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POLICY BRIEF

GFA CONSULTING GROUP
General Agent BMEL Berlin Office

GERMAN-MONGOLIAN COOPERATION PROJECT "SUSTAINABLE AGRICULTURE"

Nr. 03.2022

Key Recommendations:

- Raise public awareness on benefits of agroforestry systems, e.g. agriculture, environment, and economic and employment opportunities
- Provide policy support and implement programmes for strengthening the development of agroforestry systems including shelterbelts and improved intersectoral cooperation and coordination, e.g. between MoFALI and MoET and their agencies
- Create a legal environment on development of agroforestry systems in the country by including provisions on land allocation for agroforestry systems including shelterbelts in the revised Land Law
- Define real values at the carbon market by estimating ecological and economic impacts and actual carbon storing capacity of a tree planted in agroforestry systems
- Diversify agroforestry systems (e.g. crop, horticulture, fruit farming, medicinal plant farming) and develop scientifically based justifications and feasibility studies on their regional development
- Have a fund for development of agroforestry systems
- Provide policy support to preparation and training of agroforesty system professionals

Agroforestry Basis

Agroforestry or agroforestry systems are one of the optimal ways to solve poverty and environmental degradation issues [1]. A simple definition by the World Agroforestry Centre is that agroforestry is the interaction of agriculture and trees or agricultural use of trees [2]. The agroforestry systems are the multifunctional systems to balance various human needs under the following three functions: 1) to produce trees for timber and other commercial purposes; 2) to produce a diverse, adequate supply of nutritious foods; and 3) to ensure the protection of natural environments and ecosystem services [2]. Any stage of the agroforestry systems is actually relied on and managed by collaborative human activities so that the systems have the advantage of increasing social activity and participation, especially for women. In addition, the agroforestry systems enhance ecosystems by storing carbon, preventing deforestation, protecting biodiversity, increasing clean water resources, and controlling soil erosion while enabling agricultural lands to withstand the events such as flooding [1].

Agroforestry Practices: UN FAO defines three main types of agroforestry systems: 1) ***agrisilvicultural systems*** are a combination of trees and crops, 2) ***silvopastoral systems*** combine forestry and domesticated animals, and 3) ***agrosylvopastoral systems*** combine trees, crops, and domesticated animals. Some countries define other types such as agroforestry in riparian zones, urban parks and park-oriented agroforestry, and multi-purposed protection belts (e.g. shelterbelts and windbreaks). According to the remote sensing study results, 43% of the world's total agricultural lands have at least 10% tree cover which correspond to the agroforestry practices [3].

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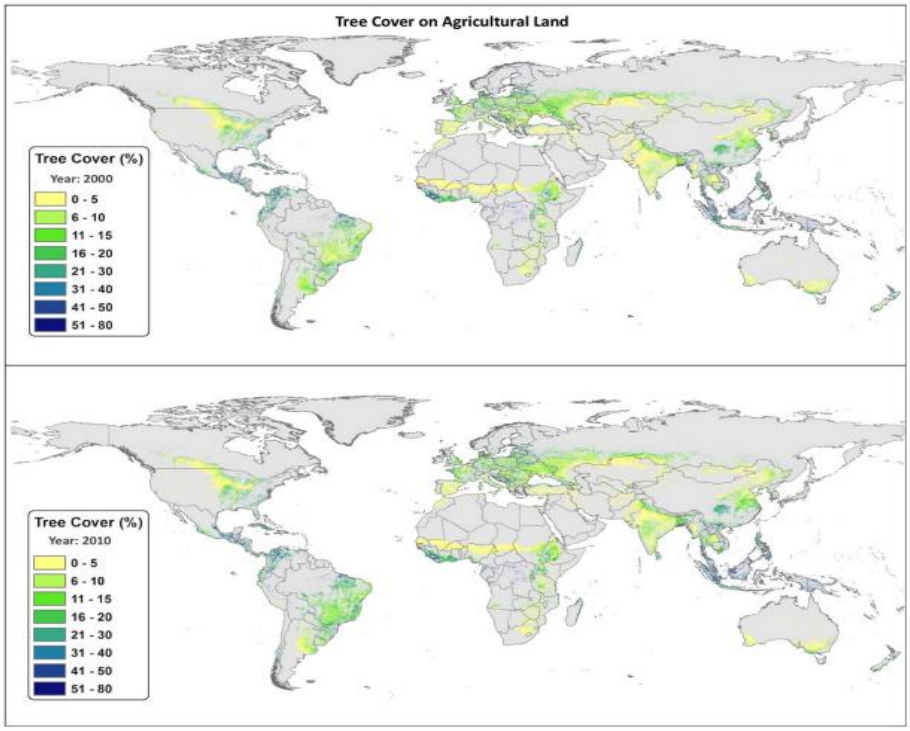

Figure 1. Global tree cover on agricultural land in the years 2000 and 2010. Approximately 40% of all agricultural land in the year 2010 had at least 10% tree cover (which corresponds to the FAO definition of forest). This increased by 3.7% by the 2010, to account for more than 43% of all agricultural land under some variation of agroforestry approaches. Based on this current analysis, these land-use types represent over 1 billion hectares of land and provide subsistence to more than 900 million people. Maps were produced based upon a geospatial analysis using ESRI ArcGIS software (version 10.3; http://www.esri.com/software/arcgis/arcgis-for-desktop).

Based on an analysis of 183 farmer interviews in 14 case study systems in eight European countries under the project "Advances in European Agroforestry" (AGFORWARD), which has been implemented within Europe, there are four main types of agroforestry systems in Europe [4] (Figure 1):

(1) Agroforestry of high nature and cultural value

(2) Agroforestry for high value tree systems

(3) Agroforestry for arable systems

(4) Agroforestry for livestock systems

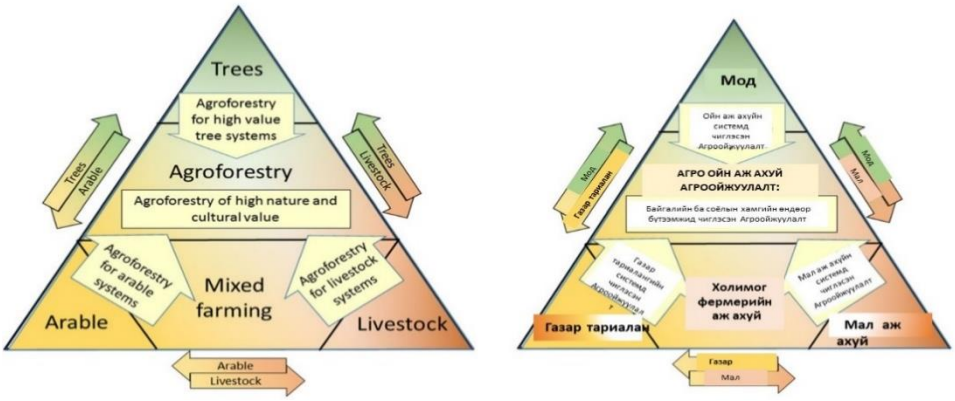

Figure 1. Main types of current agroforestry systems in European countries (*Note: The triangle illustrates four main types of current agroforestry systems in the region and their interrelationships shown in its corners and centre)*

The table below shows types of the most common agroforestry systems that are being introduced in international practices.

Table 1. Types of the most common agroforestry systems in international practices

Agroforestry systems	Main activities	Description
Agrisilvicultural system (combining trees and crops)	Improved or rotational fallows	Woody perennials including trees and shrubs are planted and used deliberately for restoring soil nutrients. Main approaches applied are rotations and, sometimes, a traditional transplanting (to rotate).
	Parks and gardens, namely multipurpose green facilities with different covering areas (a mixed system combining trees and crops)	Parks and gardens, man-made landscapes derived from agricultural activities, and other lands including terraces and low ridges (hillocks), where the mixed system is run with various deliberate designs and patterns.
	Arrangements by combining trees and crops	To obtain high valued yields, tree shades are used rotationally for cropping system or tree and crop yields are combined.
	Tree gardens – home gardens	Mixed planting of several species of fruits and other useful trees; sometimes they include year-round yields. These types of arrangements are sometimes called home gardens.
	Alley cropping (hedgerow intercropping)	Woody species are planted in hedges while crops and other agricultural species are planted in alleys in-between hedges.
	Protection belts (e.g. shelterbelts and windbreaks)	Extended forest strips (windbreaks and shelterbelts) are established to protect farmlands or plots from wind.
Silvopastoral system (combining trees and pastures/animals)	Woody species (e.g. trees and bushes) around farmlands to produce multipurpose forages (protein bank)	Protein-rich trees are planted on pastures near/on farmlands to produce protein forages.
	Live hedges – protection belts	Extended protection belts are established to protect farmlands and supply animals with forages.
Agrosilvopastoral system (combining trees, crops, and pastures/animals)	A set of production of livestock husbandry and dairy and timber products	Livestock husbandry and dairy and timber products are simultaneously produced in one area.
	Trees and bushes are planted on pastures	On pastures, trees are scattered or planted irregularly or arranged according to some systematic or random patterns.
	A set of production of livestock (meat and milk products), crops, and timber (fuelwood)	Crops, livestock (meat and milk products), and timber products are simultaneously produced in an area including surrounding areas of fenced area.
	Woody plants for green manure, animal forage, and soil protection Tree bearing pasture products	Multipurpose woody plants are planted or used to provide green manure, a feeding source for soil protection, and delineating boundaries. Herbaceous and woody plants bearing pastures
Other agroforestry systems (e.g. fish and insect bearing)	Entomo-forestry	Production combining timber and insects (e.g. bee honey, trees for honey production)
	Aqua-silvo-fishery	Trees lining fish ponds, tree leaves being used as “forage” for fish

Benefits of agroforestry systems: Agroforestry systems play an important role in carbon sequestration and mitigation of climate change [5]. For instance, the agroforestry systems can provide beneficial shade covers to crops and plants by protecting them from overheat, alleviating their drought and heat stresses and ambient

temperature fluctuations, and mitigating soil moisture evaporations and direct effects of wind depending on shelterbelt growth stages (e.g., heights and ages of trees) [6]. Windbreaks and shelterbelts on agricultural lands contribute to reduced soil moisture evaporations and nutrient losses, increased groundwater capture capacities, and snow deposition within the lands. Combination of shelterbelts and wide-alley cropping contributes to biodiversity conservation and enrichment of soils with organic matters (Figure 2).

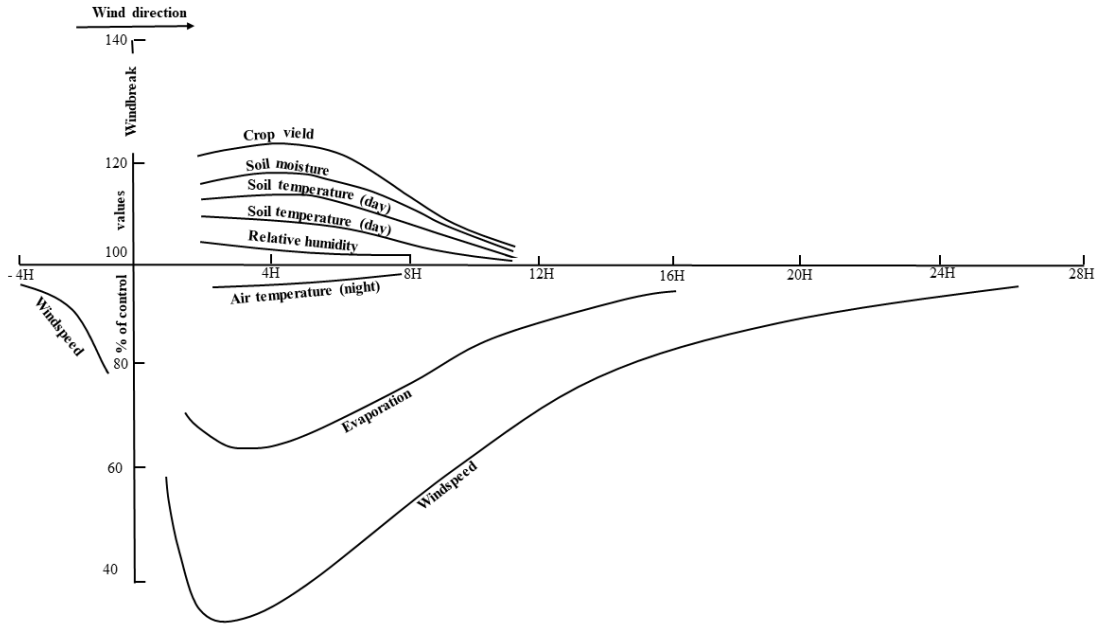

Figure 2. Changes in growths, humidity, air temperatures, wind speeds, and moisture evaporations at distances from the sheltered area (4H: distances, where tree heights are multiplied by four) [7]

According to the figure above, sheltered areas on farmlands provide a number of benefits such as reduce wind speeds and soil and air temperature fluctuations, thicken snow depositions in-between alleys or hedgerows, make melting gradual by reducing depths of freezing in soil, and capture or limit soil and plant moisture losses at certain levels.

A comparative study of cultivated soils and virgin lands in Mongolia shows that 60.8% of the cultivated soils in the country have become subject to erosion [8]. Monitoring results from designated plots on cultivated areas indicate humus contents and physical clay percentages are declined by 0.2-0.6% and 7-14%, respectively, while sand presences are increased. These monitoring findings show the country needs soil protection measures [8]. In addition, many researchers also warn that a major limiting factor for growths and yields of crops and planted species is loss of soil moisture. Preliminary results of an ongoing study in the central region of Mongolia show that soil moisture contents in unsheltered and sheltered areas as follows: soil moisture contents in unsheltered and sheltered areas are 10.61 mm and 13.53 mm, respectively, at 0-20 cm depths; and 9.76 mm and 14.30 mm, respectively, at 20-40 cm depths prior to spring cultivation. Thus, the soil moisture contents in sheltered areas on cultivated areas are higher by 2.9-4.5 mm relative to that in unsheltered areas prior to their cultivation. Another study findings on growths and yields of planted species

show wheat growth in sheltered areas is increased by 4.7 ts/ha and height of Astragalus, a medicinal plant, is increased by 0.5 cm in its first year [9].

The study findings above justify that sheltered areas on cultivated areas are much beneficial to increasing crop growths and yields by reducing soil erosion and increasing moisture and help increase food supplies, develop the domestic crop products that gradually replace imported foods, and become Mongolia a food exporting nation.

Business entities engaged in crop and horticulture do plant trees and have shelterbelts in surrounding areas of their cultivated plots under guidance of forestry professionals. They inform that precipitation amounts recorded within their plots are getting increased notably [10]. These facts are a part of demonstration practices in the sector on one hand and a part of direct interventions to mitigate climate change on the other hand.

Risk: A key point is to develop agroforestry systems as business entity levels based on specific natural features of local areas and regions. Large-scale afforestation efforts within an entire country or a region may not be a viable option. This option has been proved by the large-scale afforestation efforts in arid and semi-arid regions of China which were undertaken until 2010. The efforts were made, but tree survival in the planted areas was just 15% [11]. For shelterbelts on a cultivated area, tree species must be selected based on the areas or the region's specific natural features. Otherwise, these efforts may fail or may require costly and comprehensive technologies.

Potential and actual risks incurred to development of agroforestry systems are summarized as follows: (1) labour intensive; (2) time-consuming until planted trees become matured and act as shelterbelts; (3) limited opportunities to harvest, supply, and trade large amounts of timber and timber products; (4) absence of adequate legal environment; (5) a lack of farmers' knowledge and experiences in tree planting; (6) inadequate studies on competition between trees and agricultural species planted (e.g. shelterbelts too close to each other may result in lower yields due to their shades; extensive tree planting in semi-arid regions may lead to decreased moisture contents of planted agricultural species [crops]; and distribution spaces of tree and agricultural species roots may overlap); (7) distributions and outbreaks of alien species and associated pests; and (8) ignorance of specific characteristics of some tree species (e.g. some tree species grow and distribute with their lateral roots).

In practice, pastures and farmlands contribute to the recharge of groundwater resources through rainwater infiltration into the soil. When trees that consume soil moisture are planted on farmlands, the roots of the planted trees consume rainwater, reducing or preventing rainwater infiltration into the soil to recharge groundwater [12]. Therefore, physical distances and locations of trees in shelterbelts should be accurately estimated while keeping in mind their different moisture consumption and water penetration process between and along shelterbelts. In addition, designs and patterns of shelterbelts in agroforestry systems should be based on water source availabilities. Shelterbelts will not survive if they are not watered. Another concern for shelterbelts includes that small or immature seedlings are eaten by rabbits and livestock especially in winter, when snow covers become thick. Thus, the shelterbelts need adequate fencing to prevent livestock, rodents (e.g., rabbits), and other external risks. Otherwise, these risks may result in re-planting and ultimately unsuccessful survivability of the trees planted. In addition, shelterbelts are distributed by weeds. Extensive occurrence and over-populations of weeds may cause and increase disturbances in the shelterbelts. Upon

consideration of all these actual and potential risks to agroforestry systems in advance, a focus is given to accurate adherence of technological requirements and amounts of required investments and labour at least for the first five years of shelterbelt establishment. In recognition of these contexts, the policy and financial supports, scientifically based information and awareness are essential for successful development of agroforestry systems (e.g., shelterbelts on cultivated areas) and achievements of desired (planned) results.

To develop agroforestry systems and have shelterbelts on farmlands, human resources are vitally important. In the current Mongolian context, the perceptions: "standard agroforestry systems (e.g., shelterbelts) are still unavailable in the country due to absence of agroforestry professionals" and "business entities give up tree planting and see it as an unreachable task when the trees they planted are not survived" have become widespread. These negative perceptions maybe another major risk to the successful development of agroforestry systems in the country.

RECOMMENDATIONS:

1. Create a legal environment on development of agroforestry systems in the country by including provisions on land allocation for agroforestry systems including shelterbelts in the revised Land Law
2. Provide policy support and implement programmes for strengthening of development of agroforestry systems including shelterbelts and improved intersectoral cooperation and coordination (e.g. between the Ministry of Food, Agriculture, and Light Industry and the Ministry of Environment and Tourism and their agencies)
3. Diversify agroforestry systems (e.g. crop, horticulture, fruit farming, medicinal plant farming) and develop scientifically based justifications and feasibility studies on their regional developments
4. Have a fund and provide financial support required for the development of agroforestry systems under the objectives: 100% supply of domestic food needs and the food product development to replace imported foods and export food products
5. Provide concrete support to preparation and training of agroforestry professionals by adding new technical subjects in training curriculums of respective vocational schools and universities and publishing textbooks and handbooks
6. Define real values at the carbon market by estimating ecological and economic impacts and actual carbon storing capacity of a tree planted in agroforestry systems
7. Provide women and entities with small-medium sized incomes with the opportunities to increase their incomes and collaborate among themselves within agroforestry systems
8. Implement the scientific and technological projects and programmes that help develop scientifically based agroforestry systems in the country

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