Research and Development Protocol for Alley Cropping in Hungary

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Contents

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1 Context

The AGFORWARD research project (January 2014-December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. The project has four objectives:

1. to understand the context and extent of agroforestry in Europe,
2. to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe,
3. to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
4. to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

This report contributes to the second objective. It contributes to the initial research and development protocol (Milestone 16 (4.3)) for the participative research and development network focused on the use of agroforestry on arable lands.

2 Background

During the 20th century, agroforestry was a widespread form of land use in Hungary. However in recent decades, the practice has disappeared from large areas of the Hungarian countryside (Gál, 1961; Varga and Bölöni, 2009).

Protective tree systems (shelterbelts and buffer strips on farmsteads or between arable lands) have been common practice in Hungary over recent centuries. The number of shelterbelts increased significantly in the 1960-70s, but they fell in the following 30 years, and are still declining. According to the latest data the total area of windbreaks and shelterbelts in Hungary is about 16,000 ha. (Frank and Takács, 2012)

Alley cropping is a novel land use practice in Hungary. Those systems that exist are limited in extent, existing mostly on small farms or newly-established pilot systems for educational and/or experimental purposes (Szalai et al. 2012; Vityi et al. 2014).

About 60% of Hungary comprises agricultural land such as croplands, pastures, plantations, grasslands. Of these, 85% are classified as agro-environmentally sensitive areas (Vityi and Marosvölgyi 2013). Significant areas in the Hungarian Great Plain suffer the “triple-risk” of flooding, drought, and inland waters (Láng et al. 2007), and there is a strong need for development in climate-smart agricultural practices. Alley cropping could be one method of establishing more resilient and sustainable agricultural production.

This trial is being conducted in association with a local stakeholder: Kék Duna Agricultural Cooperative. The objective of this integrated on-farm research is to develop the cooperative’s own field trials on issues of interest. Hence the focus is on the development of more resilient agricultural production in areas without irrigation. The cooperative business includes crop production and livestock breeding, and the total area available to the co-operative is tending to decline as some of land owners do not renew their contract. The herd of about 400 cattle experience a shortage in fodder in some parts of the year. A focus on arable crop production prevents fodder production on

a major part of the co-operative. Local experiments have shown that the tree species, Paulownia, can produce an annual dry weight of about 25-30 t/ha (Vityi 2010) for bioenergy purposes. Hence combining Paulownia with alfalfa (a shade tolerant species) could provide both a highly nutritious forage supply and high wood production in the same area. The Kék Duna Cooperative and local farmers have plans to extent the use of agroforestry with a greater variety of plant species (e.g. native tree species and food crops) provided the current trials demonstrate that agroforestry can enhance agricultural production and reduce risk under local conditions. NyME KKK is providing the scientific and technical support for the experiments. The First stakeholder meeting on Alley Cropping systems in Hungary was held on 29 August 2014 where the decision on the key issues and potential innovation tests was made by the group (Vityi 2014).

3 Objective of trial

The main objective of the trial is to determine the impact of alley cropping, relative to conventional arable production, on forage yields and variability in an area in Hungary where irrigation is not possible and the climate is variable. Hence the key questions include:

- How do alley cropping system affect
    - local microclimate
    - system resilience
    - forage yields
    - tree yields
    - plant resistance
    - soil water and nutrient content
    - soil humus content

However the trial will also be used to address the following questions:

- How to control weeds (cost) effectively, to reduce the amount of labour and the use of chemicals in tree rows?
- How to effectively protect trees from wild animals?

Alongside these questions, the following hypotheses are proposed:

- Tree by-products could be used as forage for livestock
- The labour costs of applying straw mulch at the base of the trees could be offset by improved control of weeds and lower agrochemical costs.

4 System description

The above questions will be addressed in a 2 ha agroforestry system research site at Fajsz, Hungary, located on land managed by the local cooperative (Figure 1). The system comprises rows of *Paulownia tomentosa* intercropped with alfalfa (*Medicago sp.*). The tree rows orientated N-NW to S-SE (highlighted green in Figure 1). The trees were planted in 2013, and the area is protected by an external fence (Table 1).

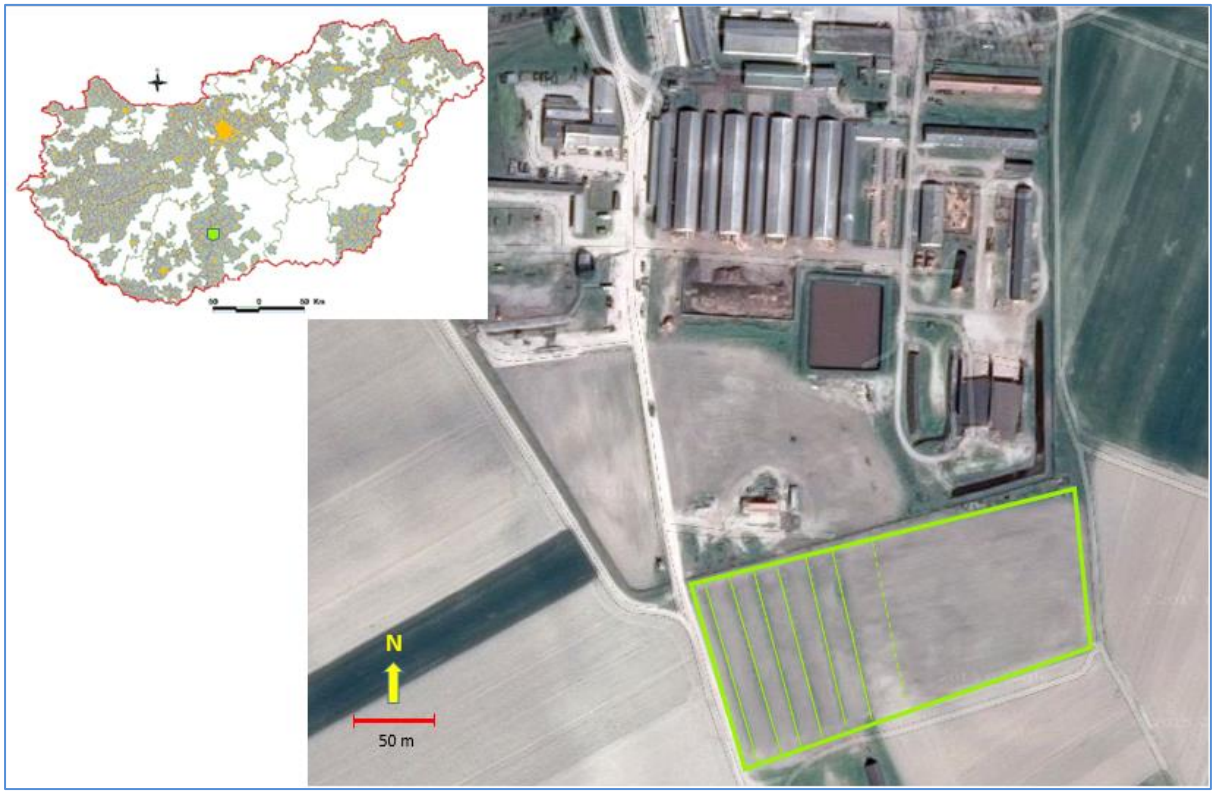

Figure 1. Aerial photograph (Google map) of the Southern Farm unit of Kék Duna Agr. Cooperative. Thick green line indicate the boundaries of the plot (dotted line separates agroforestry system and control system), light green rows indicates the tree rows in alley cropping. The insert shows the distribution of nitrate-sensitive areas in Hungary; the green dot indicates the alley cropping experimental site at Fajsz. (Original map from: 137/2004. Regulation concerning the promulgation of the National Rural Development Plan).

Figure 2. The experimental alley cropping system at Fajsz (source: A. Vityi, August 2014)

Table 1. Description of the site, with soil, tree, understorey, and climate characteristics.

Site characteristics	
Area (ha):	2.0
Co-ordinates:	46°40'51.41"N, 18°92'71.98"E
Site contact:	Andrea Vityi
Site contact email address	vityi.andrea@gmail.com

Soil characteristics	
Soil type (WRB classification)	Chernozems, Phaenozems, Fluvisols
Soil depth	>120 cm
Soil texture (sand%, silt%, clay%)	Loamy
Additional soil characteristics	Groundwater 2-5 m* below soil surface (figures from local measurements varies seasonally between 3.5 m and >6 m below soil surface)

Tree characteristics		
System	Agroforestry system	Arable system**
Tree species Variety/rootstock Tree density (spacing) Tree protection	*Paulownia tomentosa* 'Continental E.'*** 126 trees/ha (18 m x 5 m) Wire fencing around the experiment	None

Understorey characteristics		
System	Agroforestry system	Arable system*
Species Coverage Additional details	Alfalfa *(Medicago sativa)* Complete Alfalfa managed by mechanical treatment used in large scale farming	Alfalfa *(Medicago sativa)* Complete Alfalfa managed by mechanical treatment used in large scale farming

Climate data	
Mean monthly temperature	10.6-10.8°C
Mean annual precipitation	540-560 mm
Additional details	Spring frost risk, drought-risk, inland water risk
Details of weather station	Specific local data by Vantage Pro2 stations from May 2014

* According to the soil water map made by the Geological and Geophysical Institute of Hungary

** To which the agroforestry system is compared

*** National approval of plant variety is in progress

5. Trial design

5.1 Conceptual design

The primary objective is to compare the yield and variability of alfalfa production in the alley cropping area with that in the conventional arable area (Table 2). In addition to the overall design, if possible smaller experiments are planned to look at alternative methods of weed control within the tree alleys, predator control, and to determine the potential of Paulownia as a forage source.

Table 2. Description of the treatments

Alley cropping treatment	Arable treatment
Alley cropping Additional measurements on: • methods of weed control in the tree row • predator control • the use of Paulownia as forage	Conventional agriculture (crop monoculture)

5.2 Description of design

A schematic map of the field site is shown in Figure 3. The 2 ha block have been divided in parallel with the line of the trees into roughly equal plots of about 1 ha each. Management of the alfalfa crop will be similar for the two areas.

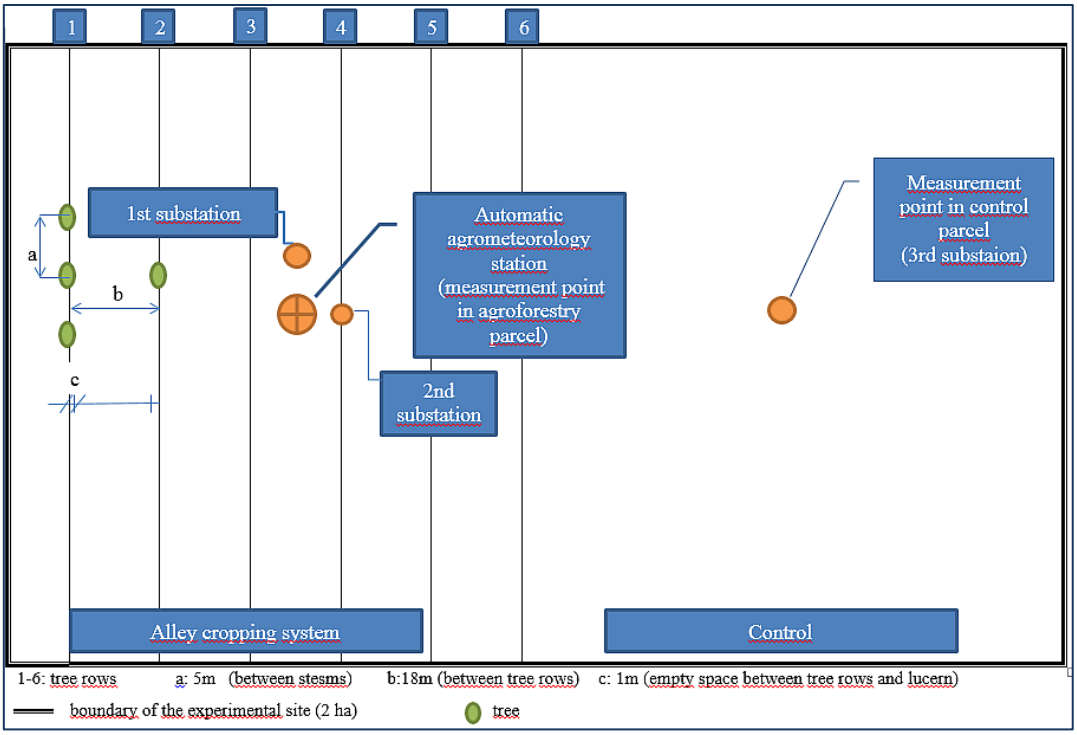

Figure 3. Schematic map of the Agricultural Cooperative Kék Duna field site with the scheme of planting structure of the agroforestry system and the agrometeorological measuring points within the plots. The trees have an intra-row spacing of 5 m, with 18 m between rows.

6 Measurements

The planned measurements to be taken in the two plots are described in Table 3.

Table 3. Measurements to be taken in the alley cropping and the control plots

Treatment	Alley cropping	Tree control	Arable control
Tree component	Tree growth Tree damage from wild animals Labour spent for weed control	Tree growth Tree damage	
Crop component	Yield Disease incidence		Yield Disease incidence
Soil component	Temperature and moisture content Soil organic matter Soil nutrient content		Temperature and moisture content Soil organic matter Soil nutrient content
Weather	Solar radiation, Air temperature and humidity Precipitation Wind speed and direction Predicted leaf surface humidity		Solar radiation, Air temperature and humidity Precipitation Wind speed and direction

6.1 Tree growth and damage

Tree diameter and height measurements for alley cropping plot will be carried out for trees on an annual basis. Tree plantations of the same species located outside the system are potentially usable for control.

Although the field is rounded by closed fence smaller animals are able to get through the wire net and can damage trees. From experience we know that wild animals can damage the whole of one-year-old Paulownia plants, while in case of older plants damage is restricted to the trunks. A protocol will be established to record annually the scale of damage, using photographs as appropriate. The use of bio-repellents has been suggested. Control test of the applied materials is planned to be arranged in existing tree plantations with the same species, located outside the protected agroforestry research field.

6.2 Weed control

It is anticipated that an inability to mechanically manage the weeds in the tree rows will lead to higher labour costs compared to an arable monoculture. In order to minimise the use of herbicides, an alternative method of weed control will be investigated. The proposal is to use straw cover in a part of the agroforestry system and to test the effectiveness by measuring the relative extent of weed cover (using photographs) before and after action. Tree row(s) without using alternative method will be the control in these measures. The labour requirements and costs spent of the weed control method will be recorded.

6.3 Crop growth and yield

Forage biomass production for each plot will be measured in each harvesting period. The effects of the presence of trees on crop disease will be determined. Photographs and samples will be taken from four plots in the agroforestry treatments and at four points in the control.

6.4 Soil measurements

In the first year of the system, the soil content of organic matter and key nutrients were determined at specific points to provide a "baseline". Similar points will be resampled to determine the effect of the trees and cropping system on organic matter and nutrients.

6.5 Weather

Microclimatic parameters (below and aboveground) are detected by an automatic agrometeorology station established by the Cooperative in the research site (Figure 3; Table 3). The data will be provided by the main station with two substations in the agroforestry plot and one substation in the control plot. These measurements will be used in the assessment of system vulnerability.

6.6 Supplementary measurements

The value of the leaves and branches of Paulownia as a livestock fodder will also be evaluated.

7 Acknowledgements

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8 References

Frank N, Takács V (2012). Hó- és szélfogó erdősávokminősítése szeélsebesség-csökkentő hatásuk alapján [Windbreaks and shelter-belts examination by their effect on decreasing the windspeed]. Erdészettudományi Közlemények 2(1): 151-162.

Gál J (1961). The effects of shelter belts on wind velocity. Publications of Forestry Science. Mezőgazdasági Kiadó 2: 5-66.

Láng I, Csete L, Jolánkai M (2007). A globális klímaváltozás: hazai hatások és válaszok. A VAHAVA jelentés. Szaktudás Kiadó Ház, Budapest, 2007.

National Rural Development Plan (2004). 137/2004. (IX. 18.) FVM rendelet a Nemzeti Vidékfejlesztési Terv kihirdetéséről, valamint az Európai Mezőgazdasági Orientációs és Garancia Alapból nyújtandó vidékfejlesztési támogatásokkal összefüggésben a kedvezőtlen adottságú területek és az azokhoz tartozó települések megállapításáról [137/2004. Regulation (IX. 18) concerning the promulgation of the National Rural Development Plan].

Szalai Z, Radics L, Divéky-Ertsey A (2012). Erdőkert – Forest garden – kialakításának megalapozása az Ökológiai és Fenntartható Gazdálkodási Rendszerek Tanszék Soroksári Kísérleti Üzemében. Kertgazdaság 44(2): 79-81.

Varga A, Bölöni J (2009). Erdei legeltetés, fás legelők, legelőerdők tájtörténete. [Landscape history of the forest grazing and wood pastures]. Természetvédelmi Közlemények, Magyar Botanika Társaság, Budapest. 68-79.

Vityi A (2011). A fajszi kísérleti császárfa ültetvény kutatási eredményei. [Unpublished results of experiments with Paulownia sp. plantation] (in Hungarian). NyME KKK, Sopron, for internal use.

Vityi A (2014). Initial Stakeholder Meeting Report: Alley Cropping Systems in Hungary. 23 October 2014. 11 pp. Available online: http://www.agforward.eu/index.php/en/alley-cropping-systems-in-hungary.html

Vityi A, Marosvölgyi B, Szalai Z, Varga A (2014). Agroforestry Research and Development in Hungary. In: JHN Palma (ed.) 2nd European Agroforestry Conference: Integrating Science and Policy to Promote Agroforestry in Practice. Cottbus: Brandenburg University of Technology. 201-204.

Vityi A, Marosvölgyi B (2013): Role of agroforestry in the development of the Hungarian rural areas. Rural resilience and vulnerability: The rural as locus of solidarity and conflict in times of crisis XXVth Congress of the European Society for Rural Sociology. 29 July – 1 August 2013. eProceedings. Laboratorio di studi rurali SISMONDI, Pisa (Italy) 281-282.