Land Use Approaches

For Promoting Biodiversity and Conserving Ecosystem Services in Agrarian Landscapes in Tajikistan

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1. Introduction

The global project "Biodiversity and ecosystem services in agrarian landscapes" was commissioned by the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in Tajikistan, India, and Kenya, where GIZ works in close cooperation with political partners.

The objective of the project is to strengthen the capacities of land users and their organisations, technical experts and decision-makers in civil society and public institutions. These stakeholders operate at local, regional and national level in the environmental, agricultural, forestry and water sectors. Improving knowledge and deploying this new knowledge in the development of strategies for planning and practical work is key to promoting biodiversity and ecosystem services in agrarian landscapes.

Land-use approaches that promote biodiversity in agriculture have been evaluated in the countries the project is implemented in, and the most promising ones have been tested in pilots at local level. In 2017, methods and approaches that have already been applied in Tajikistan in different projects and programmes as well as by various agencies were analysed to assess their direct or indirect impacts on biodiversity and ecosystem services based on ecological, social, and economic criteria. Techniques and methodologies of sustainable agriculture were identified, and six land-use approaches which conserve biodiversity in agricultural activities were formulated ahead of a pilot phase in the Zerafshan and Rasht valleys.

A pilot scheme promoting best practices and innovations for augmenting biodiversity in Tajikistan is being implemented by the German NGO Deutsche Welthungerhilfe e.V. (WHH) in cooperation with two local implementing partners in Rasht and Ayni districts. The varying climatic conditions as well as the socio-cultural characteristics of the inhabitants in these two districts may result in differences in terms of approach. The overall sustainability of any given approach is dependent on soil, exposition and water availability.

By testing approaches together with farmers or farmers' organizations, the project contributes to validating, enriching and disseminating knowledge. Finally, this knowledge will allow technical advisers and policy decision-makers to mainstream biodiversity and ecosystem services into agricultural and forestry practice. Subsequently, this knowledge can be used for the development of strategies and planning instruments. These experiences build the basis for adapting the institutional framework at regional and national level. Challenges and results in maintaining or improving biodiversity and ecosystem services in agrarian landscapes will be shared with key stakeholders in a regional dialogue, while findings and recommendations will be disseminated at international level.

This document was elaborated by the WHH IKI Biodiversity project team in Tajikistan with support from GIZ IKI Biodiversity project team in Tajikistan. The draft of the document was presented at the second meeting of the National Steering Committee in order to obtain members' comments and suggestions. Furthermore, the local implementing partners of WHH were asked to contribute to the description of approaches based on their experiences of work at field level.

The document is intended to serve as a guideline for the promotion of biodiversity and ecosystem services in agrarian landscapes by both public and private institutions and farmer families and their organizations.

2. Framework Conditions/Challenges for Promoting Sustainability in Agrarian Landscapes in Tajikistan

A number of key considerations define the promotion of biodiversity in Tajikistan's agrarian landscapes. These include the socio-economic situation, environmental changes deriving from climate change and the resulting problems of water scarcity and overgrazing.

Socio-economic Situation

Tajikistan is a low-middle income country in Central Asia. Following a devastating civil war in early independence, the post-Soviet country is especially vulnerable to economic crises, external shocks and political conflict. The estimated population of Tajikistan has grown from 7.6 million in 2010 to 9 million in 2018 of whom 50% are women. About three quarters of the population live in rural areas and depend on agriculture for income, although yields are barely sufficient for survival. Consequently, more than half of the population lives under the poverty line of 2.15 USD per day.

Migration, Remittances and Gender

Tajikistan currently ranks among the economies most dependent on remittances from labour migrants in the world. During summer, due to a lack of employment opportunities, many citizens, especially young men of working age migrate to Russia in search of work. An unofficial estimate suggests that up to 1/3 of the population of Tajikistan is directly involved in labour migration. The remittances sent by the migrants are a crucial source of income for many families in the country and equate to over 50% of Tajikistan's GDP (4.2 billion USD in 2013). As a consequence, in this period, women, elderly people, disabled, sick people, and children have to cope in the absence of male family members. Women assume roles traditionally associated with men, leading to changing labour responsibilities, life priorities, decision-making powers, and knowledge bases.

Adopting a gender-sensitive approach is vital in biodiversity promotion. The term gender denotes a socially-constructed understanding in which appearances, performances and behaviours are associated with being those of a woman or a man. Social roles attributed to men and women and the power relations between them considerably affect the use and management of natural resources and thereby the preservation of biodiversity. Because of differences in roles and responsibilities expected from women and men, they develop different knowledge about different species and how to manage and use them. Globally, gender roles tend to favour men over women regarding economic opportunities and access to and control over land and natural resources and decision-making power. According to gender roles, women and men are affected in different ways by biodiversity loss, climate change and natural disasters, and also develop different coping strategies.

In order to sustainably foster biodiversity and ecosystem services in Tajikistan, these approaches integrate the traditional knowledge and customary practices of women and men by means of their documentation and dissemination of best practices in the Farmer Field Schools.

Climate Change, Food and Nutrition Security

Climate change is particularly tangible in Tajikistan's fragile mountainous ecosystem. In a country prone to natural disasters, it is estimated that environmental degradation costs the equivalent of up to 10% of the GDP. The changing climate leads to faster soil erosion and deteriorating water quality from melting glaciers and a rapid loss of biodiversity. Resulting natural disasters such as floods, droughts, avalanches, and landslides threaten land, crops, infrastructures, and livelihoods.

As a result, food and nutrition security is constantly at stake. Despite improvements achieved during the last decades, the population of Tajikistan continues to struggle with the highest rates of malnutrition in Europe and Central Asia. A third of Tajikistan's population is considered modestly (28%) or severely (5%) food insecure with

malnutrition rates estimated to be even higher. Undernutrition is most severe and persistent among vulnerable and particularly food-insecure population groups such as women, children, elderly, sick, disabled and poor.

Due to its geography and related infrastructural problems, the food and nutrition security of the country is worst in rural and remote regions. Food security is subject to seasonal changes, and it is after the winter months from April to August that malnutrition rates are highest according to the assessment of WFP Food Security Monitoring Service (FSMS2017,18).

Water Scarcity and Irrigation

In Tajikistan, water is a scarce resource and the use of water for irrigation can result in a reduction of water availability for the broader landscape. Water use for irrigation may also compete with drinking water needs.

Harvesting of run–off water from roof tops as well as water-saving irrigation techniques could reduce the negative effects of taking the water from natural biotopes. These techniques are only relevant early on, however. Another alternative is installing drip irrigation systems. However, such systems are not affordable for most smallholder families. There is a potential for promoting much cheaper techniques that have not been fully explored, like improving irrigation by gravity.

Overgrazing and Fencing

Livestock plays a determining role for Tajikistan's landscapes. Rearing is both central to the country's agricultural sector and an important boost to the poverty-stricken rural population's hopes of survival. Overgrazing, especially in the immediate vicinity of villages, places significant pressure on the estimated 3.5 million hectares of communal pasture lands and leads to serious land degradation. Community-based controlled grazing mechanisms are not yet widespread, which means adjacent agricultural and forest areas often suffer from uncontrolled grazing. Fencing is thus essential to protect the growth of crops and trees, especially for areas adjacent to pastures and livestock corridors, and is therefore listed as a mandatory element in all approaches except for diversified kitchen gardens and forest management. Currently, fencing from (mesh) wire is widely practised in Tajikistan where it has proven to be effective. However, the material needed for that is expensive and difficult to afford for many farmers. Therefore, other techniques for fencing should also be sought such as building stone walls, which is only possible if the required material is available nearby, or planting living fences from thorn bushes. The latter can be combined with mesh wire fencing. The bushes should be planted when the fence is installed and after some years when the bushes become dense, the mesh wire can be removed and used again for fencing of other plots. Another possibility for establishing orchards or reforesting areas without erecting a fence is planting tree seedlings within thorn bush thickets where they are protected from animals. Nevertheless, this technique requires the existence of these thorn bush thickets.

Costs for fencing could also be reduced if neighbours fence their land together, which implies a significant reduction in required materials.

It is highly recommended that issues of community-based monitoring of pasture land, grazing patterns, and livestock numbers be addressed by the Farmer Field schools in order to reduce the pressure on land where fencing is either not applicable or not affordable.

Reverse Biodiversity Loss

In Tajikistan, as in other countries, the present use of resources is not sustainable, characterised as it is by uncontrolled logging for firewood and construction timber, overgrazing of pastureland and woodland, soil erosion and monocultures. These excesses prevent the rejuvenation and regeneration of natural vegetation, reduce the growth of wild plants and animals, and degrade agricultural land. At the same time, agricultural production is becoming increasingly intensive, with high input of fertilisers and pesticides. This development of the agricultural sector has negative impacts on ecosystems and biodiversity. Assisting farmers to implement the approaches described for promoting sustainable agriculture is an initial step to improve the situation. It is

important to note that smallholder farmers in Tajikistan mainly depend on the production of their land and – unlike the farmers within EU territory- are not entitled to subsidies in exchange for promoting biodiversity. Therefore, implementation of the following approaches should imply an increase in or at least maintenance of the same level of productivity currently attractive to the farmers.

3. How to use this guide

In the context of the project on biodiversity and ecosystem services in agrarian landscapes, six different land use approaches have been selected, which are suitable to promote conservation and strengthening biodiversity and ecosystem services, namely:

- Sustainably managed irrigated annual crops
- Adapted rain-fed annual crops
- Resilient orchards
- Integrative forest management
- Improved fodder production
- Diversified kitchen gardens

Each approach embraces a set of different land use techniques which should be applied to meet the set goals.

Below, brief descriptions of each approach are provided, emphasizing their importance, their challenges and their relevance for biodiversity and ecosystem services. In addition, for each approach obligatory and optional techniques are listed which shall or could be implemented. There are techniques that are obligatory for putting the approach into practice. If farmers establish plots where they apply the respective approach, they must implement the obligatory techniques to meet the minimum criteria for conserving/enhancing biodiversity and ecosystem services.

There are many techniques which are suitable or desirable to be applied in the context of the respective approach. These techniques are optional and thus could be selected and applied by interested farmers. The decision on what exactly to establish is taken by the farmer, supported by her/his external advisor (local NGOs working on behalf of WHH).

At the end of this guide, a detailed description of all suggested techniques is provided, as well as a set of methodologies supporting the implementation of piloting activities.

4. Sustainably managed irrigated annual crops

4.1. General remarks on sustainably managed irrigated annual crops

About 95 percent of the staple crop production in Tajikistan comes from irrigated land which underlines the importance of irrigation in cultivating annual agricultural crops. Irrigated annual crops are usually intensive cultures that make for efficient use of land resources. A variety of annual crops is important for generating income, ensuring food security, and balancing diets.

The productivity of irrigated annual crops depends largely on the provision of ecosystem services, e.g. pollination, water and soil fertility. Nonetheless, irrigated annual crop production systems are normally intensive cultures and constitute artificial ecosystems that cannot make critical contributions to the maintenance and improvement of biodiversity and ecosystems services. To the contrary, they mostly have a negative impact on biodiversity and ecosystem services, as they focus on applying huge amounts of chemical inputs (fertilizers, pesticides) and in many cases use water ineffectively. Nevertheless, annual crops are considered within the approaches, as they are economically very important and offer possibilities for implementing some measures for conserving and promoting biodiversity and ecosystem services.

Hence, the focus of the approach described herein is on how irrigated annual crop systems can be managed in a way that avoids negative impacts like those often induced by highly intensive agriculture that employs hybrid seeds, chemical fertilizer and synthetic pesticides as inputs. By refraining from or at least reducing such inputs, it is expectable that such a production system will become more resilient to shocks caused by climate change.

Figure 1: Wheat and potatoes planted under Sustainably managed irrigated annual crops approach in Zindakon watershed, Ayni district

Challenges

Promoting irrigated annual crops in the context of biodiversity and ecosystem services enhancement poses the following challenges:

- Traditional soil preparation for annual crops which is based on ploughing the land is resource-intense (labour, fuel);
- Annual crops require specialized infrastructure, especially for irrigation, and a lot of inputs (seeds, fertilizer, pesticides);
- Crop rotation, which would improve biodiversity and ecosystem services, is not commonly practiced. The tendency to plant the same cash crop every year is high, since doing so maximizes revenues;
- Irrigation systems require proper management, and can, if inappropriately managed, lead to reduced soil fertility, erosion and salinized soils;
- Decreasing precipitation and increasing temperatures associated with climate change are increasingly threatening the harvest of annual crops.

Relevance for promotion and conservation of biodiversity and ecosystem services

The promotion and conservation of biodiversity and ecosystem services in irrigated annual cropland is highly relevant for the following reasons:

- Traditional and local varieties of annual crops, which are usually better adapted to local climate conditions, are conserved;
- Associated crops allow for the harvesting of a variety of products during different seasons of the year and thereby contribute to food security;
- Associated or mixed crops blossom over a longer part of the year and thus offer more fodder to pollinators and other beneficial insects, especially if no synthetic pesticides are applied;
- Water is used in an efficient way by applying water-saving irrigation techniques. Taking less water from rivers and groundwater sources reduces negative effects on other ecosystems as well;
- Soil degradation and erosion are diminished or reversed through erosion control measures;
- Soil fertility is improved by a low tillage technique, as well as by crop rotation;
- Biological diversity of plants and insects is significantly improved by applying Integrated Pest Management measures;
- Natural stone walls and natural/living fences used for controlling erosion and harvesting water offer habitat and hiding places for insects and reptiles.

4.2. Management techniques

The following management techniques should be applied in order to establish and farm irrigated annual crops while also conserving biodiversity and enhancing ecosystem services:

Mandatory Elements	**Optional Elements**
Fencing	Natural stone walls
Gully control and check dams	Terracing
Contour ploughing	Shelterbelts
Water saving irrigation techniques (drip irrigation, sprinkler irrigation, improved furrow irrigation)	Soil analysis
Use of local species and varieties	Low tillage technique (direct seed)
Integrated Pest Management	Intercropping and mixed cropping
Crop rotation	Mulching
Establishment of seed banks (local and other varieties)	Use of green manure
	Harvest and post-harvest management
	Beekeeping

5. Adapted rain-fed annual crops

5.1. General remarks on rain-fed annual crops

Although about 95 percent of the staple crop production in Tajikistan is cultivated on irrigated fields, rain-fed agricultural crops are especially important for smallholder agriculture. Rain-fed crops correspond to the climate conditions in the project districts since they occupy extended areas that cannot be irrigated because of the topography of the land and/or the cost of establishing irrigation infrastructure. The traditional cultivation of rain-fed annual crops which requires ploughing of the fields is relatively costly, whereas productivity is low, mainly because yields depend on water availability. Nevertheless, smallholder farmers do plant crops on rain-fed lands for their own consumption, thereby contributing to their families' food security. The fields are generally located far away from villages and are therefore only frequented by farmers a few times every week or month.

Selecting an appropriate location is especially important in the case of cultivating rain-fed annual crops due to climatic conditions. In Tajikistan, summer months are hot and dry. The last rainfalls in spring usually occur between mid-May and early June. These precipitation conditions limit the cultivation season of rain-fed fields significantly. Therefore, land for rain-fed annual crops should be carefully selected taking into account soil, water reserves and exposition (e.g. southwards exposed slopes are dryer than northwards ones). In addition, winter and spring precipitation have a high variability from year to year which stresses the importance of cultivating native species adapted to the local climate.

Cultivating a diverse mix of species is highly recommended in order to ensure soil fertility on rain-fed land. This will contribute to a good soil structure with high humus content which is important for the productivity and water-holding capacity of the soil that in turn will lead to a stable harvest and food and nutrition security.

Applying no-tillage technique is another important measure for fostering soil conservation. However, increased growth of weeds is a negative side-affect that accompanies the introduction of no-tillage, at least during the first few years.

Starting from a gradient of 5% soil erosion should be controlled, e.g. by contour line ploughing and/or planting grass strips or bush or hedgerows alongside the contour lines.

Steeper slopes need to be stabilized by terraces to prevent erosion and to improve water infiltration. Slope areas with a gradient of 20% and upwards should not be slated for rain-fed fields.

Challenges

Promoting rain-fed annual crops in the context of biodiversity and ecosystem services enhancement poses the following challenges:

- Soil preparation for rain-fed annual crops is labour-intensive (e.g. terracing, maintenance of terraces, ploughing etc.) and requires significant inputs (fuel, seeds, fertilizer, pesticides etc.);
- Limited to non-water demanding, drought-tolerant crops;
- The growing season is short and limited to spring and fall due to very low precipitation in summer;
- High variability in winter and spring precipitation increases the risk of harvest failure;
- Relatively high risk of soil erosion, as the soil is ploughed or not covered by vegetation for most of the year. In Tajikistan, it is not possible to sow cover crops after harvesting the main crop (July, August) as during this time of the year no water is available. It is highly recommended to leave residues from harvesting (e.g. straw) on the fields to protect the soil, as practiced in other countries, instead of using it as fodder for animals;
- As the fields are often located far from the village, the cultivation of the fields is labour-intensive;
- If the fields are adjacent to pasture areas, fencing the crop field may be necessary.

Figure 2: Rainfed annual crop plot with diversified crops and trees in Jafr watershed, Rasht district

Relevance for the promotion and conservation of biodiversity and ecosystem services

The promotion and conservation of biodiversity and ecosystem services in rain-fed annual cropland is highly relevant for the following reasons:

- Traditional, local varieties of annual crops, which are better adapted to local climate conditions, are conserved and promoted;
- Associated crops allow for the harvesting of a variety of products during different seasons of the year and thereby contribute to food security;
- Associated or mixed crops blossom over a longer part of the year and thus offer more fodder for pollinators and other beneficial insects, especially if no synthetic pesticides are applied;
- Soil fertility is improved by contour ploughing or better still by applying low or no tillage techniques, cultivating diversified crop varieties as well as through crop rotation;
- The biological diversity of plants and insects is significantly improved by applying measures of Integrated Pest Management;
- Natural stone walls and natural/living fences used for controlling erosion and harvesting water, offer habitat and hiding places to insects and reptiles;
- Land degradation is halted;
- Barren lands are cultivated and provide work and income.

5.2. Management techniques

The following management techniques should be applied in order to establish and farm irrigated annual crops while also conserving biodiversity and enhancing ecosystem services:

Mandatory Elements	Optional Elements
Fencing	Soil analysis
Gully control and check dams	Low or no-tillage technique
Soil conservation measures (contour ploughing, contour lines, terracing, grass strips, bush- or hedgerows on slope areas)	Shelterbelts (flowering trees, medical plants, fast growing trees for firewood, living fence etc.)
Water conservation measures (water harvesting through contour trenches, conservation ponds, harvesting of snowmelt during winter)	Intercropping and mixed cropping
Use of local species and varieties	Mulching
Diversified crops (oil crops specifically important for rain-fed fields)	Green manure
Phytosanitary measures	Harvest and post-harvest management
Crop rotation	Beekeeping
Farmer seed banks (local and other varieties)	

6. Resilient orchards

6.1. General remarks

Orchards are very common in landscapes of Tajikistan and both small and large-scale orchards are widely employed to cultivate fruit trees. A multitude of fruit trees as well as nut trees grow in the country. However, for efficiency reasons, many orchards are comprised of only a limited variety of species, despite the fact that a diversified orchard offers multiple benefits.

Diversified tree species reduce the risk of massive pest and disease outbreaks and ensure a healthy soil structure with an adequate balance of nutrients. Furthermore, the different flowering periods for tree species provide nectar for pollinators over a longer period and hence offer benefits for beekeepers.

Perennial plants take years to grow and bear fruits. To lower production risks, it is recommended to plant local varieties or to graft the varieties on local variety rootstocks, which are often better adapted to the climate and thus ensure long-term productivity. Plantation of shelterbelts or shade-providing trees might be necessary prior to planting other species. Depending on the tree species, associated crops or fodder plants can be grown in between the trees and either consumed, used as feed for animals, or sold at market.

The diversified production of fruits and nuts also contributes to an improved vitamin and nutrition intake through a balanced diet. The fruit and nut harvest can be sold in local markets. Processing fruits to make dried fruits, jam, juice, or compote generates additional income, especially if stored and sold during the winter months.

When setting up a resilient orchard, it is recommended to conserve natural flora and fauna. Removing existing bushes, trees, and other plants can have a counterproductive effect on biodiversity. Therefore, it is recommended to establish the orchard in such a way that disruption of the surrounding environment is kept to a minimum e.g. incorporating existing natural resources like rocks into the structure of the orchard, avoiding levelling the area with a bulldozer and using as few extra inputs as is possible. The key to designing a resilient orchard is selecting fruit tree species and developing a long-term orchard management plan (10-15 years).

Challenges

The following challenges affect the promotion of resilient orchards in the context of biodiversity and ecosystem services enhancement:

- Establishing an orchard requires specific knowledge of fruit tree species and their site requirements, pruning and grafting techniques as well as Integrated Pest Management etc;
- Economic benefits appear only in the medium and long term whilst initial investment is relatively high, especially if an irrigation system is required;
- Irrigation may risk erosion and increases to soil salinity if not managed properly;

Relevance for the promotion and conservation of biodiversity and ecosystem services

The promotion and conservation of biodiversity and ecosystem services in resilient orchards is highly relevant for the following reasons:

- Traditional, local varieties of fruit trees, which are normally better adapted to the local climate conditions, are conserved;
- Fruit trees associated with vegetables, herbs and fodder plants offer pollen and nectar to pollinators and other beneficial insects over much of the vegetation period, especially if no synthetic pesticides are applied;
- Natural stone walls and natural/living fences offer habitat and hiding places for fauna;

- If fruit trees are associated with fodder plants for production of hay, fodder supply for animals is better and grazing in early spring can be reduced.

Figure 3: A Farmer Field School session in an orchard plot, Pokhut watershed, Ayni district

6.2. Management techniques

The following techniques should be applied to establish and manage resilient orchards while conserving biodiversity and enhancing ecosystem services:

Mandatory Elements	Optional Elements
Fencing	Soil analysis
Local varieties or varieties grafted on local rootstocks	Shelterbelts
Planting fruit tree seedlings following contour lines and applying compost	Gully control and check dams
Water harvesting measures (conservation ponds, roof top water harvest, contour trenches)	Water retention through planting trees in higher areas
Water saving irrigation techniques (drip irrigation, sprinkler irrigation, improved furrow irrigation)	Drought or flood tolerant species from collections of local species
Pruning	Soil conservation measures (soil coverage, terracing, etc.)
Grafting	Mulching
Integrated Pest Management, especially phytosanitary measures and biological pest control	Pheromone traps as part of IPM
Crop association (vegetables, fodder plants, staple crops)	Harvest and post-harvest management
	Green manure (after harvesting vegetables)

7. Integrated forest management

7.1. General remarks

Forests play a key role in the lives of the rural population in Tajikistan, however their sustainability is impaired by two major factors-climate change and excessive exploitation of forest resources.

Changing climatic conditions further intensify the pressure on forests by increased frequency and intensity of disasters such as floods and landslides in spring and higher temperatures during summer. Forests are important for regulating the water system and providing protection against natural disasters. Increased forest biodiversity improves soil structure and fertility, reduces the risk of pests and diseases and increases the number (insects and insect species) of pollinators.

Figure 4: A Farmer Field School session in a forest plot, Jafr watershed, Rasht district

In Tajikistan, forests have suffered from deforestation as the trees are mainly used for firewood (due to lack of fuel), timber and handicraft. Reforestation in Tajikistan is normally possible only on marginal sites. Areas that can be irrigated are used for cultivating annual crops, and rain-fed areas are used for rain-fed crops or pasturing animals. Therefore, except for reforestation of degraded lands, it is usually not possible to reforest extensive, coherent areas. Reforestation is rather limited to planting trees and bushes alongside roads and streams, gully control and establishing windbreaks.

The integrative forest management approach builds on previous successful experiences with collaborative forest management in several regions of Tajikistan[1]. The approach sets out to diversify existing forest plots with local tree species. These are better adapted to local climatic conditions and have the potential to reduce the risk of natural disasters such as floods and landslides.

It is recommended to cultivate local fodder crops, fruit bearing bushes, herbs and medical plants between the trees to mitigate erosion and generate income. Wild fruits should not be harvested completely, and some fruit seeds should be left for natural reproduction and wildlife.

Typically, at landscape level, forests are interwoven with other land use forms, particularly with pastures. Management practices and plans for integrative forests must therefore include both land use forms. The design of the area to be reforested, including the selection of species of forest trees and bushes is vital, as is long-term planning (10-15 years ahead).

Challenges

Promoting integrative forest management in the context of biodiversity and ecosystem services enhancement poses the following challenges:

- Preventing the destruction of forest areas by grazing is especially difficult due to ever-growing livestock numbers and scarce pasture areas;
- Fencing extended areas is expensive and labour-intensive;
- Specific knowledge on tree species and reforestation is needed;
- The initial investment is relatively high, especially in the event of irrigation or fencing costs, while economic benefits arrive only later;
- Weeding is required during the first years after planting forest trees and bushes;
- In most areas of Tajikistan, watering is required for forest trees and bushes at least during the first years after planting;
- Inadequate irrigation can increase the risk of soil erosion and increases in soil salinity.

Relevance for promotion and conservation of biodiversity and ecosystem services

The promotion and conservation of biodiversity and ecosystem services in integrative forest management is highly relevant for the following reasons:

- Forest stand reduces disaster risks such as flooding, landslides, soil erosion, etc.;
- Traditional, local species, which are better adapted to the local climate conditions, are conserved and constitute diverse sources of income for the population.
- A diversified forest with different herbs and fodder plants offers fodder for pollinators, other beneficial insects and animals in general, as well as hiding places during most of the vegetation period;
- Natural stone walls and natural/living fences offer habitat for natural fauna and flora;
- If forest trees and bushes are associated with fodder plants for production of hay, fodder supply for animals is better and grazing in early spring which is especially harmful to biodiversity, can be reduced;
- Reforestation with diversified native species can help boost local tourism, especially agro-ecotourism.

[1] Joint forest management (JFM) essentially involves leasing state forest land to local people long-term. The tenants rehabilitate and use the leased forest plots according to management plans, while the local representative of the state forest agency advises the tenants on forest rehabilitation. For more detailed information please consult the JFM guidelines provided by State Forest Agency and GIZ.

7.2. Management techniques

The following techniques should be applied to conserve biodiversity and enhance ecosystem services in forests:

Mandatory Elements	Optional Elements
Protection of single tree seedlings by planting them inside of thorn thickets	Water harvesting measures (conservation pond, contour trenches etc.)
Gully control and check dams	Mulching
Soil conservation measures (soil coverage, grass stripes following contour lines, contour line fascines)	Beekeeping
Native tree/bush species adapted to local climate and soil (a mix of slow growing native trees with faster growing ones), preferably from local nurseries	
Planting forest trees and bushes following contour lines	
Proper tree management (weeding during the first years, phytosanitary pruning, replanting)	
Support existing forest nurseries with local forest species or establish new ones	

8. Improved fodder production

8.1. General remarks

There are extensive areas of rain-fed pastures in Tajikistan with a highly diverse composition of plants, in particular endemic species. Pasture areas are commonly divided into summer and winter pastures. Winter pastures are located close to the villages. Every day, livestock is brought to the winter pastures and held in small shelters by each owner separately. Summer pastures are located in remote areas, usually at higher altitudes and are therefore only accessible during the warmest months. Livestock is brought and kept there for 3 - 4 months by shepherds.

Currently, the average productivity of winter pastures is approximately 1.5 - 2.8 quintals/ha, spring-autumn-5, 5 quintals/ha, summer pastures 6-7 (maximum 12-15) quintals/ha of dry mass. An increasing number of livestock and a general scarcity of pasture areas has led to overgrazing of most pastures, especially winter pastures. Fodder is scarce and often does not last until spring, which leads to pastures being grazed too early in spring, lacking time for growth. Regulations on pastures as well as pasture rotation systems should be put in place to reduce livestock grazing that is currently significantly beyond what carrying capacity allows.

Figure 5: Effect of fencing in Improved fodder production plot in Jafr watershed, Rasht district.

This approach seeks solutions at local level for rehabilitating degraded summer pasture land, improving the nutritional status of grazing animals by conserving biodiversity and improving ecosystem services. It is based on fencing off rain-fed pasture land located close to the villages and thereby protecting it from free grazing animals. Furthermore, it is based on sowing grasses and legumes like sainfoin and alfalfa to make fodder. The land should be pastured for a limited time only in autumn when animals are on their way back from the high mountains. Fencing off pasture areas to produce fodder is more efficient than extensive grazing as fodder does not need to be bought for the winter season and livestock can be brought to winter pastures later in spring once grass regeneration has begun. Local grass and herbaceous species tolerant of the dry climatic conditions should be identified and sown on the pastures. Appropriate species include *Melilotus officinalis* (L.) Pall., *Vicia tenuifolia* Roth., *Prangos pabularia* Lindl. and *Poa pratensis* L. Diversifying fodder plants also creates habitats, attracts pollinators and other beneficial insects while protecting soil against erosion. Most of the fodder species flower after the

blossoming of fruit trees, thereby extending the period when nectar is available for pollinators. Importantly, fodder can be sold at relatively high prices in winter, offering farmers an incentive to produce more fodder than the amount that is needed to feed livestock.

Challenges

Promoting improved fodder production in the context of biodiversity and ecosystem services enhancement poses the following challenges:

- Outdated maps on pastoral corridors;
- Fencing extended areas is expensive and labour-intensive;
- Labour-intense weed control measures on the fenced plots are needed to ensure strong and good quality fodder production;
- Lack of fodder storage space and inadequate hay storage management can cause hay losses;
- Saving seeds of local fodder varieties and herbaceous species for reproduction is not commonly practiced, which leads to non-availability of these seeds.

Relevance for promotion and conservation of biodiversity and ecosystem services

The promotion and conservation of biodiversity and ecosystem services in improved fodder production is highly relevant for the following reasons:

- Traditional, local varieties of plants are conserved;
- Small habitats in pastureland are protected;
- Fodder plants offer nectar for bees, other pollinators and beneficial insects in general and provide nesting places for most of the vegetation period;
- Natural stone walls and natural/living fences or hedgerows offer habitat and hiding places for natural fauna;
- Control or reduction of soil erosion by mitigating overgrazing in pastures;
- The availability of fodder reduces the need for grazing in early spring, allowing time for natural regeneration;
- Enhanced productivity of the fodder plots and the expansion of beekeeping also generates higher income.

8.2. Management techniques

The following management techniques should be applied in order to increase fodder production while conserving biodiversity and enhancing ecosystem services on pastures:

Mandatory Elements	**Optional Elements**
Fencing (mesh wire, living fences) for small fodder production or demo plots	Beekeeping
Gully control and check dams	Water harvesting measures (conservation pond, contour trenches etc.)
Soil conservation measures (e.g. installing tree lines or hedge rows)	
Diversification and reseeding of pasture crops for fodder production with an emphasis on local species	
Manage livestock access to fodder plots efficiently	
Fodder storage management	

9. Diversified kitchen gardens

9.1. General remarks

Kitchen gardens are very important for improving the nutrition of Tajik families in rural areas as they contribute to food security by providing a diversity of vegetables, herbs and berries. Thus, they are a very important nutrition source for subsistence farmers.

Managing a kitchen garden allows women to diversify the family diet and take on important roles both inside the family and in the neighborhood. Kitchen gardens enable women to make a significant contribution towards increasing biodiversity.

Vegetables, herbs and spices, berries, and fruits are cultivated in small-scale kitchen gardens, often directly adjacent to houses. Products from kitchen gardens can be sold fresh or processed, generating additional income. Harvest and post-harvest management skills, including drying and storage, are specific skills passed through generations.

Figure 6: Diversified kitchen garden harvest in Jafr watershed, Rasht district

The diversified kitchen gardens approach aims to improve the management system of kitchen gardens by diversifying cultivated crops, enhancing irrigation systems and improving techniques for better soil fertility management. Simple techniques, such as crop rotation or composting can have beneficial impacts on the soil structure and nutrient cycles within the soil. Furthermore, diversified kitchen gardens attract pollinators and provide suitable habitats for bees.

Challenges

Promoting diversified kitchen gardens in the context of biodiversity and ecosystem services enhancement poses the following challenges:

- Management of diversified kitchen gardens demands a sound knowledge of the requirements of different crops and makes having a cropping plan and rotating crops essential, as the size of the kitchen garden is normally relatively small;

- Intensifying production in a kitchen garden also requires sound pest and disease management (e.g. preparation of homemade insecticides, biological pest control etc.), which is time consuming and adds costs to the production of crops, vegetables and fruits;
- Intensifying production in a kitchen garden entails fertilization of crops, fruits and vegetables through composting and green manure use;
- Crops are not planted according to the seasonal calendar;
- Lack of seed availability; the seeds of vegetables are not commonly reproduced and there is no tradition of exchanging local seeds at village level.

Relevance for promotion and conservation of biodiversity and ecosystem services

The promotion and conservation of biodiversity and ecosystem services in diversified kitchen gardens is highly relevant for the following reasons:

- Traditional, local varieties of crops, vegetables and herbs, which are usually better adapted to local climate conditions, are conserved;
- Soil fertility is increased by planting diversified crops, and by practicing crop rotation;
- Vegetables, herbs and flowering plants offer fodder for pollinators and other beneficial insects, as well as hiding places for most of the vegetation period;
- Integrated Pest Management measures contribute to better maintenance of beneficial insects.

9.2. Management techniques

The following management techniques should be applied to establish and farm kitchen gardens while conserving biodiversity and enhancing ecosystem services:

Mandatory Elements	Optional Elements
Water harvesting measures (roof top water harvest, conservation ponds)	Fencing (in exceptional cases when the kitchen garden is only partially fenced)
Soil conservation measures (terracing, soil coverage, planting crops alongside contour lines on slope land)	Soil analysis
Water-saving irrigation techniques (drip irrigation, sprinkler irrigation, improved furrow irrigation, wastewater from household uses)	Low or no-tillage technique
Promotion of diversified local fruit and vegetable species	Mulching
Sowing /planning crops following the seasonal calendar	Green manure
Intercropping and mixed cropping	Promotion of berries
Integrated Pest Management (preparation of homemade insecticides, biological pest control)	Greenhouses
Crop rotation	
Compost	
Harvest and post-harvest management (storage, preservation etc.)	
Collection, reproduction and redistribution of local varieties of seeds	

10. Land management techniques for fostering biodiversity and protecting ecosystem services

For each of the above-mentioned six land use approaches for enhancing biodiversity and protecting ecosystem services, several land management techniques are recommended. In the following section, these techniques are described, and their advantages and disadvantages briefly discussed.

The table below indicates the level of financial and labour resources required for each technique. This overview presents low input practices that serve to improve biodiversity, conserve ecosystem services and consequently improve soil fertility and ensure sustainable agricultural output in the long-term.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs				YES			Yes	
Labour				NO			Only at the beginning	
Skills							No	

The land management techniques recommended are as follows:

10.1. Preparatory techniques

a) *Fencing*

Due to a large number of livestock, fencing often becomes necessary for annual crops, for pasture areas with fodder production and for orchards. Especially, if the cultivated fields are located close to roads or livestock corridors, fencing is essential. There are several forms of fencing practiced in Tajikistan.

Fencing with mesh wire

Fencing with mesh wire is expensive. In many cases, costs for materials are covered entirely or in part by development projects with an in-kind contribution by farmers for setting up the fences (labour) or through a loan. Unlike natural fences, fences from mesh wire will not create additional income through fruit yields or timber.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs			X	YES			Yes	
Labour			X	NO	X		Only at the beginning	X
Skills	X						No	

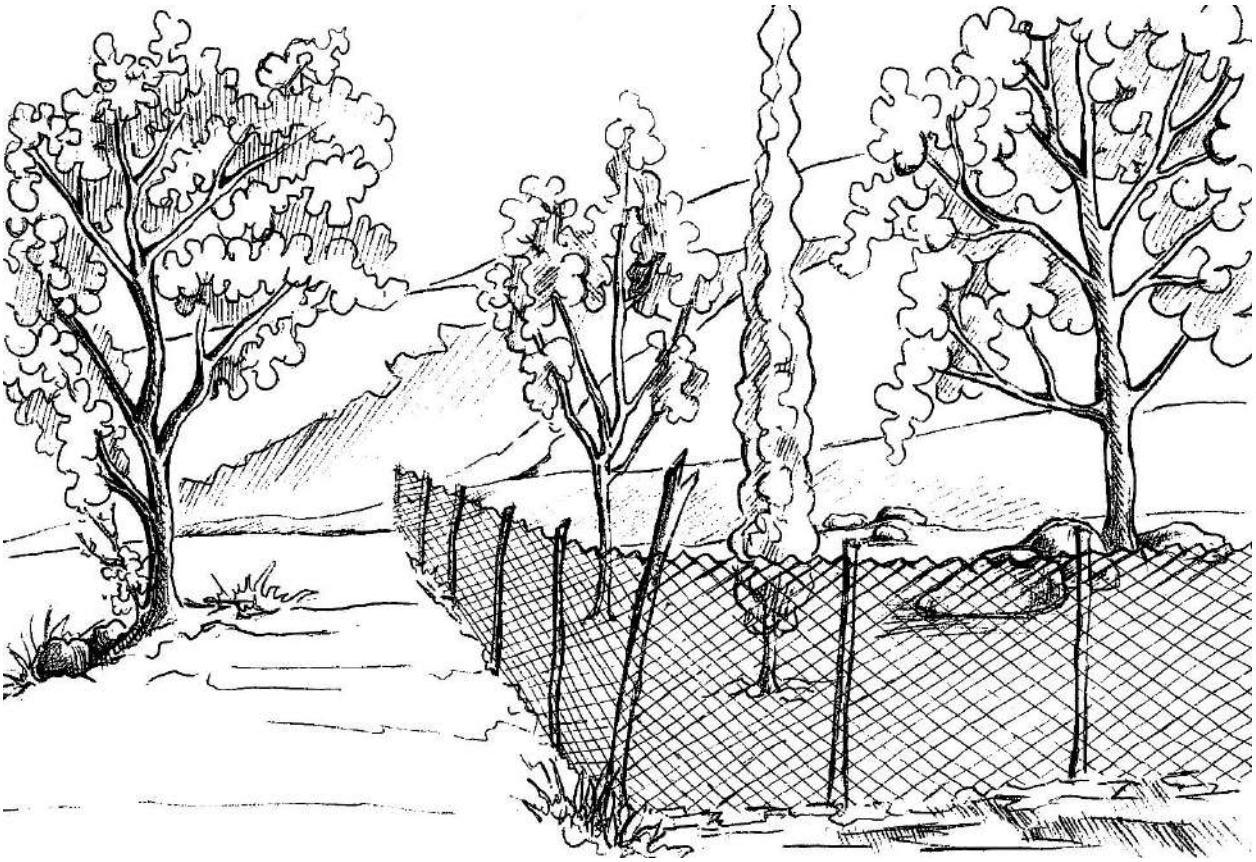


Figure 7: Mesh wire fence

Fences from natural materials

Whenever it is possible, natural, local materials (e.g. branches, brushwood, stones, wooden sticks etc.) should be used for fencing. These materials are cheaper than mesh wire or concrete, locally available, provided by nearby natural ecosystems and, therefore, easier to put to use. However, if no living material is available or the materials would have to be taken from vulnerable areas where soil cover is already scarce, it is recommended to use other fencing techniques.

Living fences made of local trees and bushes are more suitable as they contribute to increasing biodiversity and also provide firewood and create habitats for pollinators and birds. However, it should be noted that to build and maintain this kind of fence, irrigation of trees and bushes is required in most areas of Tajikistan, at least for the first years after planting.

If stones are available on site, fencing with stone walls should also be considered in order to use natural, locally available and cheap materials instead of industrially produced inputs brought from outside. Natural stone walls are not only durable, they also create habitats for pollinators, other insects and small mammalians. However, setting them up requires technical skills and their construction is time consuming and dangerous for workers that lack experience.

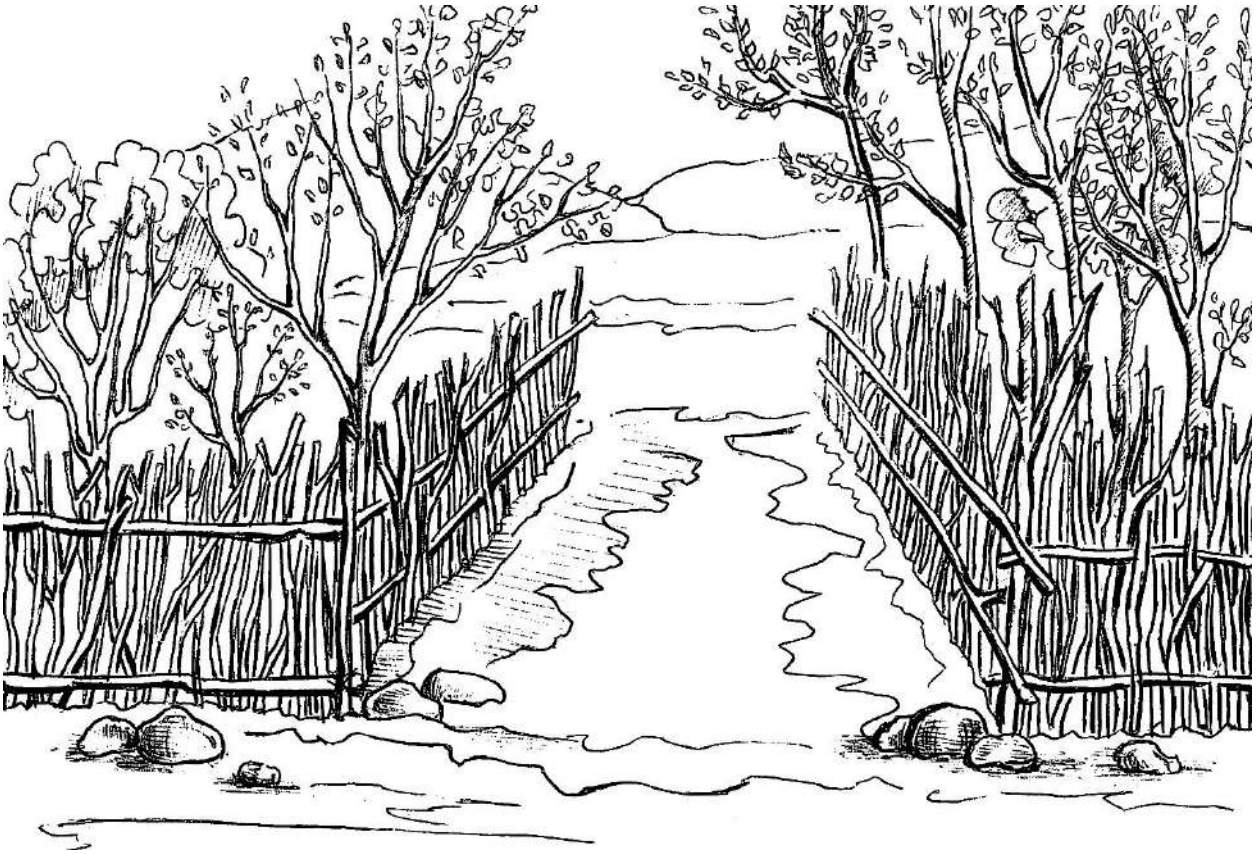


Figure 8: fence made from natural material

	Input			Requirements				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES			Yes	
Labour			X	NO	X		Only at the beginning	
Skills		X					No	X

Planting of tree seedlings within thorn thickets

The planting of fruit tree seedlings inside thorn thickets represents a special kind of fencing that protects the land from grazing animals. This technique is cheap and effective but is only appropriate for establishing extensive orchards. In many cases it is not possible to create an orchard wherein distances between tree seedlings are pre-defined.

b) *Terracing*

Slope terracing maximizes arable land areas, enables water to infiltrate the soil and reduces the risk of soil erosion. Therefore, it is recommended to establish terraces on slopes with a gradient of 20% and more. The costs of terracing depend on the quantity of soil moved. Building terraces is labour intensive. Usually, terraces are established on a slight gradient with channels right above the ridge so that run-off water can be directed to the edge of the terrace. If the soil is readily absorbing water and precipitation rates are low, flat terraces can be installed. As spring rains in Tajikistan are usually very strong, the first option is recommended to divert excess

water. The ridges should be covered with natural vegetation, preferably with long roots in order to improve and stabilize the constructed terraces. If a two-wheel hillside tractor is used, the terraces should be designed so as to have a minimum width of 1 m.

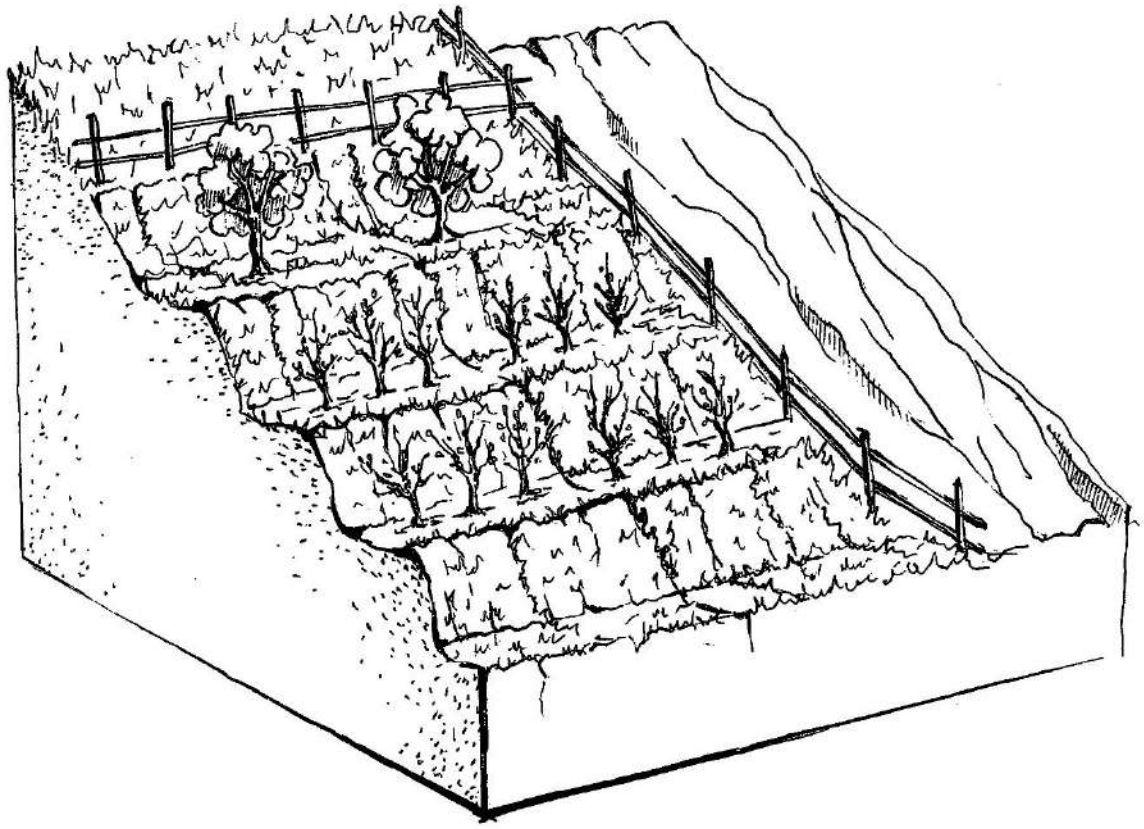


Figure 9: Terracing

If the slopes are long and steep, contour line fascines should be established by using living material such as bushes and trees. Furthermore, contour line fascines create habitats for pollinators and other beneficial insects.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES	X	Training on use of A-frame level	Yes	
Labour			X	NO			Only at the beginning	X
Skills		X					No	

c) *Shelterbelts (wind breaks)*

Strong winds not only impair the growth of annual crops and fruit trees but also cause erosion. If agricultural land is seriously affected by wind, setting up shelterbelts is recommended. Shelterbelts should consist of one or more rows of trees and shrubs planted around an agricultural field. The trees and bushes should be composed of a mixture of tall trees, such as poplars, smaller trees, which could also provide fruits, nut trees and both wide and

thorny shrubs – dog rose or sea buckthorn, for example. Shrubs serve as habitat for a multitude of insects and small mammals, whilst protecting the fields from livestock grazing.

So far, shelterbelts are not often applied, as their set-up is resource-intensive and their positive impact on crops is visible only years after they become established. Moreover, in the first years, irrigation is needed. To encourage the setting-up of shelterbelts, a combination of trees and bushes which bring economic benefits, such as fruit yields, is recommended. Flowering trees and bushes furthermore create habitats for pollinators and other beneficial insects and could also be of interest to beekeepers. If the shelterbelt is built thick enough, it also serves as an effective living fence, and can thus fulfil two functions at once.

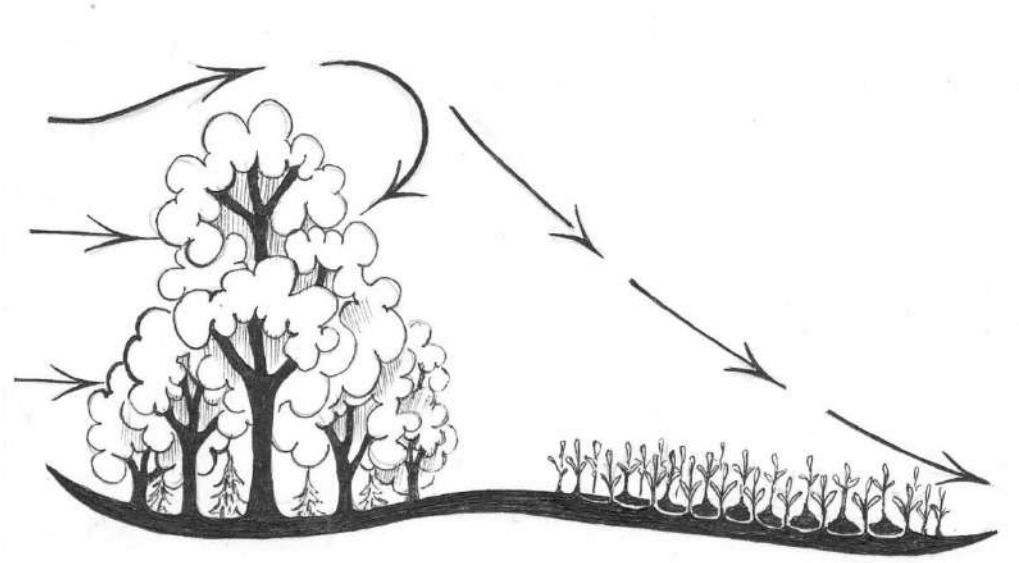


Figure 10: Shelter belt

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES			Yes	
Labour		X		NO	X		Only at the beginning	X
Skills		X					No	

d) *Gully control and check dams*

Gullies develop easily on degraded sites. Rills develop on steep areas and eventually enlarge to become gullies. Heavy rain on slopes often causes gully erosion that is compounded by light soil cover. Erosion can be reduced and prevented by constructing check dams that use living or dead material. The construction of check dams should be reinforced by planting bushes and trees alongside the gullies. As the gullies normally originate above the planned plot, this area has to be included as well. Gully plugging, and check dams also reduce the risk of mud flows and floods further downhill. This technique is relatively labour-intensive to set-up and maintain but does not require specific skills and is low in terms of costs, as long as building material is available locally. For living material, it is recommended to plant fruit trees and bushes. Investing in gully plugging and check dams is rewarding since it can generate some yield and income in the future. However, living material also attracts livestock, hence it requires protection.

Figure 11: Gully erosion

	Input			Requirements				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES			Yes	
Labour			X	NO	X		Only at the beginning	X
Skills		X					No	

e) *Contour lines fascines*

Contour line fascines are set up on dry slopes to catch debris, to stabilize soil, and to increase water infiltration into the soil. The contour lines stabilize the soil immediately after planting and develop into strong lines of vegetation. In order to establish fascines, a planting material is required, which is not always locally available. Contour line fascines also need watering, at least during the first years after installation in most areas of

	Input			Requirements				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES	X	Training on use of A-frame level	Yes	
Labour			X	NO			Only at the beginning	X
Skills		X					No	

Tajikistan.

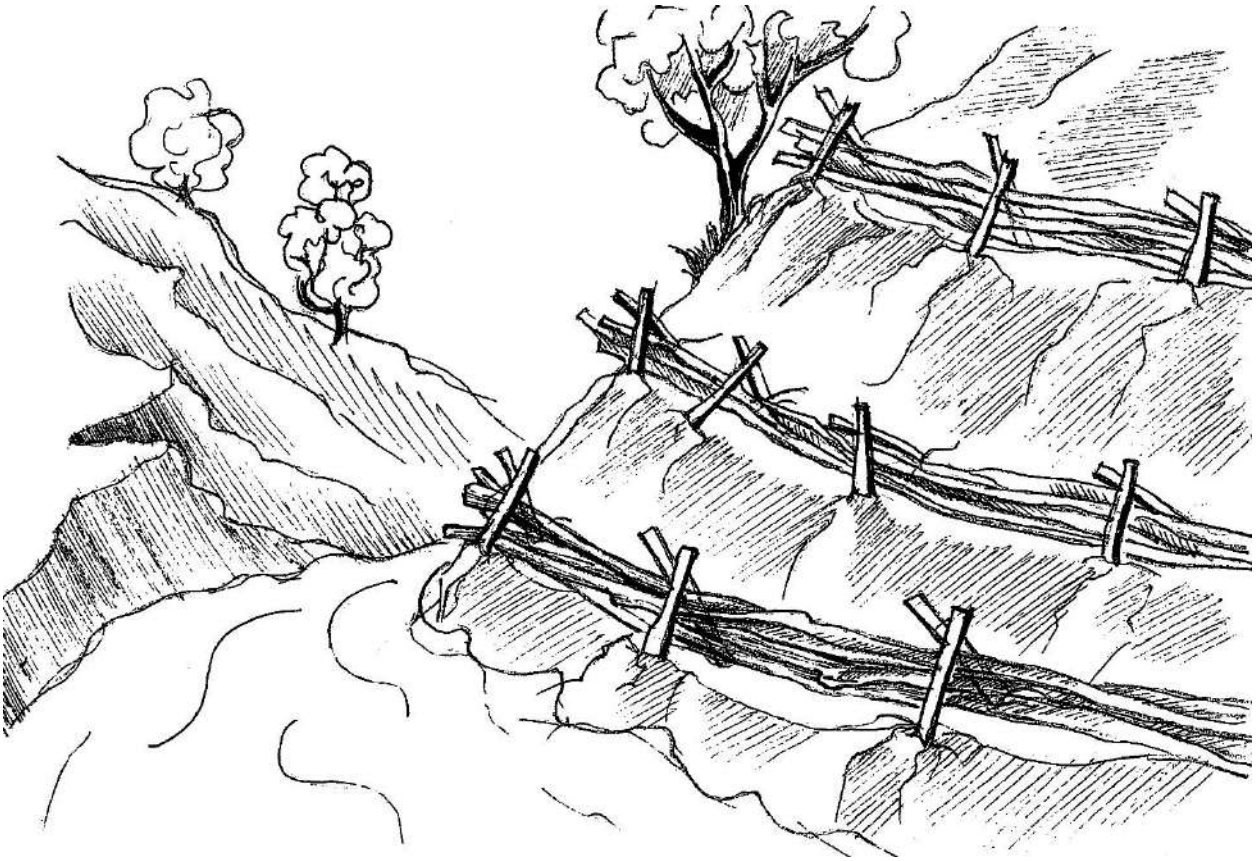


Figure 12: Contour lines fascines

f) *Greenhouses*

Greenhouses allow for the production of vegetables, herbs and other cultivated plants under controlled conditions. Specifically, they make the factors that determine the growing environment of plants – temperature, light, and humidity – controllable. This means that the short growing seasons in spring and fall can be extended. Most commonly, greenhouses are set up in kitchen gardens and built with locally available material. A simple greenhouse can be established with sticks and a translucent plastic foil. The plastic foil from simple greenhouses can be removed during summer months and the plants grown in the open air. Bigger greenhouses with non-detachable coverage can be shielded to provide shade for the plants in the hotter months. Seeds can be sown earlier in greenhouses and transplanted to the field at a later date, when open air temperatures have risen sufficiently. Water-intensive vegetables such as tomatoes, can be grown in greenhouses. In this way, greenhouses can make important contributions to food and nutrition security in mountainous areas.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES	X	Training on greenhouse management	Yes	
Labour			X	NO			Only at the beginning	X
Skills			X				No	

Due to high moisture and temperature levels, outbreaks of diseases can be fast and intense, however. Sound management and adequate phytosanitary measures are therefore very important.
Strong plastic materials should be used to construct greenhouses due to the strong winds in most valleys of Tajikistan. This plastic material should be replaced after some years. As substitution of plastic foil is costly, provisions should be made for financing new material. Waste plastic should be adequately disposed of in order to avoid polluting the environment.

Figure 13: Greenhouse in pilot area

10.2. Planting crops

a) *Mixed cropping and intercropping*

Intercropping is a planting technique that involves cultivating two or more crops on the same field. Intercropping helps increase biodiversity, which attracts a variety of beneficial pollinating insects. Furthermore, intercropping improves yields by using the available planting space and nutrients effectively.

There are three basic classifications for intercropping:

a) mixed cropping, which involves planting a variety of compatible plants together;
b) row cropping or alley cropping, in which different plants are planted alongside each other in rows;
c) temporal intercropping, in which a slow-growing crop is planted alongside a faster growing one, which is harvested earlier, allowing the slow-growing crop to subsequently occupy the entire planting area.

If one of the crops is a legume, the other benefits as well, as the legume fixes nitrogen and thus improves soil fertility. The associated or mixed crops should belong to different plant families, in order not to share the same pests and diseases and to have different requirements in terms of soil fertility and nutrients. An example of successful intercropping is alternating rows of carrots and onions. These vegetables extract nutrients from different soil layers as carrots have a tap root and onions a bunch root system. Furthermore, the carrot fly is

deterred by the smell of onions. Mixed cropping is used by planting maize and beans together. The maize crop serves as a support for beans which climb up it. Beans, in turn, fix nitrogen in the soil from which the maize derives benefits.
Potatoes can be planted with horse beans to hedge against infestations of Colorado beetles, since these pests avoid beans. A good example of a temporal cropping combination is potatoes and pumpkins. In this system, after the potatoes are harvested, the pumpkin plants remain and cover the entire field.

Intercropping and mixed cropping increase biodiversity and attract beneficial and predatory insects. Through diversified crops the flowering season is prolonged, which is favourable for beekeeping.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES	X	Training on different types of crop association	Yes	
Labour		X		NO			Only at the beginning	X
Skills		X					No	

b) *Crop rotation and diversification of crops*

Crop rotation means planting different annual crops in a particular order over several years on the same field. Crop rotation helps ensure long-term soil sustainability as the crops have different requirements in terms of nutrients. Moreover, it prevents the accumulation and propagation of soil-borne diseases and pests. In Tajikistan, cultivating the same cash crops, e.g. cereals in rain-fed areas or potatoes in irrigated lands, is generally preferred to applying crop rotation. However, oil crops (flax, sunflower, and safflower) and pulses (chickpeas, green peas, lentils) can be used to promote crop rotation and crop diversification. Simultaneously, pulses fix nitrogen and thus improve soil fertility. Most of these crops are important for pollinators.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES	X	Training on crop rotation and diversification of crops	Yes	
Labour		X		NO			Only at the beginning	X
Skills		X					No	

10.3. Formation and composition of orchards

In order to promote biodiversity, orchards should be semi-intensive and consist of a variety of different species. It is recommended that managers combine species that have long-life spans with shorter life-span species, eliminating the latter when they become non-productive after approximately 8 – 10 years. This approach allows space for slower-growing species. The distance between trees depends on the species. For instance, apricot, apple and pear need more space than peach, sour cherry and plums.

The different species cultivated need to be compatible, e.g. walnut should not be planted inside an orchard as the trees become very big and have a negative allelopathic effect on other species. Walnut trees should therefore be

planted on the margin of the orchard or alongside roads, rivers, gullies or gorges, where they can contribute to controlling erosion.

Orchards should not be too large in size[2] since workloads increase as orchards grow and enter production. Soil cultivation within orchards and on integrative forest plots should be kept to a minimum. However, establishing tree pits around seedlings which are kept free from weeds during the first years of establishment is essential to enable the proper growth of the young seedlings. If fruit trees are associated with annual crops or for re-seeding fodder plants, no-tillage or low tillage soil cultivation should be applied to avoid erosion, especially on slopes.

For re-seeding fodder plants in recently established orchards, where trees do not provide sufficient shade for the ground, barley should be sown in the autumn. In this way, barley can provide shade for other fodder crops, such as alfalfa or sainfoin, which are sown in spring. The barley can be harvested in June, while alfalfa and sainfoin continue growing and can be cut for hay in the following years.

Slopes with an inclination of more than 45° are too steep for agricultural practices due to a high risk of erosion and are thus well-suited to afforestation and reforestation. If steep slopes are afforested from scratch, setting up contour lines is recommended to protect new tree seedlings from erosion and enable maximum infiltration of water into the soil. The contour lines also prevent water run-off. If an orchard is established on slopes, fruit trees should be planted in contour lines.

Planting, formation and maintenance of fruit trees

Fruit trees should be planted during vegetative rest periods, preferably in autumn, which allows the seedlings to develop fine, secondary roots that increase their resistance to drought. Compost should be applied in the planting hole and it should be ensured that the grafted parts of the trees remain above ground level. The tree seedling should be supported by a stick and plant pruning should be introduced as a first step in the fruit tree's formation. A tree pit should be dug and kept clean from weeds, at least during the first years after planting.

Regarding the management of the orchard, a long-term management plan should be elaborated in order to determine the activities which need to be undertaken. This is especially vital to ensure sustainable orchard management.

In order to develop good quality fruit yields and to enable the combination of fruit growing with vegetable or fodder production in the long-run, optimal fruit tree formation is vital. At the beginning of their lifecycle, fruit trees are shaped by pruning, binding up and spreading branches. Later on, maintenance pruning is used to remove deadwood (typically used as firewood), control pests and diseases, and remove branches and shoots. These processes allow sunlight to penetrate the core of the tree,

Figure 14: Example of vegetable production in orchard

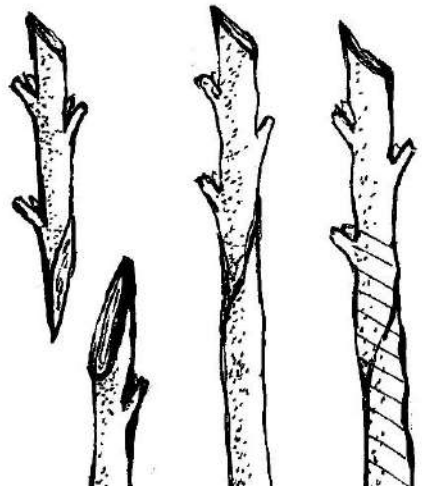
[2] The recommended size for orchards depends on the man power of a family. Following the experience of WHH, one person can manage adequately 0.5 ha of orchard. This relatively low quantity can be attributed to the low mechanization of fruit growing in Tajikistan.

offering the conditions to produce bigger fruits that taste better. When fruit trees do not bear fruits anymore, they can be rejuvenated through rehabilitation pruning.

Local varieties on medium growing rootstocks should be formed pyramidal, half standard tree with stem prolongation, with three to four skeleton branches and fruit branches. This system confers stability to the trees and ensures that all fruits receive enough sunlight.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES	X	Group training within the FFS on establishing orchards and formation of fruit trees	Yes	
Labour		X		NO			Only at the beginning	X
Skills			X				No	

Grafting of fruit trees



While the process of forming and maintaining fruit trees is well known to most orchard owners, grafting is a technique that requires certain knowledge and skills and is typically only practiced by professional fruit growers. However, proficiency in grafting is necessary in order to conserve and disseminate local varieties of fruit trees, improve pollination within orchards and graft popular varieties with less popular or inappropriate varieties of fruit trees.

Figure 15: Grafting techniques

a) *Associated crops*

Vegetables or fodder crops can be planted between rows of fruit and other trees facilitating income from year one, when fruit and other trees have not yet entered production. Vegetables can be used for subsistence or sold at market, whilst fodder crops like alfalfa and sainfoin can be planted to produce hay for feeding animals or for sale. The other advantages of the fodder plants are that they create habitats and feed pollinators and beneficial insects while protecting the soil from erosion. Most of these species flower after fruit trees have already blossomed, thereby extending the fodder supply for pollinators.

Vegetables and fodder crops are already grown with agricultural crops in Tajikistan. However, if trees are not formed adequately, they expand and gradually suppress the agricultural crops. Fruit trees should be formed with longitudinal crowns, consisting of stem prolongation and two skeleton branches aligned along the row of trees, which allows for the cultivation of vegetable and fodder plants.

	Input			Requirements				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES	X	Group training within the FFS on the topic	Yes	
Labour	X			NO			Only at the beginning	X
Skills		X					No	

10.4. Soil conservation and management of soil fertility

a) *No-tillage or low-tillage technique and contour ploughing*

Soil cultivation in Tajikistan is mostly done using a plough or a disc for breaking and turning the soil surface. However, this type of cultivation decreases fertility by augmenting the decomposition of organic matter, leads to reduced water retention capacity and soil erosion, especially on slopes, and impedes the build-up of a stable soil structure.

No-tillage or low-tillage is a technique to cultivate crops that involves little or no disturbance to the soil. This reduces and often totally negates soil erosion. By applying the no-tillage technique, the soil structure is not disturbed, as only a small slot is opened for seeding and, eventually, the application of fertilizers. The soil is cultivated only superficially with discs but not turned. The no-tillage technique requires less machinery and consequently uses less fuel.

Nevertheless, the no-tillage technique also requires specialized equipment[3] which in many cases is still not available in the country. Also, it should be noted that the no-tillage technique stimulates weed growth, at least for a couple of years, until a solid mulch layer can be built up to suppress the weeds. The use of herbicides should be avoided whenever possible. Weed control during this period should instead be implemented though hand weeding or row weeding using horses, donkeys or tractors.

	Input			Requirements				
	Low	**Medium**	**High**	**External support:**	**by**		**Financial project support required**	
Costs		X		YES	X	Training on no-tillage or low-tillage technique and contour ploughing	Yes	
Labour	X			NO			Only at the beginning	
Skills		X					No	X

[3] SAROB, a Tajik provider for agricultural extension services, is working in Tajikistan to promote the no-tillage technique and has no-tillage equipment that it rents to interested farmers and projects, e.g. those implemented by Welthungerhilfe and its local partners in different parts of Tajikistan.

Conventional tillage	Reduced tillage	No-till

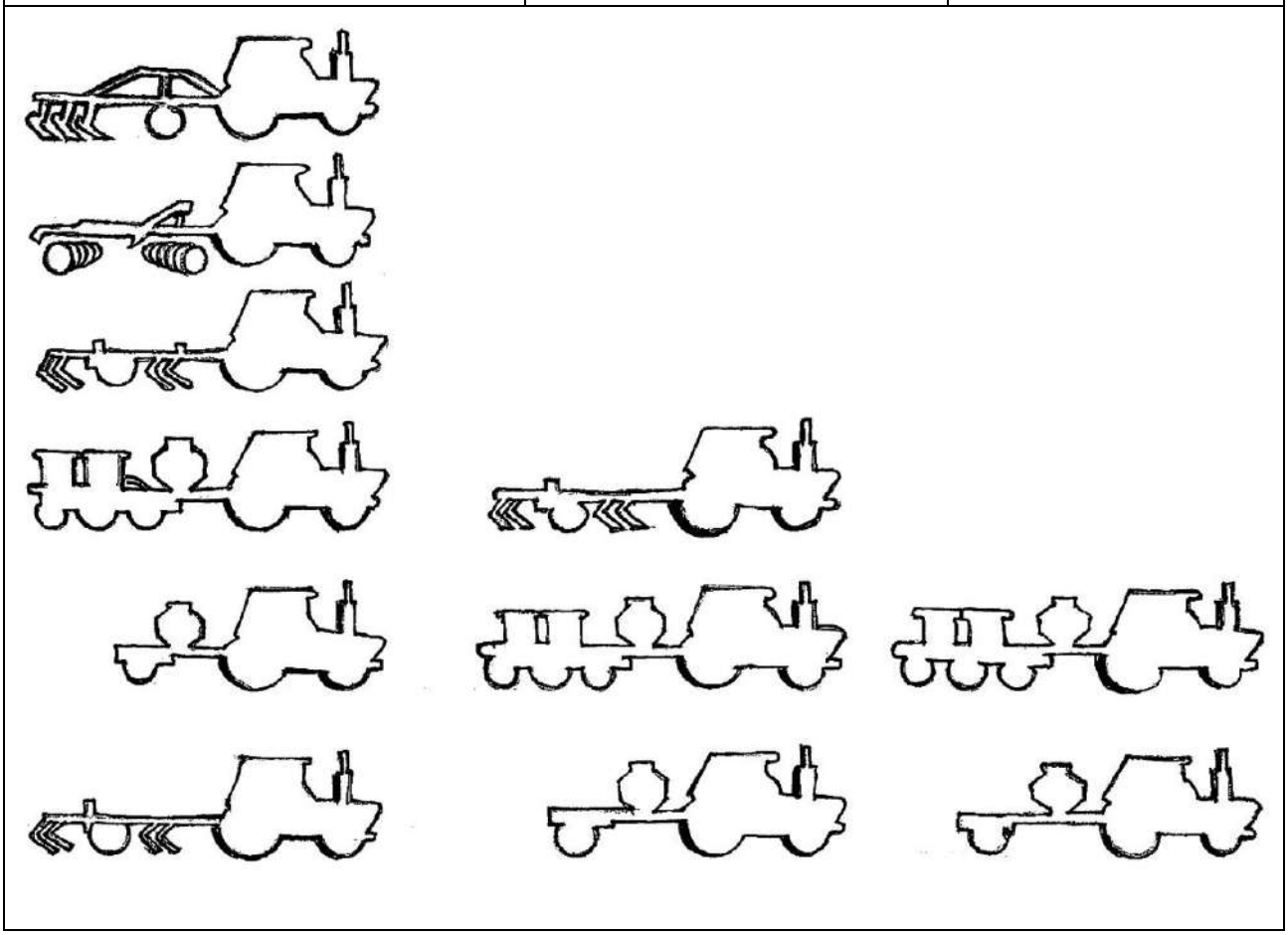


Figure 16: Tillage techniques

When no-tillage or low-tillage techniques cannot be practiced, notably on slopes of a certain gradient, contour ploughing emerges as the most optimal approach. The land is ploughed perpendicular to the slope, alongside contour lines that curve around the arable land. Contour lines reduce the formation of gullies, as water run-off is stopped, which in turn reduces soil erosion and increases water infiltration. The effect of contour lines can be augmented by planting grass strips, bushes or hedgerows alongside them.

b) *Soil analysis*

The content and composition of nutrients (major macronutrients, N, P,K and micronutrients) as well as the organic matter content of the soil can be analysed after soil samples are taken. In this way, it can be seen which nutrients are lacking, so that organic or, if necessary, chemical fertilizers, can be applied to restore the soil relatively quickly. After the restoration of the nutrients, land use practices need to be adjusted to ensure they remain in the soil (e.g. through mixed cropping or low-tillage, which protect against nutrient loss). In Tajikistan, chemical fertilizers are widely available on the local market, but only at relatively high costs. Moreover, most chemical fertilizers are low quality and come without clear guidelines for use. Applying chemical fertilizers indiscriminately not only lowers long-term soil productivity but also negatively impacts consumers' health, water quality, and seed production. Furthermore, excessive application of chemical fertilizer increases crops' susceptibility to diseases. A properly executed soil analysis can prevent excessive application of chemical fertilizers but such analyses tend to be conducted by research institutes at high costs. As an alternative, the composition and appearance of ground-cover plants can serve as natural indicators of nutrient deficiencies. Curled dock (*Rumex crispus*), stinging nettle (*Urtica dioica*) and melde (*Chenopodium album)* indicate a high nitrogen content in soil. Conversely, whitlowgrass (*Erophila verna*), common heather, (Calluna *vulgaris*) and sheep's fescue (*Festuca ovin*a) reveal that the soil is nutrient-poor. Sorrel (Rumex acetosa), creeping soft grass *(Holcus mollis)*, and rabbitfoot clover (*Trifolium arvense*) are indicative of a soil with strongly acidic characteristics.

Figure 17: Application of natural fertilizer in the pilot area

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs			X	YES	X	Group training within the FFS on conducting soil analysis by indicator plants	Yes	X
Labour		X		NO			Only at the beginning	
Skills			X				No	

c) *Production and application of organic fertilizers*

Additional soil fertilization is sometimes needed to compensate for the extraction of nutrients by crops. Preferably organic manure should be applied. While chemical fertilizers only nourish the crops, organic manure improves soil quality and fertility in the long term. Furthermore, plants fertilized with organic manure tend to be more resistant to pests and diseases and yield better quality produce that can be stored for a longer period of time. Organic fertilization is frequently applied in the form of mulching, or through the production of green

manure or compost. Cow manure collected over the winter months, when the cattle are held in barns, can be applied to fields in the spring.

The application of organic fertilizer is, however, not always feasible, due to material shortages. Generally, organic matter is used to feed animals rather than prepare compost. In particular, rain-fed agricultural land located far from villages suffers from significant shortages of organic material.

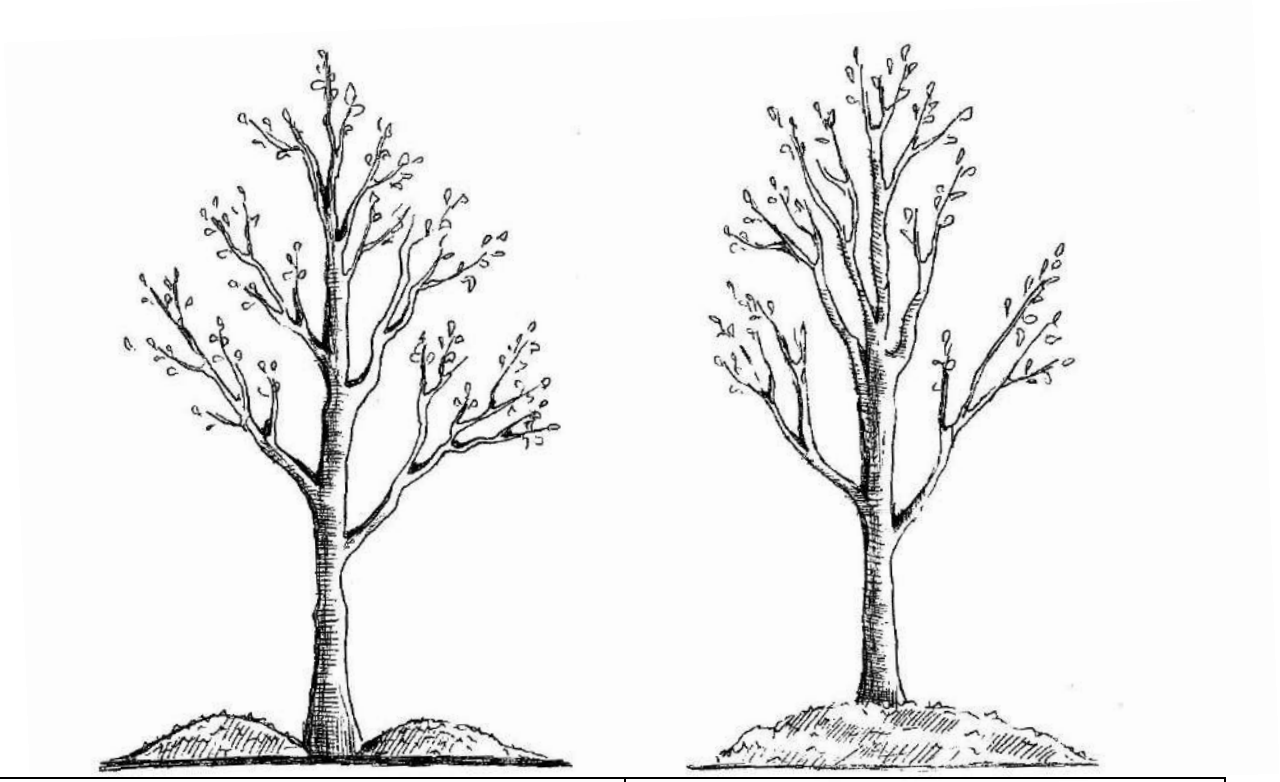
Fruit trees require less fertilization than annual crops and it is preferable that different kinds of fertilizers are applied. If annual crops are planted below fruits trees and fertilized, the residual fertilizer is normally sufficient to nourish fruit trees. In general, fruit trees should only be fertilised with specific chemical fertilisers if severe deficiencies occur. It is particularly important to avoid excessive doses of nitrogen, as they can trigger diseases. Organic manure should be applied at regular intervals, especially if no associated annual crops are planted below the fruit trees.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES	X	Training on preparation of organic fertilizers	Yes	
Labour			X	NO			Only at the beginning	
Skills		X					No	X

Mulching

Mulch is a layer of organic material applied around trees or between crops. Mulching is an appropriate technique for conserving soil humidity, providing nutrients, controlling weeds and preventing erosion. Organic mulch may consist of grasses, hay, leaves, wood chips, wool, or manure. When weeds are controlled manually within annual crops, they can be used as mulch as well. In Tajikistan, the availability of mulch is limited as weeds and leaves are conventionally used as fodder for the cattle. Consequently, mulching is normally applied only around tree pits where the results of its application are strong and visible. However, it is recommended to apply mulch not only around tree pits, but also between annual crop rows.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES			Yes	
Labour		X		NO	X		Only at the beginning	
Skills	X						No	X



Mulch should not come in contact with the tree	Excessively mulched tree

Figure 18: Mulching technique

Green manure

The use of green manure increases soil fertility, particularly when nitrogen-fixing legumes are deployed, by enriching the soil with organic matter and reducing soil-borne pests and diseases. Deep rooting green manure crops improve the soil structure and make nutrients from deeper layers available to following crops. Green manure plants also provide food and create habitats for pollinators and other beneficial insects. At the time when green manure is sown (July - September), water is often not available or scarce. Preferably other crops are watered, or a second crop is sown to provide immediate revenue. As such, green manure cannot be sown in rain-fed areas as a catch crop from July onwards due to lack of water. Nevertheless, it can be sown in rain-fed areas in spring, occupying the place of a main crop in a crop rotation system. Clearly, this means that there will be no harvest from the land where the green manure is sown for one year. In areas of irrigated annual crops, green manure can be sown as a catch crop.

The cost of seeds and the burden on water resources, the space needed to sow green manure and the lack of immediate benefits, are the four main reasons for green manure's present unpopularity. For the moment, it is mostly used as fodder. But even in this case, organic matter from the green manure reaches the soil.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES	X	Training on use of green manure	Yes	
Labour	X			NO			Only at the beginning	X
Skills		X					No	

Figure 19: Field on which green manure is grown

Compost

By decomposing organic matter, natural soil fertilizer can be generated from what is usually regarded as waste. Composts are often applied in kitchen gardens or to high-value crops. Compost mainly consists of cut grass, weeds, green and brown pruning material, and kitchen waste, such as eggshells and vegetable peels.

Compost not only improves the soil structure but also its porosity, creating a better environment for the root system of plants. It also increases the permeability of heavy soils and reduces erosion and runoff by increasing the soil's water retention capacity. Compost supplies a variety of macro- and micronutrients and in general a

significant amount of organic matter. It supplies beneficial microorganisms to the soil, and thereby improves and stabilizes the soil's pH level. Depending on the composition of the compost, the season, and the precipitation rate, the decomposition process takes 3 - 4 months.

Because of the climatic conditions in Tajikistan, which has very dry summers and cold winters, compost is normally produced in pits. Most commonly, a two-pit system is recommended, so that the decomposition process can take place while new waste is thrown into the second pit. Setting up compost pits usually requires some prior training for beginners.

In opposition to synthetic fertilizers, the effects of compost are only visible over a long period of time. If a more immediate effect is required, liquid manure can be prepared from compost. To achieve this, compost is suspended in water overnight, following which the resulting liquid manure is filtered and sprayed on the leaves of the plants.

	Input			Requirements				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES	X	Group training within the FFS on composting	Yes	
Labour		X		NO			Only at the beginning	
Skills		X					No	X

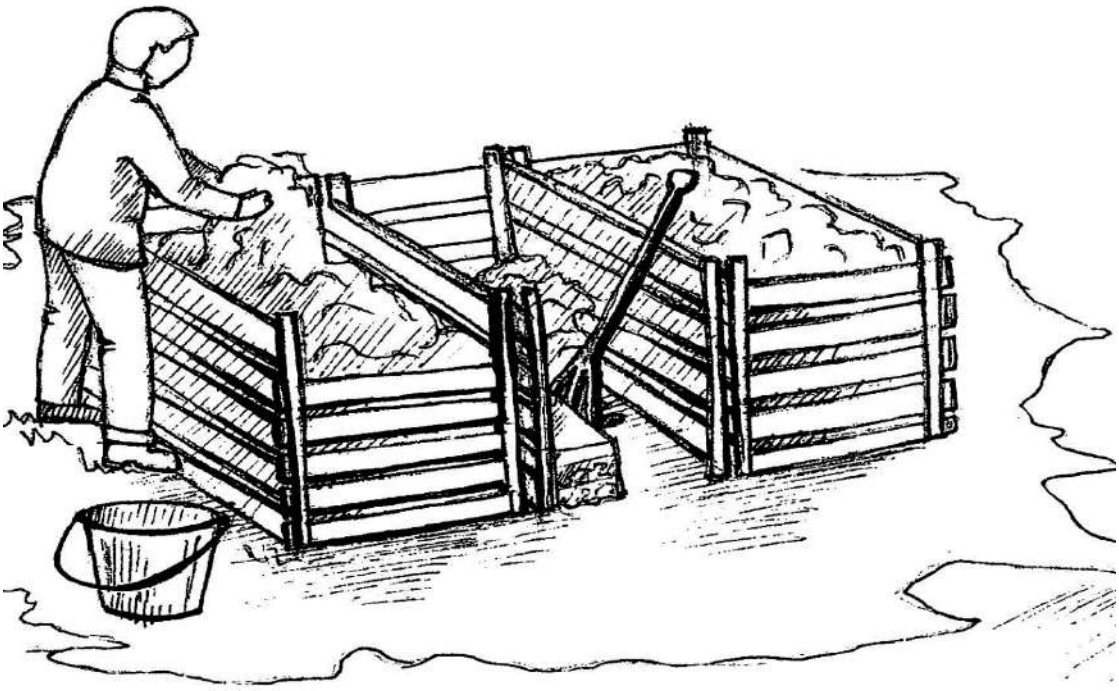


Figure 20: Establishment of a compost

10.5. Integrated pest management – IPM

Pests and diseases directly impair the production and quality of crops, providing a strong motivation for engaging in pest control. While the application of chemical pesticides is increasing in large-scale and industrial farming, the purchase of chemical pesticides is too expensive for subsistence farmers. Nevertheless, some form of pest control is still vital for such farmers, since a serious infestation can lead to a total loss of crops. IPM should be promoted in order to support the safeguarding crops and the pursuit of eco-friendly alternatives over synthetic pesticides. In this way, biodiversity can be conserved as part of an overall integrated pest management (IPM) scheme. Significantly, IPM does not aim at eradicating pests and diseases but rather at controlling them and keeping them at a tolerable level. IPM demands regular monitoring of pestilence and disease levels. Measures taken as part of IPM should prioritise effectiveness, while minimising negative impacts on the ecosystem, with stronger measures deployed only if earlier ones fail. Possible measures within IPM include preventive measures (e.g. phytosanitary measures), mechanical control (e. g. hand picking) and biological control (eco-friendly insecticides). Only if no other solution is successful should the application of chemical pesticides be considered. The application of eco-friendly pesticides is especially recommended as it does not harm pollinators, other beneficial insects and birds.

It should be noted that IPM requires permanent monitoring of the fields' phytosanitary status and training so that adequate measures are taken on time. This accords with the principle that "the field orchard wants to see its owner every day".

a) *Considering habitat requirements of crops*

One of the most elementary ways of guarding against pests and diseases is planting crops and trees in locations where their habitat requirements are fulfilled. Their needs for water, nutrients and sunlight should be accounted for and weeds should be regularly controlled. Farmers may consult with district departments of agriculture to obtain information on the species and varieties that the Ministry of Agriculture of Tajikistan recommends for planting in the country.

b) *Phytosanitary measures*

Phytosanitary measures are an essential component of IPM. To avoid problems with pests and diseases, phytosanitary measures should be taken into account, beginning with the use of certified seeds free from pests, diseases and weeds. Moreover, adequate pruning with clean pruning knives helps stop tree crowding and allow wind to pass through. If planted too densely, the leaves of the trees will remain humid after rain or dewfall, conditions that favour the germination of disease spores. Other mechanical control measures for fruit trees or bushes include eliminating diseased branches and recollecting infested fruit mummies. In the case of annual crops, entire plants should be eliminated while the disease's dissemination is still limited in order to avoid it spreading further. This is especially important for diseases caused by viruses e.g. in potatoes.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES	X	Group training within the FFS on the topic	Yes	
Labour		X		NO			Only at the beginning	
Skills		X					No	X

c) *Homemade insecticides*

Homemade insecticides can be prepared by mixing spices (chili, garlic, onion etc.) or toxic plants (walnut, tobacco etc.) with soap, alcohol or oil. They can be applied to control insects such as aphids, thrips, and mites. Their effect is not as immediate and resounding as with synthetic pesticides. In general, several treatments are necessary in order to achieve the expected result. Nevertheless, homemade insecticides were used in other projects as their preparation is cheap and most of them are not harmful to the environment and users. Among them, only nicotine is a neurotoxin. People should therefore be careful when preparing, handling and applying this insecticide, as it can otherwise have harmful and negative effects on people and the environment.[4] Generally, it is more difficult to control pests with homemade insecticides than with synthetic ones. Close field monitoring is necessary from the very beginning to identify early indicators of infestation since diseases can then be controlled more easily.

[4]Commercial insecticides that have nicotine as an active ingredient have been banned in most countries.

	Input			Requirements				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES	X	Group training within the FFS on the topic	Yes	
Labour			X	NO			Only at the beginning	
Skills			X				No	X

Beneficiary insects

Pest control can also be managed by promoting and conserving beneficiary insects, e.g. by planting native, flowering plants in stripes within or at the margin of fields to attract and provide habitats for beneficiary insects (predators, parasites). The flowering plants also serve pollinators and can be used for home consumption as spices or for preparing herbal tea.

Traps

Various kinds of traps can be used for controlling pests. Some of them, such as light traps or yellow cards are not expensive or can be self-made. However, pheromone traps, which are very effective pest controls, are often unaffordable for smallholder agriculture and thus demand project support (e.g. the use of *pheromone threads* for controlling apple codling moth). Nevertheless, the use of pheromone traps is recommended, whenever affordable.

10.6. Conservation of local varieties

Local annual crops

Planting modern varieties of annual crops, particularly in the case of cereals, is generally preferred since yields are higher. However, hybrid varieties of seeds cannot be reproduced at village level. Furthermore, modern varieties are more demanding in terms of fertilizers and water supply, which increases farmers' dependencies on external financial support. Local, traditional varieties of open pollination are generally better adapted to the local climate and soil conditions, including resistance or tolerance to pests and diseases. However, the yield level of local varieties is often considerably lower than from improved varieties. This is partly because local varieties have degenerated as they are not adequately maintained in a country where seedbanks are very rare. The selection of good quality seeds for planting and the support of seedbanks in the management and reproduction of local seeds is absolutely essential.

a) *Local fruit tree varieties*

It is cheaper to establish a traditional or semi-intensive orchard with local varieties than an intensive orchard based on imported seedlings, since locally produced ones are cheaper and fewer plants/ha (approximately 500 – 600 vs 2´600 – 3´125) are required. Furthermore, a semi-intensive orchard system based on local varieties allows for better vegetable growing and fodder planting between the trees. This outweighs the disadvantage that orchards established with local varieties and grafted on local rootstocks enter production later than intensive ones (5 – 6 years vs. 2 – 4 years).

Traditional varieties of fruit trees are normally better adapted to local climate conditions and are more resistant or tolerant to pests and diseases. That implies economic benefits as costs for applying pesticides are reduced considerably, production levels are stable, and less irrigation water is needed. In addition, local varieties bear fruits much longer (30 – 50 years vs. 10 – 12 years). It is recommended to involve specialists and consult with local nurseries before beginning reproduction of fruit tree seedlings, since grafting requires some experience. Local nurseries can establish collections of varieties for cutting scions and hand them over to interested fruit growers, for example. This would contribute to their conservation and propagation. Furthermore, the exchange of grafting material from traditional varieties of fruit trees and the establishment of collections of local varieties of fruit tree species should be encouraged at village level.

Before promoting propagation, however, the existence of markets for these traditional varieties should first be determined.

Figure 21: Fruit tree in pilot area

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES	X	Group training within the FFS on the topic	Yes	
Labour		X		NO			Only at the beginning	X
Skills			X				No	

b) *Support for seed banks of local varieties of annual crops and vegetables*

Due to increasing demand for hybrid species, local varieties of annual crops and vegetables have become increasingly unavailable at local markets. The advantage of local varieties is that they derive from open pollination, i.e. their seeds can be reproduced at village level. However, the purity of the varieties requires constant control. Plants that do not demonstrate the characteristics of the variety should be eliminated.

Figure 22: Local seed storage

It is recommended to conserve local seeds by supporting the seed banks of local varieties and store seeds. This does not just ensure seed availability for the next season, but also safeguards local genetic material.

It is recommended to establish mechanisms to share and exchange local seeds at village level and to store seeds in local seed banks. If no local seedbank is in place, the establishment of a new seedbank should be supported to ensure the long-term availability of genetic material. If a seedbank is already in place, the seedbank should

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES	X	Group training within the FFS on the topic	Yes	
Labour		X		NO			Only at the beginning	X
Skills		X					No	

10.7. Water conservation

In Tajikistan, precipitation varies largely depending on the season. In spring, the precipitation level is relatively high, while in summer months from June to September there is nearly no rainfall. During this time, melt water from snow and glaciers is used for irrigation. For most species of fruit trees, bushes and also crops, additional irrigation is required for good quality produce. Exceptions include drought-tolerant species such as pistachio, almond, grapes, walnut, dog rose, and barberry, which can grow in rain-fed lands under favourable conditions as well. For example, they grow at the bottom of the valley, where humid conditions prevail or on northwards

exposed slopes or higher altitude and/or on deep water retentive soils. However, under these conditions, irrigation is required during the first years after planting such species. The need for additional irrigation of annual crops and fruits trees and bushes is rising in Tajikistan as a consequence of climate change which has led to drier and warmer summers.
Depending on the land use type and local climate conditions, different water saving techniques and irrigation schemes can be set up.

a) *Rainwater harvesting*

Figure 23: Rainwater harvesting

Rainwater harvesting should always be considered in dry areas where rainfall is erratic. If there is no possibility to establish irrigation water systems - if little irrigation water is available or if irrigation is too expensive - harvesting rain water during spring is an economically viable alternative.

The easiest method to harvest water is through contour trenches. These are dug according to contour lines and are non-continuous in order to absorb run-off water which then gradually infiltrates the soil.

Conservation water ponds enable the irrigation of orchards and annual crops downhill from the pond. Ponds are recommended since they are cheap and easy to build. The disadvantage of conservation ponds is that they can normally only be used until the beginning of summer, after which they dry up.

It is also possible to collect and save rain water from dirty roads and even slopes by directing the run-off water towards specially dug pits lined with plastic foil.

In areas with buildings, rooftop water harvest systems can be set up. Through this simple and low-cost technology, rainwater is collected from the rooftop and transferred by tube to a water reservoir, which is usually subterraneous and lined with plastic foil.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs	X			YES	X	Group training within the FFS on the topic	Yes	
Labour			X	NO			Only at the beginning	
Skills		X					No	X

b) *Irrigation*

If bigger amounts of water are needed for farming, irrigation schemes can be set up. Different types of irrigation systems have been applied successfully in Tajikistan.

Irrigation by gravity

Irrigation by gravity (furrow or surface irrigation) is the main irrigation technique used in Tajikistan. To avoid erosion, irrigation channels should be installed in such a manner so that irrigation furrows follow contour lines. Special attention should be paid to avoid excessive watering as this can lead to soil erosion and gullies. The water influx should be slow, so as to increase water infiltration into the soil and decrease the risk of erosion along the irrigation channel. Most importantly, the amount of water should be adjustable in order to avoid oversaturation of the soil. Irrigation by gravity can be improved by lining the feeding channels with plastic foil or by distributing water to the furrows through plastic pipes.

After irrigation by gravity, it is crucial to break the soil surface between the contour lines in order to destroy capillaries and thus preserve humidity.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES	X	Group training within the FFS on the topic of improving irrigation by gravity	Yes	X
Labour		X		NO			Only at the beginning	
Skills		X					No	

Drip and sprinkler irrigation

Drip and sprinkler irrigation systems are the most efficient irrigation methods. However, they are expensive and generally not affordable without external financing. Nevertheless, for some areas in Tajikistan they are the most and sometimes only suitable irrigation method, as very little water is available in summer months.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs			X	YES	X	Group training within the FFS	Yes	
Labour		X		NO			Only at the beginning	
Skills			X				No	X

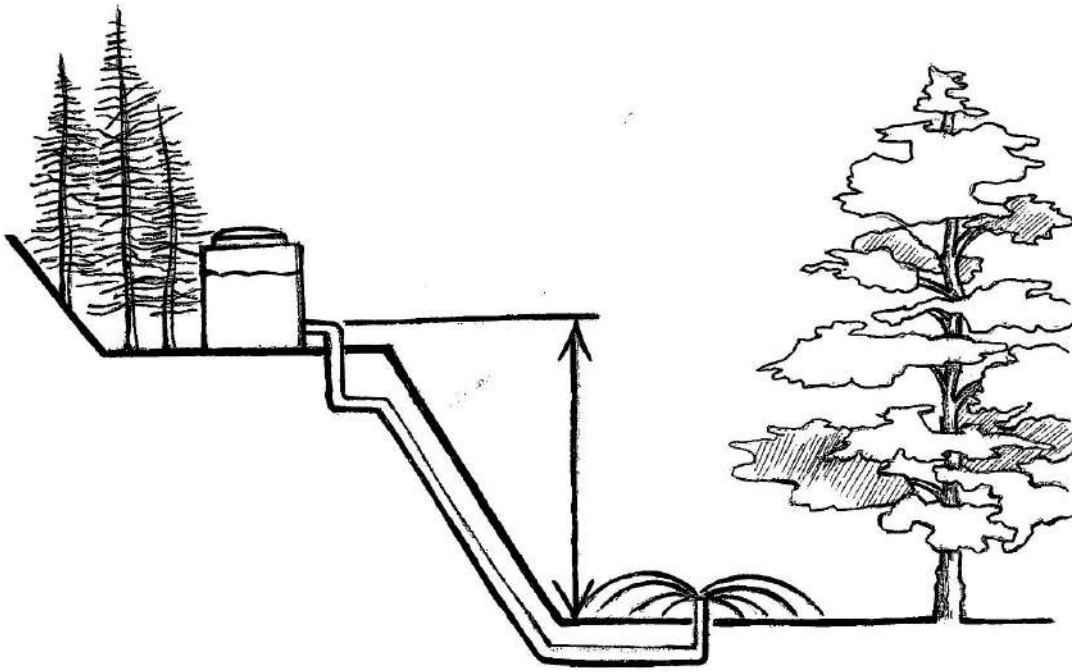


Figure 24: Irrigation by gravity

If fruit trees are associated with fodder plants or vegetables, drip irrigation schemes could be set up to water trees and sprinklers to irrigate the associated crops. Drip irrigation systems should be carefully designed and installed. Water quality should be analysed before establishing a drip irrigation system, as sediments are likely to clog up the drip irrigation pipes. Reservoirs need to be constructed if drip or sprinkler irrigation is set up.

As in many cases sources of water are not available, water could be brought from lower areas by pumping it up using electric or solar pumps. These techniques are effective for irrigating orchards but are expensive and, particularly in case of using electric pumps, only make sense if combined with drip irrigation.

10.8. Reseeding of rain-fed pasture land and fodder storage management

a) *Reseeding of rain-fed pasture land for fodder production*

Natural pasture land is frequently degraded by overgrazing and the percentage of soil coverage is low. Fencing is an indispensable first step towards recovering these lands and allowing for improved fodder production. The second step consists of reseeding the plots with fodder species. Since the roots of grass and herbal species still remain in the soil and will sprout if there are no graminivores in the area, soil cultivation on these pasture plots should be kept to a minimum. This will also help prevent erosion on slope areas. Therefore, the no-tillage technique should be applied for reseeding former pasture areas. This can be carried out using two-wheel hillside tractors. When sainfoin or alfalfa are used for reseeding, fodder barley should be sown in autumn with the no-tillage technique; in spring, seeds of alfalfa or sainfoin are spread. The legume seeds can be brought in contact with the soil by frost seeding. In this way, seeds are spread very early in spring when there is still snow and they sink into the soil when the snow melts. Another possibility later in the year is passing with a bundle of brushwood after spreading the seeds. The barley shields the young plants of alfalfa and sainfoin and is harvested in June to produce hay. Alfalfa and sainfoin continue growing and, in the years that follow, can be cut for hay and pasture. Sainfoin is better adapted to dry conditions than alfalfa.

To conserve and promote biodiversity, indigenous grass or herbaceous plants that produce fodder and are suitable for pasturing under adverse conditions as drought, should also be used. These species are normally better

adapted to local climate conditions and more resistant or tolerant to pests and diseases. One possibility for propagating these species beyond scattered fodder plots consists of seeding appropriate locations in higher mountain areas.

Fodder plants are normally cut before flowering when their protein content is highest. However, strips of fodder plants within the plot boundaries should be cut only after producing and casting seeds.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs			X	YES	X	Group training within the FFS on pasture reseeding	Yes	
Labour			X	NO			Only at the beginning	X
Skills		X					No	

b) *Fodder storage management*

Animal grazing in early spring can only be reduced if the fodder produced on reseeded rain-fed pasture lands is adequately stored and available at the right time, in early spring. For this reason, appropriate fodder storage space and adequate hay storage management are necessary in order to produce sufficient amounts of good quality hay.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs			X	YES	X	Group training within the FFS on fodder storage management	Yes	
Labour			X	NO			Only at the beginning	X
Skills		X					No	

10.9. Harvest and post-harvest management

Adequate harvest and post-harvest management are especially important in case of irrigated and rain-fed annual crops, fruits and vegetables.

Grains and oilseeds should be stored in a dry and cool but frost-protected storage space, which should be disinfected before the products are put inside. Excesses of storage pests should be prevented. These pests not only cause damage to produce by eating it but also contaminate it, rendering future sales impossible. Periodic inspections of the store rooms are therefore necessary. The use of pesticides should be avoided for controlling pests as these also contaminate food products. Instead, specific equipment, including various types of traps, should be used.

Fruits can be preserved post-harvest by making compote, jam or by drying the fruits. When storing fresh fruits like apples, harvesting should be handled without causing any damage to the fruits, in order to minimize the risk of putrefaction. As in the case of grains, they should be stored in a dry and cool, but frost-protected room that

has been previously disinfected. Storing apples and potatoes together should be avoided as apples produces ethylene, which can cause potatoes to sprout.

Like fruits, many vegetables can be preserved in jars, while others, such as tomatoes, can be dried. The easiest and cheapest method is keeping them in storage clamps that are covered by straw and earth to protect from frost. The clamps should be controlled regularly to prevent infestation by pests, especially mice.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES	X	Group training within the FFS on harvest and post-harvest management	Yes	
Labour			X	NO			Only at the beginning	X
Skills		X					No	

10.10. Beekeeping

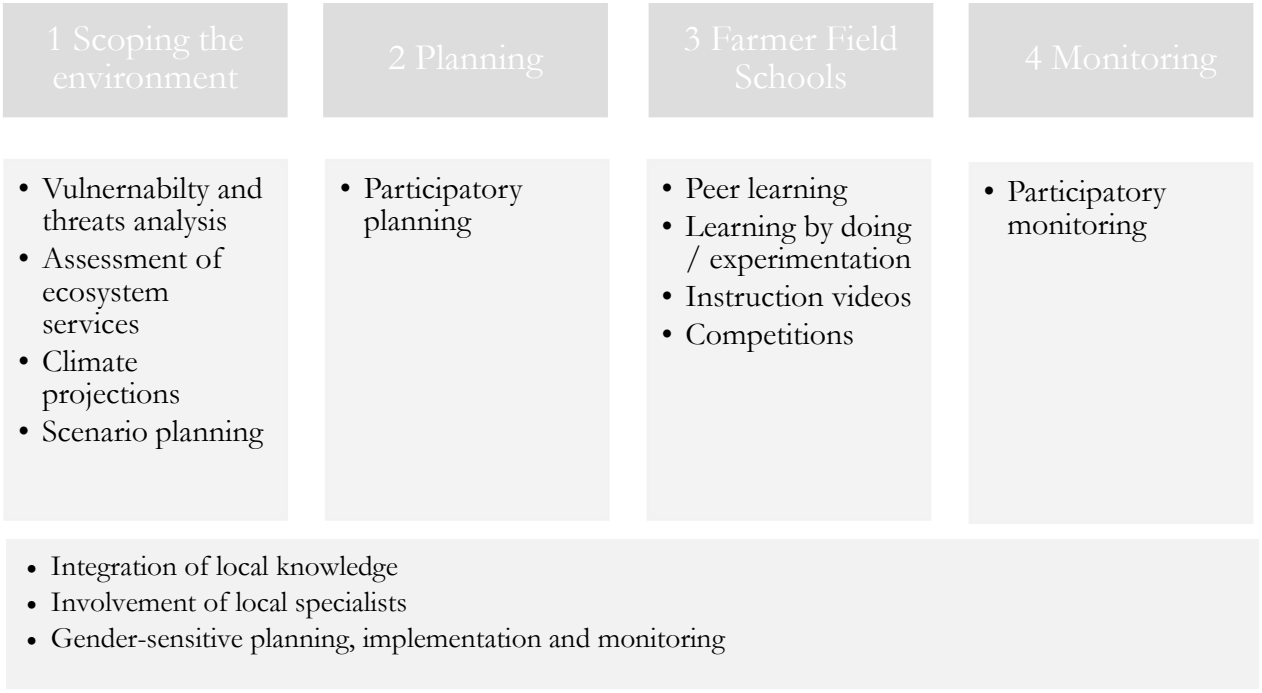
Beekeeping is widely practised in Tajikistan and is a valuable source of income, as honey can be sold at a profit on the market. Furthermore, bees and other pollinators are essential for pollinating most of the fruit trees and bushes and also many annual crops planted in Tajikistan. Ensuring the availability of flowering crops, trees and bushes, is, however, challenging. The use of insecticides, e.g. codling moth for controlling apple, is harmful to bees. Too often insecticides are not used properly and bee-friendly instructions for their application are not followed. Increasing the diversity of the planted species on pasture, cropland and in orchards will increase the number of bees and other pollinating insects as nectar becomes available throughout the spring, summer and autumn season.

	Input			**Requirements**				
	Low	**Medium**	**High**	**External support:**		**by**	**Financial project support required**	
Costs		X		YES	X	Group training within the FFS on the topic	Yes	
Labour		X		NO			Only at the beginning	X
Skills		X					No	

Figure 25: Beehives in pilot area

11. Methodologies for implementing the approaches

In the following section, suitable methodologies for the implementation of the techniques described above are introduced. These methodologies can be used when applying one or several of the approaches. It is recommended to use all, or a suitable mix of them, according to circumstances. The methodologies can be divided into four main categories. First, methodologies that support the scoping of the environment, which includes an assessment of the ecosystem, its vulnerabilities and services, and a consideration of potential climate scenarios and adaptation strategies. Second, participatory planning of interventions should involve local knowledge. Third, once the activities are planned and introduced, peer-to-peer learning at village level should be facilitated with clear learning mechanisms put in place. In the context of Tajikistan, the establishment of Farmer Field Schools is an important and feasible step towards continuous learning and the exchange of best practices. This includes the involvement of local specialists to ensure the use of local knowledge, sustainability and acceptance, as well as gender-sensitive planning, implementation and monitoring. Lastly, participatory monitoring of the activities should be carried out and technical and methodological modifications introduced according to need.



11.1. Scoping the environment

Before starting any field activities, it is important to scope the environment. In a setting where climate change has severe impacts on the agricultural landscape, it is recommended to follow the *Open Standards-based framework for planning and implementing Ecosystem-based Adaptation*[5] measures. The Open Standards-based EbA framework is a methodology for participatory strategy development, planning and adaptive management of ecosystem-based and other complementary climate change adaptation measures. It was derived from the CMP Open Standards for the Practice of Conservation and consists of nine essential steps. The framework has been designed for use by

[5] https://link.springer.com/chapter/10.1007/978-3-319-72874-2_2

communities with support from an experienced facilitator to guide the process. The full facilitators guide takes readers through each of the nine steps and provides information and tools to facilitate the workshop. In the following chapter, an overview of the most essential steps is provided that should offer insights into the method and highlight the importance of scenario planning.

a) *Assessment of ecosystem services and identification of threats*

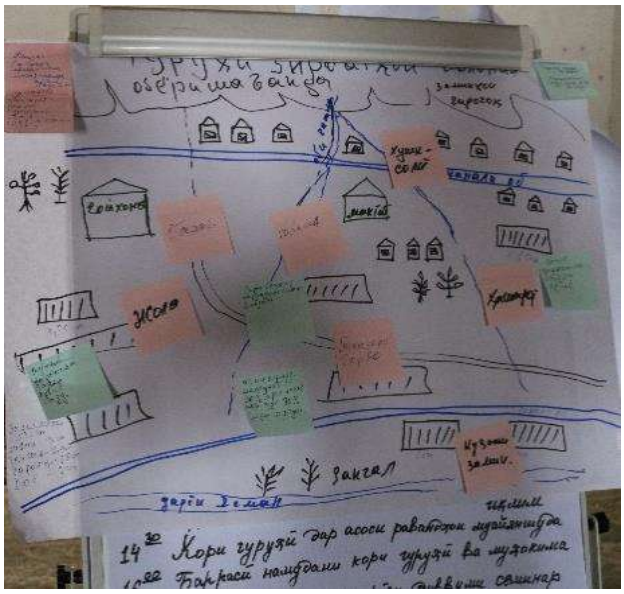


Figure 26: Ecological drawing

As a first step, it is necessary to identify which services people derive from the ecosystems that surround them and quantify the community's dependence on these ecosystem services. Valuable tools to this end include ecological drawings and seasonal calendars. With ecological drawings, the community depicts its surrounding ecosystem and identifies the services they derive from it (**Error! Reference source not found.**). Potential challenges, such as scarcities of ecosystem services, degraded ecosystems, or land use conflicts, are identified at the same time. Then, the linkages between ecosystems, ecosystem services, and human well-being are depicted in the ecological drawings and discussed with the community. Seasonal calendars are applied to identify seasons and potential seasonal shifts due to climate change (**See Figure 27**Error! Reference source not found.**)**. The threats identified during the brainstorm are linked to the seasons when they occur (e.g. avalanches in the winter months, landslides during heavy spring precipitation).

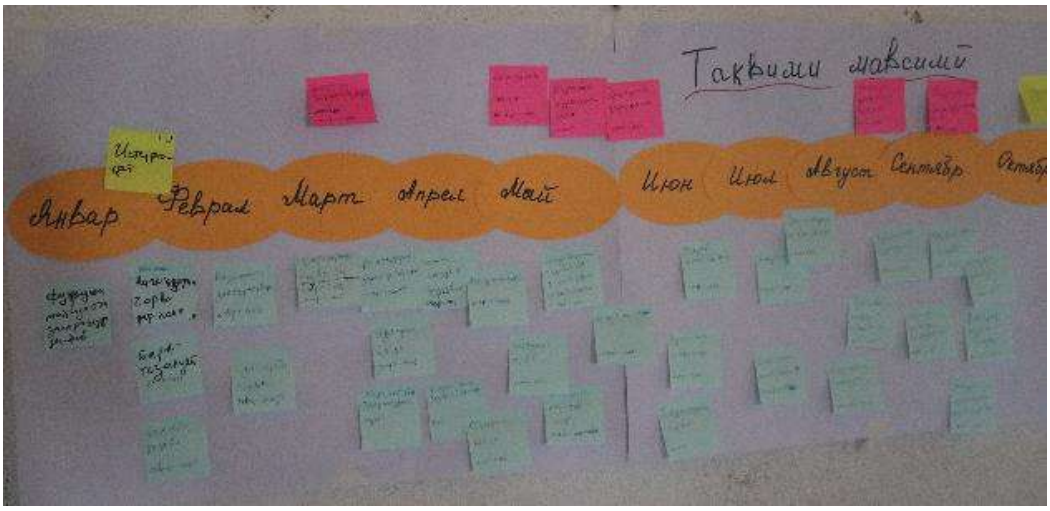


Figure 27: seasonal calendar

b) *Conventional vulnerabilities of people and ecosystems*

Climate change-related impacts are far from the only anthropogenic impacts affecting the ecosystems on which communities depend. Rather, climate change impacts accentuate – and often interact with – other, conventional stressors on ecosystems. This also affects the capacities of these ecosystems. As a second step, the community identifies threats to each ecosystem.

c) *Climate projections and scenario planning*

Climate change not only accelerates many current threats but also brings considerable uncertainty into sustainable land use management. What works fine today, might, due to climate change, no longer work in a few years. As healthy ecosystems and biodiversity are more resistant to stresses like climate change, it is recommended to apply scenario planning. Scenario planning helps manage uncertainty and factor in uncertainty during planning. In this way, solutions are provided to farmers, which are adapted to current and future climate conditions. Therefore, as a third step, scenario planning based on climate projections should be applied. The climate projections are derived from downscaled climate data, which enables analysts to foresee long-term trends.

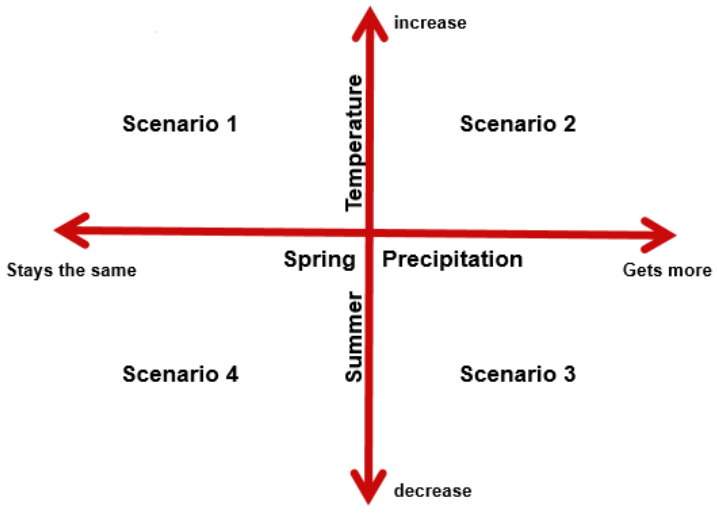
The following graph depicts projected changes in temperature and precipitation (

Figure 28). The seasons can be adjusted for use by specific communities if seasons have already shifted or were not depicted correctly. Attention, however, must be drawn to absolute changes in precipitation and temperature. While the graph below shows a percentage change of -11% for precipitation in the summer months, summer precipitation in absolute terms is still very little. For this reason, a potential change of -7% in spring precipitation would be much greater in absolute terms.

	Scenario axis for Temperature in C			Scenario axis for Precipitation in %	
	From	To		From	To
Winter	0.7	1.7	Winter	-1%	18%
Spring	1.0	1.9	Spring	-7%	11%
Summer	0.9	1.9	Summer	-11%	0%
Autumn	1.0	1.8	Autumn	-10%	11%

Figure 28: Example of possible scenario axes

The most severe changes are chosen as scenario axes together with the community. In this example changes in summer temperatures and changes in spring precipitation have been noted as having the most severe impact on the community (Figure 29). If the two axes are superimposed, four scenarios are created:



Scenario 1:
Summer temperatures ↑
Spring precipitation =

Scenario 2:
Summer temperatures ↑
Spring precipitation ↑

Scenario 3:
Summer temperatures ↓
Spring precipitation ↑

Scenario 4:
Summer temperatures ↓
Spring precipitation =

Figure 29: Scenario Planning

With these four scenarios and maximum changes in temperature and precipitation noted above, the diagram depicts the most severe impacts of climate change for the community. Showing the potential future change in climate in four scenarios helps account for uncertainty in land use planning and ensure the sustainability of newly introduced practices. Only agricultural practices that work under all four scenarios are considered climate-robust. In practice, this means that certain agricultural practices might be climate-robust in one area but not in another. In order to avoid misapplication when implementing or recommending the practices above, their climate-robustness must first be verified.

11.2. Planning Workshops and selecting pilot farmers (participatory planning)

Planning workshops are held in the pilot areas, where farmers and farmers' associations are informed about the approaches identified by the project. After becoming acquainted with the approaches and their related techniques, farmers interested in benefiting from the approaches are requested to submit a letter of intent to participate in the project. Those who want to cooperate with the project must agree to apply at least one the following techniques to promote biodiversity:

- No-tillage or low tillage technique for land preparation
- Using mainly seeds from traditional, local varieties of annual crops and with open pollination, no hybrid seeds
- Crop rotation
- No or only limited use of chemical fertilizer and synthetic pesticides
- No use of herbicides
- Preferably mixed cropping or association of crops
- Careful and efficient use of irrigation water, without causing erosion
- Protection of fields preferably by natural/living fences or natural stone walls.

In the scope of the planning workshops, the participants:

- analyse climate change impact in the pilot areas, following the EbA-approach
- become acquainted with conservation and promotion of biodiversity and ecosystem services (ES)
- receive more detailed information about approaches for promoting and conserving biodiversity and ES
- identify location-appropriate techniques and practices for conservation and promotion of biodiversity and ES
- learn about and discuss criteria and process for selecting demo plots[6] to promote and conserving biodiversity and ES
- confirm interest to implement measures for promoting and conserving biodiversity.

The proposals presented by farmers' groups and individual farmers are analysed, discussed with the farmers and, as required, adapted to the pre-defined techniques to be applied in the scope of one or another approach. Afterwards, the proposed plots are visited by the project team (WHH/ staff of local NGOs) and are assessed in terms of the conditions they offer for implementing one of the six approaches for promoting and conserving biodiversity.

[6] Demonstration plots are organised by WHH and its local partners in several projects related to orchards, annual crops, pasture management etc. The demo plots present showcases for the correct application of innovative agricultural measures and techniques. Demo plots are established on the lands of farmers, who get financial or material support from the project and also make their own contributions to the projects. It should be noted that the technical innovations tested at the demonstration plots are neither expensive nor sophisticated. This means that in the future they can be repeated/replicated by neighbouring farmers without external support.

11.3. Dissemination

a) *Involvement of local knowledge and specialists*

When implementing the approaches described above, it is recommended to involve local specialists and consider the local knowledge of farming families. A local specialist could be one of the beneficiaries, a lead farmer, with sound knowledge in the above-mentioned techniques. Alternatively, the specialist could belong to a local NGO or a Public Organisation. Working with local specialists is likely to enhance acceptance of the project, increase the likelihood of approaches being replicated beyond the project, and ensure the sustainability of post-project learning process.

b) *Famer Field Schools*

The concept of the Farmer Field Schools (FFS) is participatory, actively involving farmers in the process of learning through the exchange of knowledge, experience and best practices in agriculture. This process is supported by the staff of local implementing partners in order to ensure its proper management and facilitate the regularity of the participatory training sessions.

Methods to be applied within the scope of FFS are:

- Group training, including presentation of videos to distribute useful information about the approach
- Field visits, for assessing crop condition and identifying problems on the ground
- Learning-by-doing / practical training in the field for discussing problems with trainers and other farmers and putting the new techniques into practice
- Exchange visits or study tours involving farmers from other areas so that they can gain theoretical and practical knowledge to apply on their plots
- Field days involving non-target farmers into project activities and motivating them to replicate innovative techniques promoted by the project in their own plots

Replication of the approach by other farmers and farmer's organizations

To have an out-scaled effect, other farmers and farmers' organizations in the areas are invited to the FFS to become actively involved in the learning process and take part in the field and exchange visits. To ensure the sustainability of conservation and promotion of biodiversity and ecosystem services, local implementing partners facilitate replication of the approaches identified by the project and the techniques related to these approaches.

Events such as competitions will stimulate farmers to promote and conserve biodiversity by demonstrating and showcasing their best practises. Small prizes, like agricultural tools or inputs may be provided as incentives in such events.

11.4. Participatory monitoring

It is vital that throughout the participatory monitoring process, farmers and farmers' organizations understand what they want to achieve and decide on how they will measure progress. This process is facilitated by the local implementing partners, who ensure the purpose of the project is understood by the community, that indicators are determined collectively and, most importantly, that monitoring continues after the project's conclusion.

The aim of participatory monitoring is to introduce a record-keeping habit backed up by regular analysis and timely responses. This allows for the early identification of problems and their subsequent rectification through appropriate adjustments. It also helps farmers evaluate best possible uses for resources and base their decisions on reliable information. The data gathered through participatory monitoring can be used to fine-tune each approach and adapt it to specific local conditions.

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