How to make agriculture more biodiversity-friendly in Dedoplistskaro, Georgia – Concept Paper

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Situation analysis

Dedoplistskaro Municipality is one of the most important agricultural areas of Georgia situated in the Southeast of the country. Natural as well as agricultural biodiversity are high, although both came under severe pressure over the last decades due to the intensification of agricultural production.

Definition of Ecoagriculture

Ecoagriculture refers to an approach to managing landscapes specifically to meet three goals simultaneously and sustainably (that is, to be able to continue meeting those goals indefinitely): conserve biodiversity and ecosystem services, provide agricultural products, and support viable livelihoods for local people.

Source: Ecoagriculture.org

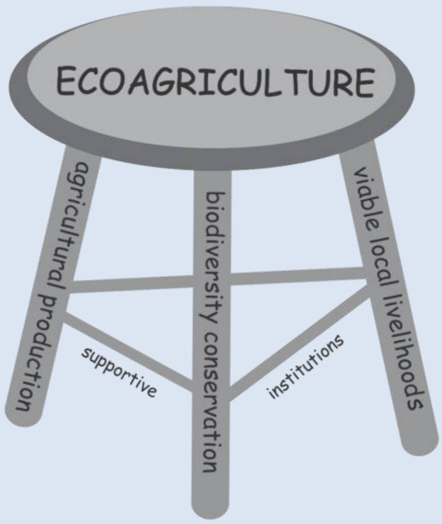
Agricultural production and practices

Georgia has a rich agricultural tradition. Agriculture played an important role in the formation of the Georgian statehood and contributed much to its economic development. 46% of the population were living in rural areas and 52% of the active workforce was employed in the agricultural sector in 2013. The Georgian agricultural sector is characterised by a very low productivity in comparison with most of the post-Soviet countries. Agricultural production only accounted for 9.3% of the GDP in 2013, even though it has high agricultural potential with high range of varieties and fertile soils.[1]

Dedoplistskaro Municipality, especially Shiraki Valley, is known as Georgia's "bread basket". Agriculture is the main economic sector in the region, and within the sector cereal production (mostly wheat, less frequent barley and maize) is the predominant agricultural activity. Animal production is less common and mostly restricted to grazing areas with sheep herds. The main arable lands of Dedoplistskaro Municipality lie in Shiraki Valley, but of the 31,533 ha arable land available, only 21,151 ha are temporary planted with crops.[2]

The area has very fertile soils with a deep humus layer and, in general, good potential for agriculture. However, yields are often limited by a shortage of available water, especially at crucial times of plant growth and grain formation. The annual precipitation is as low as 400 mm and very unevenly distributed over the year. Another limiting factor is the strong winds that cause serious topsoil erosion. Hence, farmers in the region cannot fully realise the potential of such fertile soils and harvest up to 6 tons of wheat per hectare only. In extreme years, such as in 2014 when a severe drought hit the region, average yields were as low as 300-400 kg per hectare.[3]

Three Dimensions of Ecoagriculture



Source: Own figure based on Shames, Seth (2008): Ecoagriculture Partners: Progress towards linking conservation, production and rural livelihoods.

Furthermore, climate change scenarios indicate that extreme weather events, such as droughts or heavy storms may occur frequently and be more severe in future, leading to a further weakening of

[1] Kobakhidze, Natia (2015): Impact analyses on status of biodiversity in Armenia, Azerbaijan and Georgia, and at regional level (South Caucasus). Tbilisi: Sustainable Management of Biodiversity, South Caucasus/GIZ.
[2] National Statistics Office of Georgia (GEOSTAT) (2014): Agriculture Census Results. URL: http://census.ge/en/results/agro-census.
[3] Klein, Florenz (2015): Assessment of crop cultivation methods and wheat yields in Shiraki valley in 2015, Georgia. Tbilisi: Sustainable Management of Biodiversity, South Caucasus/ GIZ.

the already fragile agriculture ecosystem with increased wind erosion, harvest losses due to lack of water, and further degradation of pastures and grazing areas.

Suitable adaptive measures are needed to secure sustainable yields for local farmers. Apart from the impacts of climate change, loss of biodiversity, pastures degradation due to overgrazing and land degradation are regarded as the most important environmental issues. The region is thus under the permanent threat of crossing the threshold to desertification.[4]

Agricultural practices in Dedoplistskaro

The agricultural landscape of Dedoplistskaro is characterised by a number of large farms with up to several hundreds of hectares for crop production and pasture. Most of the farm owners have only rudimentary agricultural knowledge, having bought the land without an agricultural background after the end of the Soviet era. Therefore, currently applied farm practices in the area are in many cases not in line with sustainable agricultural production standards.[5]

One example for not adapted agricultural practices in Dedoplistskaro is the application of deep ploughing. Ploughing with a mouldboard plough is a well-known and simple soil management technique used mainly for weed control and loosening the soil. However, there are substantial negative side-effects, especially in dry areas with fragile and loose soils. Heavy tractors with heavy cultivation and harvesting equipment increase soil compaction. Soil compaction in turn, affects plant growth, as the pores between soil particles are reduced and limit root infiltration, drainage, and air circulation. Soil compaction decreases the water uptake and storage ability of soil, which results in more runoff and erosion. Another negative effect is the loss (due to evaporation) of the water stored in the lower layers of the top soil when turned upside down. The disturbance of the soil also leads to faster decomposition of the organic matter in the soil and, as an effect, the loss of nitrogen. All of this results in reduced plant growth and lower yields, especially during periods of drought.[6]

The current mode of soil cultivation was introduced and practiced during Soviet times. It is not adapted to the local climate and soil conditions, especially not regarding the projected effects of climate change. These practices have led to serious soil degradation over the past decades, making farming increasingly difficult in East Georgia. Hence, a new set of techniques and management practices is required to better adapt to the limited availability of moisture for agriculture production in the region.[7]

Local livelihoods and agriculture

Georgia’s cultivated land is almost completely privatised. Around one million hectares of land have been transferred to private ownership, 80% of which is agricultural land. Approximately 72% of the total agricultural land is operated in plots with the land size less than 10 ha. A large majority of agricultural holdings are small scale farmers with only around 2 ha of arable land. These small scale farmers are involved in subsistence or semi-commercial farming. They produce goods for their own consumption and derive income from selling agricultural products.

The privatisation in the early 1990s provided farmers with enough land for subsistence farming but did not consider the effect of land fragmentation over the long-term development of agricultural production. The issue of land fragmentation could also not be solved in the second wave of land privatisation in 2005. Significant problems remain regarding the land registration. In some cases exact borders of the land plots were not defined, which created ambiguities and conflicts over the ownership of land.[8]

In Dedoplistskaro Municipality, nearly 2,000 farmers are cultivating between one and two hectares of agricultural land, which is the biggest share of the 7,500 land holding farmers in the area. There are also more than 3,000 land holders who own less than one hectare of land. These figures support the assumption that the land plots are often too small to secure the livelihood. Nevertheless, in a survey of 300 farmers in Dedoplistskaro in 2016, 90% stated that farming is the main livelihood activity of the

[4] Gönner, Christian/ Weigel, Olga/ Kolbin Giorgi (2014a): Concept on Climate-adapted Agriculture in Georgia. Tbilisi: Sustainable Management of Biodiversity, South Caucasus/GIZ.

[5] Camacho, Alberto/ Oberthür, Frederik/ Waldmüller, Luis (2015): Recommendations on Sustainable Agriculture Promotion and Agrobiodiversity for the Program on Sustainable Management of Biodiversity in Georgia. Tbilisi: Sustainable Management of Biodiversity, South Caucasus/GIZ.

[6] Gönner et al. (2014a)

[7] Camacho et al. (2015)

[8] Kobakhidze (2015)

household. Furthermore, 54% of the interviewed farmers declared to have less than GEL 500 household income per year.[9] In contrast, there are also 41 farmers with more than 500 ha in Dedoplistskaro revealing the potential for agricultural businesses in the area.[10]

In conclusion, the agricultural sector is of major importance for local livelihoods in Georgia and especially in Dedoplistskaro Municipality. However, the present agricultural management is not taking advantage of the full potential of agriculture for the improvement of local livelihoods.[11]

Biodiversity conservation

The present farming practices have a negative effect on the ecology and biodiversity of the region. Agrobiodiversity has declined significantly over the past decades in Georgia. One reason is the industrialized agriculture introduced in the Soviet Union which led to the degradation of agricultural ecosystems and the loss of local plant and animal genetic resources. Local landraces were replaced by high-yielding varieties and monoculture plantations reduced the variety of plants in the field. Furthermore, non-systematic propagation and inbreeding hampered the development of local landraces, reduced productivity and increased the risk of extinction.

Definition of Agrobiodiversity

Agricultural biodiversity includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agricultural ecosystems: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem. Agrobiodiversity is the outcome of the interaction among genetic resources, the environment and the management systems and practices used by farmers and herders. It has developed over millennia, as a result of both natural selection and human interventions.

Source: GIZ (2015): Understanding agrobiodiversity. Bonn/Eschborn: GIZ.

In-situ and ex-situ conservation

Recently, there have been efforts to restore agrobiodiversity through *ex-situ* conservation of genetic resources: A field crop gene bank was established at the Lomauri Institute of Farming, and also other institutes improved their collections of plants and microorganisms. “Agro” – the National Centre of Production of Grapevine and Fruit Panting Material was established. Furthermore, the Association Elkana has established collections of 100 different varieties of indigenous seeds, and a catalogue on agrobiodiversity in Georgia was developed by Elkana in cooperation with GIZ and the Ministry of Agriculture[12]. However, the measures regarding *ex-situ* conservation are not well coordinated and some stakeholders, like the Ministry of Education and Science, are insufficiently integrated in the process.

There have also been improvements regarding *in-situ* conservation. The *in-situ* conservation of certain crop landraces and the rehabilitation of degraded agricultural lands, windbreaks and forest edges were supported in Dedoplistskaro. Nevertheless, incentives for the promotion of *in-situ* conservation are missing as the local seed law is not acknowledging and protecting indigenous seeds and due to the absence of a market for indigenous crop varieties.[13]

In conclusion, the initiatives have not been sufficient so far as the degradation and genetic erosion of the agricultural biodiversity continues to increase. Especially, agricultural plant genetic resources have declined significantly, despite recent efforts to promote *in-situ* conservation of genetic resources and the establishment of gene banks for *ex-situ* conservation. There is a lack of specific strategy and coordination on agrobiodiversity promotion contributing to uncoordinated activities in *in-situ* and *ex-situ* conservation by different actors, ultimately leading to further decline of agrobiodiversity instead of its preservation[14].

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[9] Westerberg, Vanja/ Costa, Luis/ Ghambashidze, Giorgi (2016): Cost Benefit Analysis on the case for ending crop residue burning within the Dedoplistskaro district of Georgia. Tbilisi: Integrated Biodiversity Management, South Caucasus/ GIZ.

[10] National Statistics Office of Georgia (GEOSTAT) (2014)

[11] Kobakhidze (2015)

[12] The catalogue is accessible under http://catalog.elkana.org.ge/?lang=en.

[13] Camacho et al. (2015)

[14] Ibid.

Pressures on agrobiodiversity in Shiraki Valley

In Dedoplistskaro and especially in Shiraki Valley unsustainable agricultural practices constitute the major pressure on agrobiodiversity.

This includes among others the use of **monocultures**. More than 13,500 ha of the 21,151 ha (64%) of land cultivated in 2014 were used for wheat and another 3,384 ha were used for barley. Furthermore, sunflowers were planted on 2,675 ha.[15] These production systems are one of the major causes for the loss of agrobiodiversity as monoculture productions replaced polyculture fields with a high number of varieties.

Furthermore, the often indiscriminate and non-targeted **use of pesticides and fertilizers** is negatively affecting agrobiodiversity in Dedoplistskaro. As mentioned above, many of the farmers in the area have no agricultural education and therefore lack knowledge on the proper application of pesticides and fertilizers. This results in an overuse of agrochemicals negatively affecting wild plant species, animals and pollinators. In Kakheti region, 10,300 tons of mineral fertilizers were used, and pesticides were applied on 164,300 ha of agricultural land in 2015.[16]

In 2015, a team of international experts assessed several farms in Dedoplistskaro regarding the sustainability of their agricultural farm enterprises using the Response Induced Sustainability Evaluation (RISE) method. The RISE analysis pointed out that the farmers in Dedoplistskaro are not protecting biodiversity sufficiently and that a great share of biodiversity already got lost because of unsustainable farming practices, for example through the intensive use of agrochemicals. Only few farmers are still using local wheat varieties, while most fields can be described as monoculture landscapes with very low biodiversity within a fragile ecosystem.[17]

Another important factor jeopardizing agrobiodiversity is the **burning of crop residues** in the region. Traditionally, crop residues are burned after harvest. The idea is to burn the straw to free the area from vegetation for the next cultivation period. Furthermore, it is believed that the ashes of the burned crop residues provide minerals to the soil and that fire helps to control pests. This burning practice not only negatively affects the soil, as it destroys also other organic material in the soil, the ashes are often blown away by wind or washed off by rain, while more minerals are brought into the soil by mulching instead of burning, but it also has immediate effects on agrobiodiversity. Agrobiodiversity does not only include the diversity of crops but also of plants (including hedges, trees, herbs and flowers, etc.) and habitats in and around agricultural fields. Burning affected more than 79% of the area of Shiraki Valley in July and August 2015 and destroyed large parts of the windbreaks surrounding the crop fields. These windbreaks are important habitats for plants and animals which provide important ecosystem services for the agricultural production, including predation on agricultural pests.[18]

One of the underlying causes for the burning practices is the missing **legal, institutional and policy framework**. The protection of agrobiodiversity depends on coordination and cooperation between different sectors, most importantly the Ministry of Environment and Natural Resources Protection and the Ministry of Agriculture, as it is a cross-cutting issue which cannot sufficiently be addressed by one of the actors alone. Such intersectoral coordination regarding the protection of agrobiodiversity, including wild biodiversity surround agricultural production is still insufficient. Therefore, the implementation of ecoagriculture principles can only be successful if the measures are embedded in a well-coordinated institutional framework at local, regional and national level. The political will towards the development of an institutional framework balancing the interests of the different sectors is already pronounced regarding the protection of windbreaks. These first initiatives for an intersectoral cooperation for agrobiodiversity protection have to be widened and consolidated to enable a sustainable agricultural production in Dedoplistskaro.[19]

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[15] National Statistics Office of Georgia (GEOSTAT) (2014)

[16] National Statistics Office of Georgia (GEOSTAT) (2015): Agriculture of Georgia: Statistical Publication. Tbilisi: National Statistics Office of Georgia. URL: http://geostat.ge/cms/site_images/_files/georgian/agriculture/2015%20wlis%20soflis%20meurneoba.pdf.

[17] Camacho et al. (2015)

[18] Klein, Florenz (2015): Report on windbreaks inventory of September 2015. Results of survival rate surveys in April and September 2015. Tbilisi: Sustainable Management of Biodiversity, South Caucasus/ GIZ.

[19] Gönner, Christian/ Weigel, Olga/ Kolbin Giorgi (2014b): Concept on “Rehabilitation of Windbreaks in East Georgia”. Tbilisi: Sustainable Management of Biodiversity, South Caucasus/GIZ.

Vision and objectives

The vision is to improve the framework conditions for biodiversity in agriculture in Dedoplistskaro. The concept of ecoagriculture creates a good basis for the improvement of framework conditions for biodiversity in the agricultural sector as it combines the conservation of biodiversity with the enhancement of agricultural production and includes the needs for local livelihoods. The protection of agrobiodiversity in ecoagriculture includes the diversity of crops used in agricultural production, as well as the biodiversity constituting the agricultural ecosystems. Therefore, the proposed approach aims at protecting the diversity of crop varieties and of the biodiversity of the surrounding area.

The ecoagriculture approach includes six key strategies to promote biodiversity in agricultural landscapes:

1. Create biodiversity reserves that also benefit local farming communities;
2. Develop habitat networks in nonfarmed areas;
3. Reduce (or reverse) conversion of wild lands to agriculture by increasing farm productivity;
4. Minimize agricultural pollution;
5. Modify management of soil, water, and vegetation resources;
6. Modify farming systems to mimic natural ecosystems.[20]

Scherr and McNeely (2003) point out that the application of the key strategies depends on the locally existing farming conditions. Therefore, for the implementation of the concept in Dedoplistskaro, the focus should be on: measures to develop habitat networks in nonfarmed areas (2.), minimize agricultural pollution (4.), and modify management of soil, water, and vegetation resources (5.) as the area is characterised by intensive agriculture with small nonfarmed spaces in between the fields.

Proposed approach

For the proposed approach to be sustainable it has to be embedded in an enabling environment including a clear institutional framework and holistic land management planning, along with forests and pastures. Nevertheless, the here described measures will focus on the agricultural sector.

For the development of habitat networks in nonfarmed areas the following measures can be applied:

- Rehabilitation of windbreaks;
- Usage of flowering stripes;
- The establishment and protection of small habitats.

To minimize agricultural pollution, the following can be applied:

- Targeted utilization of fertilizers and pesticides, as well as integrated pest management;
- Mechanical soil treatment;
- Promotion of wider crop rotation.

Measures to improve soil, water, and vegetation management are:

- Promotion of minimum tillage;
- Use of cover crops;
- Promotion of the use of fallows;
- Development of alternatives for the use of crop residues;
- Introduction of an integrated fire management system;
- Support of the utilization of local (adapted) varieties in agricultural production.

Windbreaks

Windbreaks typically consist of rows of trees and bushes along the edges of agricultural fields to protect the topsoil from strong winds. They reduce wind speed to a distance of up to ten times their height, and they improve the micro-climate for crops growing in their shelter by reducing moisture loss.

[20] McNeely, Jeffrey A./ Scherr, Sara J. (2003): Ecoagriculture: Strategies to Feed the World and Save Wild Biodiversity. Washington DC: Island Press; pp. 108f.

In addition, windbreaks provide shelter and habitat for a wide range of plants, pollinating insects, wildlife and birds, including predators of agricultural pests.[21]

The measures regarding the rehabilitation of windbreaks will concentrate on the support of the Ministry of Agriculture and the Ministry of Environment and Natural Resources Protection in the development of a suitable political, legal and institutional framework for the rehabilitation of windbreaks. The legal framework shall comprise a stronger involvement of municipalities and the creation of a local steering group on windbreaks.

However, all further measures on the rehabilitation of windbreaks are explained in the concept paper on windbreaks developed in 2014.[22]

Flowering stripes

Flowering stripes or sown wildflower stripes are a conservation management measure to reduce the negative effects of intensive agriculture on biodiversity. Their goals include the promotion of biodiversity, pest control and pollination services.

These stripes are mostly sown with a seed mixture of wild flowers on arable land along field boundaries, and therefore act as a kind of living fences or border plantings between farms. The combination of seeds and the planting practices have to be adapted to local conditions.

In many cases the flowering stripes are directed towards insect conservation with two crucial aims: favouring pollinators to ensure crop pollination and contributing to biological pest control by favouring predators. Furthermore, they are used to increase plant diversity at field margins, to support birds by providing food resources in the form of seeds and invertebrates, and to enhance amenity by creating areas with attractive flowers.[23]

The application of flowering stripes in Dedoplistskaro should be tested using different seed mixtures. In the selection of seeds it has to be ensured that no wild herbs are used which could spread to the crop fields and might affect the harvest.

Small habitats

In agricultural landscapes, patches of natural or semi-natural habitat are crucial for the survival of plant and animal populations, which in turn are essential to maintain ecosystem functioning. Uncultivated stripes within crop fields can be used as habitats for wild relatives of crop plants or for animals.

These small habitats are mostly established at marginal locations and can have very different forms according to its surrounding. For example, wetlands could be used as watering holes for animals/livestock and partly be planted with reed to provide habitat for amphibians. Furthermore, small islands of bushes (woody islands) can be created as habitats for birds and other wild animals and protect tree biodiversity, while at the same time provide fire wood for the community.

In Dedoplistskaro, possible areas for small habitats have to be identified and the establishment of the habitats should be supported considering local conditions and participatory planning with farmers. Furthermore, the condition of already existing habitats should be assessed and, if necessary, in cooperation with the farmers and local government rehabilitated.

Utilization of fertilizers and pesticides including integrated pest control

The excessive and non-targeted use of chemical fertilizers and pesticides has major negative effects on biodiversity and ecosystem services in the pilot region. The overuse of agrochemicals is especially affecting wild species, animals and pollinators. Therefore, the aim of the concept is to evaluate and improve the usage of fertilizers and pesticides in Dedoplistskaro. In order to minimise negative side-effects of mineral fertilizers, proper analysis of the soil is needed prior to fertilising. Considering the results of the soil analysis, alternative sources of fertilizer (for example organic manure) can be tested.[24] Furthermore, alternatives to pesticides in pest control shall be promoted. One option could be the use of biological pest control, e.g. the use of predator populations. Possible measures could be the

[21] Weigel, Olga (2015): Climate-Adapted Agriculture in South-Eastern Georgia.
[22] Gönner et al. (2014b)
[23] Haaland, Christine/ Naisbit, Russell E./ Bersier, Louis-Félix (2011) Sown wildflower strips for insect conservation: a review. In: Insect Conservation and Diversity, Vol. 4, No. 1, pp.60-80.
[24] Gönner et al. (2014a)

support of birds-of-prey hunting rodents by providing sitting poles for migratory birds, while rose-coloured starlings or shrikes feeding on locusts could be supported by protecting and replanting windbreaks or establishing woody islands within the agricultural landscape.[25]

Moreover, **integrated pest control** (IPM) is an alternative to the extensive use of pesticides. It allows farmers to focus on existing pests and apply pesticides strategically when necessary (only when a certain number of pests occur per plant or per area) to prevent major losses, instead of following a strict schedule. An immediate benefit is the reduction of costs for pesticides. Additionally, biological control measures can be used, for example the introduction of parasitic or predator species to control pest populations. Another option is the application of cultural control mechanisms like the creation of habitat conditions adverse to pests for example the planting of a mixture of crops to encourage natural enemies of pests and slow spread of pests.[26]

Mechanical soil treatment

The constant treatment of the soil is one option to keep down wild herbs on the crop fields and thereby reduce the demand for herbicides. At the same time, the mechanical soil treatment with rollers and harrows helps against rodents. Therefore, a higher frequency of soil treatment can help reduce the demand for using pesticides. However, at the same time care needs to be taken to avoid further compacting of the soil (see minimum tillage).

Crop rotation

Furthermore, crop rotation can be used to control weeds, pests, and diseases. Moreover, it improves soil fertility, soil structure and organic matter content. This is an important measure to maintain soil fertility in Dedoplistskaro. Especially crop rotation or intercropping with legumes improves the availability of nitrogen in the soil. As water is the limiting factor in Shiraki Valley, suitable crops need to be resistant to drought and heat. Yet, most farmers will only plant additional crops if they can use them economically.[27]

In crop rotation two or more crops are grown after each other. In the current system the farmers plant wheat in the first two years and barley or sunflowers in the third year. This traditional rotation system should be amended to increase the positive effects on soil fertility and pest control. Therefore, rapeseed, alfalfa and sainfoin (*Onobrychis*) should be tested as further varieties for the crop cycle.[28] The harvest can then be used as fodder for cattle or sheep as most farmers are also engaged in livestock keeping. This new form of crop rotation has a positive effect on farm production and increases the profitability per unit land area of the selected crops.[29]

Minimum tillage

The fertile soils of Shiraki Valley technically allow for high agricultural yields. However, due to inappropriate cultivation techniques over the past decades, the formerly loose and well aerated black soil is highly compacted. Wind erosion and decomposition have significantly reduced the humus layer on top and led to a loss of nutrients. Frequent tillage not only damages the soil structure but also significantly harms soil biodiversity with major effects on the soil physical structure and water- and nutrient-holding capacity.[30]

The programme on Integrated Biodiversity Management, South Caucasus (IBiS) and its predecessor project already piloted the shift from mouldboard ploughing to low-tillage disc-cultivation. Through the use of minimum tillage organic matter is conserved in the topsoil and moisture is retained. In addition, disc-cultivation makes burning obsolete, and, hence, contributes to the protection of windbreaks from

[25] Ibid.
[26] McNeely/ Scherr (2003); p. 152.
[27] Ibid.
[28] Currently, alfalfa is being tested in Shiraki Valley. Other possible intercrops may include sainfoin, drought resistant soy, sorghum. But it is essential for most alternative crops that there is a possibility to process (oil production) and market them.
[29] Weigel, Olga (2015): Climate-Adapted Agriculture in South-Eastern Georgia.
[30] McNeely/ Scherr (2003); p. 164.

fire.[31] The knowledge on the use of disc harrows has to be shared with other farmers in the pilot area on a larger scale to have a far-reaching effect on agriculture in the region.

Cover crops

The usage of cover crops is highly connected to the establishment of alternative crop rotation in Dedoplistskaro. Cover crops are high-biomass crops, such as alfalfa, that are grown after the main crop is harvested. They are used to protect soil from water and wind erosion by maintaining effective ground cover. Cover crops can either be harvested and processed, used as fodder for livestock or used as green manure tilled into the soil to enrich soil organic matter and nutrient content before the cropping season.[32]

As already described, rapeseed, alfalfa and sainfoin will be tested as further varieties for the crop cycle in the pilot region and can act as cover crops.

Fallows

Leaving fields fallow for a year is a suitable measure to maintain soil fertility. Furthermore, fallows using trees, shrubs, or herbaceous plants can enhance wild biodiversity as there will be no application of agrochemicals and soil life can recover. Moreover, it provides habitats.[33]

The benefits of fallow for the soil and biodiversity are undisputable. Nevertheless, most farmers in Dedoplistskaro regard a year of fallow as a lost year. Therefore, the measures on the promotion of fallow will concentrate on convincing farmers to leave their fields fallow as part of the crop rotation. A change of mind-set of the farmers is needed.[34]
The use of fallows could be difficult in Dedoplistskaro as farmers are already facing problems regarding the large amounts of biomass on their fields, which are currently burned. The testing of safe ways to remove biomass therefore has to be part of measures regarding the use of fallows. Experiments could include the controlled burning of areas or one-time ploughing.

Alternative use of crop residues

Farmers in Dedoplistskaro face difficulties due to large amounts of biomass on their fields especially after harvest, or after a fallow year. Many farmers tend to burn the crop residues at the cost of soil quality and biodiversity. Therefore, alternative ways to use the crop residues have to be found to prevent burning. IBiS has conducted a Cost Benefit Analysis to study the costs of the current burning practices and possible benefits of alternative uses of crop residues.[35]
One promising option is to use a combi-harvester and a disc cultivator for better incorporation of residues into the soil. Another option is to collect the straw and use it in livestock production, sell it on the market, or process it into straw pellets for animal bedding, feed for animals, or for fuel for heating for home and industry use.

Integrated fire management

In Dedoplistskaro, the burning of crop residues is a common measure to clear the field after harvest. These fires can often not be controlled and spread to other fields and to the windbreaks which has major negative effects on wild biodiversity. Careful integrated fire management can ensure that timing and scale of fires (also considering wind) are appropriate to the ecosystem and can improve the agricultural system.[36]

[31] Gönner et al. (2014a)
[32] McNeely/ Scherr (2003); p. 165.
[33] Ibid.
[34] Gönner et al. (2014a)
[35] For further information see: Westerberg, Vanja/ Costa, Luis/ Ghambashidze, Giorgi (2016): Cost Benefit Analysis on the case for ending crop residue burning within the Dedoplistskaro district of Georgia. Tbilisi: Integrated Biodiversity Management, South Caucasus/ GIZ.
[36] McNeely/ Scherr (2003); p. 165.

The institutionalisation of an integrated fire management approach is currently under development in the pilot area.[37] Integrated fire management should comprise legal regulations including sanctions, information and education of the public, especially farmers, collective responsibility and action for fire prevention and safer burning (when unavoidable), as well as granting private ownership of wind-breaks. In order to address the persistent fire danger, an integrated fire management approach en-compassing all relevant stakeholders (including migratory shepherds) has been initiated including the establishment of a “Working Group on Biodiversity Protection and Crisis Management in Agriculture in Dedoplistskaro Municipality”, which already successfully coordinated and organised fire prevention measures throughout Shiraki Valley in 2016. The efforts taken regarding the institutionalisation of a fire management system have to be further consolidated in order to prevent disasters as the major fires in 2015.[38]

Local (adapted) varieties

Most of the agricultural areas in Shiraki Valley are planted with wheat. The farmers have the choice between local autochthonous varieties or try new imported varieties. If farmers can afford it they mostly invest in imported high-yielding varieties. The strict focus on only few crops and the planting of monocultures is negatively affecting the crop diversity in the region. Local varieties face the risk of extinction.

The use of local wheat varieties for example would protect these varieties from disappearing. Moreover, the use of local and adapted varieties can work as an insurance crop in case of natural disasters as most of the indigenous crops can cope with abrupt and transformative changes in their biophysical and socio-economic environment. Additionally, a more diverse farming system with a wide range of crop species and cultivars can result in much greater wild biodiversity as various forms of wildlife move in to occupy the expanded ecological niche. Underutilized niches on the farm can be filled with economically valuable indigenous species.[39]

Possible measures regarding the conservation of local varieties could be the promotion of the usage of local wheat varieties like red doli. Therefore, awareness regarding the benefits of this variety has to be created and possible markets for the crops have to be identified or established.[40]

Monitoring of concept implementation

The monitoring of project measures is elementary to ensure transparency and to steer the implementation process. Therefore, possible monitoring systems already need to be taken into consideration before the implementation starts. For the monitoring of the implementation of ecoagriculture measures the Pressure-State-Response framework (PSR) for environmental monitoring of the Organisation for Economic Co-operation and Development (OECD) will be used. The PSR system is recommended by the Georgian National Biodiversity Strategy and Action Plan (NBSAP) and is also the basis for the Georgian National Biodiversity Monitoring System (NBMS)[41] developed by the Ministry of Environment and Natural Resources Protection with support of GIZ. The response measures described above will be monitored through indicators comparing the state of

Pressure-State-Response framework:

This framework was introduced for environmental indicators and indicators of sustainable development.
Pressure caused by human activities exerted on the environment, including natural resources, considering direct and indirect pressures.
State describes existing conditions and relates to the quality of the environment and the quality and quantity of natural resources.
Response shows the extent to which society responds to environmental concerns. This includes measures to:

- “Mitigate, adapt to or prevent human-induced negative effects on the environment;
- Halt or reverse environmental damage already inflicted;
- Preserve and conserve nature and natural resources.”

Source: Linster, Myriam (2003): OECD Environmental Indicators: Development, Measurement and Use. Paris: OECD.

[37] Based on Global Fire Monitoring Center (GFMC) (2015): Wildfires in Dedoplistskaro Municipality Shiraki Valley, Georgia. Rationale and Proposal for a Fire Management Concept. Tbilisi: Sustainable Management of Biodiversity, South Caucasus/ GIZ.
[38] Gönner et al. (2014b)
[39] McNeely/ Scherr (2003); p. 166.
[40] Camacho et al. (2015)
[41] The NBMS includes indicators on agrobiodiversity regarding its state, pressure and response: S2: Agrobiodiversity; P5: Intensity of Agriculture; R6: Extent of organic farming.

agrobiodiversity at the beginning of the implementation with the situation of the pilot area at a later stage. In addition, response indicators can be used for monitoring the implementation process.

Needed institutional, legal and policy framework

As mentioned above, a clear **institutional framework** is needed for the ecoagriculture measures to be effective. The institutional framework comprises legislation, policies and incentive mechanisms, as well as their implementation. Therefore, a strong environmental **legislation** regulating the restoration, sustainable use and conservation of biodiversity and agroecosystems is required. This legislation has to be closely coordinated with the agricultural sector to ensure the consideration of ecological principles in agricultural policies focusing stronger on agrobiodiversity and taking into account the potential of ecoagriculture.

Agrobiodiversity is a typical cross-cutting issue which can only be addressed through intersectoral cooperation. To create a common understanding and a regulatory frame regarding the protection of agrobiodiversity a **political negotiation process** has to be initiated. All political stakeholders including the Ministry of Environment and Natural Resources Protection and the Ministry of Agriculture have to demonstrate the political will to come to an agreement on the future direction in agrobiodiversity protection. These common understanding and agreements should result in new legislations and support coordinated decision-making on the topic. This will foster strategic cooperation with other actors, such as scientific research centres like the Scientific Research Center of Agriculture (SRCA), or the Information and Consultation Center (ICC) of the Ministry of Agriculture to ensure the sustainability and possibility to upscale successful approaches.

Furthermore, there has to be a closer cooperation among the **different political levels**. Well-coordinated action is needed at national, as well as at regional and local level to ensure an enabling institutional environment.

Moreover, **incentive mechanisms** for improved biodiversity protection have to be developed. These can include governmental, as well as private economic incentives. Possible state measures to support agrobiodiversity could comprise the abolition of biodiversity-harmful subsidies, tax reductions for ecoagricultural productions, investment grants, and improved access to affordable loans. Another possibility could be the support of already existing international certification schemes for biodiversity-friendly production, or to develop a contest for innovative projects protecting biodiversity in agricultural production.

The development of niche markets for biodiversity-friendly products is a precondition for the shift from commercial to an ecologically-oriented agricultural production. Farmers cannot afford to focus their production on goods without reliable sales markets. In addition, organic farming should be promoted including awareness raising in the broader society regarding the benefits of this form of agriculture. To achieve these objectives a close collaboration with the economic and educational sector is needed. These examples outline once again the interconnectedness of the topic and calls upon enhanced co-ordination and cooperation.