crops and animals. - Reduced external input requirement (e.g., water, nutrient supplements, chemical products against pests/diseases for proper growth). - Reduced labor and material inputs for caring against diseases and extreme weather. - Higher labor input for formulation and implementation (including monitoring and maintenance) of management rules.
Use of Native Forest Plants and Animals in Forest Regeneration	Use of **native** forest plants and animals to benefit from their **suitability** to the local environment and **adaptability** to its changes. - Forests with native trees provide habitats to other native **flora** as well as **fauna**, with which they form **interdependent** (symbiotic or competitive) relationships.	EbAM provides: - Sensitization and training. For animals, sensitization and capacity building on planning. - Native seeds/saplings. - Native plant nurseries. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material inputs for daily care of crops and animals. - Reduced external input requirement (e.g., water, nutrient supplements, chemical products against pests/diseases for proper growth).

Technique	Description	Technical Feasibility
		- Reduced labor and material inputs for caring against diseases and extreme weather.
Assisted Natural Regeneration/ Farmer Managed Natural Regeneration	A blend of **active planting** and **passive restoration**, in which recovery of **native vegetation** is promoted by eliminating barriers and threats to their growth and by making use of **local knowledge** on ecosystems and **traditions**. - **Farmer-Managed** Natural Regeneration is based on **existing community resources** and **community engagement**. - **Techniques** include: firebreak; prescribed burning/controlled burning; fencing of saplings; removal of invasive plants; pruning and thinning; applied nucleation; potted seedling/Miyawaki method; and boomerang berm.	EbAM provides: - Sensitization and training. - Hoe, shovel/spade, digging bar, seeds/saplings. - [Firebreak] Slasher, rake, fire resistant and non-invasive plants. - [Prescribed Burning/Controlled Burning] Sprayer, backpack pump, drip torch, fire rake, etc. - [Fencing of Saplings] Biodegradable fence material. - [Pruning and Thinning] Secateurs, bypass shears, bypass pole pruners, fruit saw. - [Potted Seedling/Miyawaki Method] Soil amendment material (e.g., rice husks), tree seeds/saplings. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material inputs for daily care of crops and animals. - Reduced external input requirement (e.g., water, nutrient supplements, chemical products against pests/diseases for proper growth). - Reduced labor and material inputs for caring against diseases and extreme weather. - Higher labor input for formulation and implementation (including monitoring and maintenance) of management rules. - [Firebreak/Prescribed Burning/Controlled Burning] Reduced labor and material for irrigation. - [Firebreak/Prescribed Burning/Controlled Burning] Reduced labor and material for pest and weed suppression. - [Prescribed Burning/Controlled Burning] Fire plan, including fire controlling measures. - [Applied Nucleation] Reduced labor inputs and costs for regeneration. - [Boomerang Berm] Reduced labor inputs and costs for regeneration and soil erosion control.

Technique	Description	Technical Feasibility
Use of Wild Products and Non-Timber Forest Products for Livelihood Purposes	Integration of **wild products** and **non-timber forest products** – such as herbs, nuts, fruits, gum, fungi, honey, material for household needs – into **livelihoods.**	EbAM provides: - Sensitization and training. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material inputs for crop caring against diseases and extreme weather. - Reduced needs for external assistance due to smaller cash deficit at household levels.
Forest Farming	See Forest Farming under *Crop Land Management*.	
Vegetation and Soil Management for Well-Functioning Ecosystems *Grassland/Rangeland Management*		
Use of Native Plants and Animals	Cultivation of **native** plants and animals to benefit from their **suitability** to the local environment and **adaptability** to its changes. - Aids in **restoring local ecosystems**.	EbAM provides: - Sensitization and training. For animals, sensitization and capacity building on planning. - Native seeds/saplings. - Native plant nurseries. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Animals to be introduced, if planned. - Reduced labor and material inputs for daily care of crops and animals. - Reduced external input requirement (e.g., water, nutrient supplements, chemical products against pests/diseases for proper growth). - Reduced labor and material inputs for caring against diseases and extreme weather.
Use of Wild Products for Livelihood Purposes	Same as Use of Wild Products and Non-Timber Forest Products for Livelihood Purposes under Forest Management.	

Technique	Description	Technical Feasibility
Cover Crop in Rangelands	A type of **mulching** with a **living plant** to enhance biological enrichment of soil. - It is also a type of **intercropping**, not for harvesting a secondary crop, but for covering soil surface to retain soil moisture and for improving soil nutrient cycling. - **Variation** includes: green manure.	EbAM provides: - Sensitization and training. - Hoe and seeds. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor and material input for pest and weed suppression. - Reduced labor and material for compost/fertilizer. - Higher labor input per area because of higher diversity of crops. - [Cover Crop] Additional land for cultivation.
Minimum Tillage/ Conservation Tillage in Rangelands	**Minimum disturbance** of **soil** to improve biochemical and physical properties of soil, including no burning or little removal of crop residue. - Conservation tillage may designate any method of soil cultivation that leaves crop residue before and after planting the next crop. - **Variation** includes: no (or zero) tillage, direct seedling.	See Minimum Tillage/ Conservation Tillage under *Crop Land Management*.
Rotational Grazing in Rangelands	A practice to contain animals in **one portion of pasture** (paddock) at a time for **grazing** and moving animals through pasture to improve soil, plant and animal health.	EbAM provides: - Sensitization and capacity building on planning. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Fences. - Higher labor input for moving animals and monitoring residual forage.

Technique	Description	Technical Feasibility
Diversification of Forage Plants in Rangelands	Cultivation of **various** forage plants that are of **sufficient botanical difference** to benefit from their different abilities in modifying biochemical and physical properties of soil and other elements of microenvironment. - Prevents creation of an environment suited to uncontrollable proliferation of pests and weeds. - Varied resilience of crops to climate change improves overall resilience of farm. - **Variations** include: mulching with living plants; and crop rotation/intercropping/companion cropping (excepting relay planting).	Same as Diversification of Crop Plants and Animals under *Crop Land Management*
Integrated Crop and Livestock Cultivation in Rangelands	Same as Integrated Crop and Livestock Cultivation under *Crop Land Management.*	
Silvo-Pastoralism	A type of agroforestry which cultivates **pasture grasses/forage crops** with **trees**. - Also a type of **intercropping.** - Occasionally equated with **agroforestry**.	Same as Agroforestry under *Crop Land Management*.
Windbreak/Hedge/ Hedgerow/Shelter Belt/Vegetative Barrier/ Wind Barrier/Living Fence	Same as Windbreak/Hedge/ Hedgerow/Shelter Belt/Vegetative Barrier/ Wind Barrier/Living Fence under *Crop Land Management*.	
Watershed Management for Well-Functioning Ecosystems *Water Regime management*		

Technique	Description	Technical Feasibility
Conservation of Riparian Buffer Zone and Floodplain	**Preservation** of **riparian buffer zone ecosystems** and **floodplain ecosystems**, important components of watersheds, to **maintain natural river flows/configuration** and **functions**. - **Activities** may be: **hydrological** (water regime regulation, including floodwater conveyance/storage, groundwater recharge, wave attenuation, stream bank erosion control); **biochemical** (water quality regulation); or **habitat** provision for **native species**. - Activities are to: either positively affect riparian buffer zone/floodplain functions; or moderate/prohibit actions that negatively affect them. - Activities to positively affect riparian buffer zone/floodplain functions may be called **rehabilitation**. - **Techniques** include: revetment and its variations (deformable bankline; and degradable toe/ deformable toe).	EbAM provides: - Sensitization and training, including geological/hydrological/ecological surveying and definition of current and future riparian buffer zones and floodplains. - Native flora/fauna/geological material of riparian buffer zones and floodplains. - Establishment of native plant nurseries. - [Revetment/Deformable Bankline/Degradable Toe/Deformable Toe] Earth moving equipment, vegetation/rocks (and in case of gabion, wire and wire cutter)/boulders, biodegradable fabric, poles. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Relocation of man-made structures of certain size in riparian buffer zones and on floodplains. - Possible relocation of farms in riparian buffer zones and on floodplains. - Possible changes in farming methods and water use in buffer zones and on floodplains. - Less labor and material for flood and drought control. - Less labor and material for water quality control. - Higher labor input for formulation and implementation (including monitoring and maintenance) of management rules.
Conservation of Wetland	**Preservation** of **wetland ecosystems**, important components of watersheds, to **maintain natural hydrological cycle** in the watershed. - **Activities** may be: **hydrological** (water regime regulation, including floodwater conveyance/storage, groundwater recharge, wave attenuation, stream bank erosion control); **biochemical** (water quality regulation); or **habitat** provision for **native species**. - Activities are to: either positively affect wetland functions; or moderate/prohibit actions that negatively affect them.	EbAM provides: - Sensitization and training, including geological/hydrological/ecological surveying and definition of wetland boundaries. - Native flora/fauna/geological material of wetland. - Establishment of native plant nurseries. - [Revetment/Deformable Bankline/Degradable Toe/Deformable Toe] Earth moving equipment, vegetation/rocks (and in case of gabion, wire and wire cutter)/boulders, biodegradable fabric, poles. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation.

Technique	Description	Technical Feasibility
	- Activities to positively affect wetland functions may be called **rehabilitation**.	- Relocation of man-made structures of certain size in wetland and its buffer zones. - Possible relocation of farms in wetland and its buffer zones. - Possible changes in farming methods and water use in wetland. - Less labor and material for flood and drought control. - Less labor and material for water quality control. - Higher labor input for formulation and implementation (including monitoring and maintenance) of management rules.
Use of Native Plants and Animals	Same as Use of Native Plants and Animals under *Grassland/Rangeland Management.*	
Contour Bunding/ Contour Riding/ Contour Trenching/ Diversion Ditch/ Contour Vegetation Strip/ Contour Hedgerow	**Reinforcement of soil** along **contour** lines by stones, grasses, ridges, trenches, etc. to intercept water flow, encourage water infiltration and discourage soil erosion by water. - **Variations** include: terracing/continuous contour trenching; contour swale/berm n' basin; and diversion swale. - Dug-out material is usually placed downstream to form a bund/ridge/berm. - The more permeable contours are, the more water/nutrient/contaminant percolation occurs across bunds/ridges/trenches.	EbAM provides: - Sensitization and training. - Contour gauge/A-frame, hoe and material for contour marking. - [Contour Bunding/Contour Ridging/Contour Trenching/Diversion Ditch/Contour Swale/Berm n' Basin/Diversion Swale] Pegs, hammer, spade, wheelbarrow. - [Contour Swale/Berm n' Basin/Diversion Swale] Perennial vegetation. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Higher labor input for construction of runoff outlets, e.g., grassed waterways, in the first year. - Higher labor input for contour marking in the first year. - [Contour Vegetation Strip/Contour Hedgerow Terracing/Continuous Contour Trenching] Higher labor input for maintenance (removing debris from outlets, smoothing silt bars in channels, rebuilding terrace ridges, etc.).
Brush Fill/Brush Plug	A **continuous filling** of small **gullies** with **brush**, **branches** of trees, **stems** of bushy vegetation, etc.	EbAM provides: - Sensitization and training. - Shovel/spade, digging bar, vegetation. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor inputs and costs for irrigation and flood control.

Technique	Description	Technical Feasibility
Gully Plug/Check Dam/Check Wall	A **small barrier or dam** constructed across a **contour or diversion swale**, or other area of **concentrated water flow**, for reducing water velocity and soil erosion. - Check walls tend to be smaller and of simpler structure than check dams; the latter can be large enough to contain a water reservoir. - **Variations** include: gabion check dam/gabion retaining wall.	EbAM provides: - Sensitization and training, including geological/hydrological/ecological surveying. - Earth moving equipment, rocks/boulders/posts/brushwood/wire/logs. - [Gabion Check Dam/ Gabion Retaining Wall] Contour gauge/A frame, soil compacting equipment (spades, wheelbarrow, plow, etc.), wire, wire cutter, rocks. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor inputs and costs for irrigation and flood control. - Higher labor input for construction of outlets/spillways for runoff in the first year.
Water Harvesting	Collection of **rainwater**, **road runoff** and other water **overflowing from storage unit** for use. - Recipient may be groundwater aquifer or man-made wetland.	EbAM provides: - Sensitization and training. - Simple water collection/distribution (and treatment in case of road runoff) systems. Beneficiaries provide: - Time and interest for sensitization and training. - Local/traditional knowledge and labor for technique implementation. - Reduced labor for-water collection. - Higher labor input for system installation in the first year. - Higher labor input for formulation and implementation (including monitoring and maintenance) of management rules.

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