EIP-AGRI Focus Group

Agroforestry

MINIPAPER 5: Practical Tree Knowledge on Farm level
25 April 2017

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1.   Introduction

Agroforestry systems are increasingly relevant as a land use concept. A rising number of farmers is affected by this system, but very often have little or even no practical experience at the beginning, especially with the management of trees in arable land. Concerning that issue, many practical questions arise:

- What are the appropriate tree species and varieties for my site?
- Which kind of tree management can ensure the economic efficiency, the product quality and the productivity at the same time?
- Trees and crops - which complement each other best?

The tree is in the focus and has to be managed to fulfil the desired functions in an optimal manner. It should be kept in mind that different tree species have different requirements, fulfil different purposes and functions and that the different functions require different management practices. Therefore, it is very difficult to give general recommendations about tree care being adequate for all systems. Furthermore, different climatic conditions require different species and management. This minipaper is intended to provide approaches to link existing knowledge, across different agroforestry systems and national borders.

1.1 Targets Minipaper 5

This minipaper wants to outline the current status of practical tree management in agroforestry systems on farm level. It wants to provide a basis for the possible decision-making regarding the practical tree management. In addition, perspectives for closing knowledge gaps will be presented and ideas for better linking existing knowledge across system and national boundaries will be developed.

2.   Practical Tree knowledge in agroforestry systems – where do we stand today?

The tree as a central element in agroforestry systems has been largely neglected in EU agroforestry research over the past few decades. The research focused strongly on the effects of trees on the biodiversity, the shading of the crop, the influence on erosion, nutrient export, etc. The trees themselves and their specific needs were given less attention.

The existing knowledge in practice is very different. It is mainly dependent on whether the farmer has experiences with trees outside the agroforestry system, for example with fruit trees or as a forest owner with valuable timber or timber trees.

2.1 Reasons for the loss of general Tree knowledge

Today, trees in the cultivated land are viewed primarily from the aspect of their ecosystem service. As a standalone productive element, the tree is scarcely perceived, but in earlier times the tree was inextricably linked to agricultural use: it supplied firewood, timber, fruit, protection, shade for the cattle, the foliage fertilized the land and the root plant fortified slopes and drainage ditches.

Today, we can still find relicts of these forms of use in many regions of Europe: Pollard Willow, Shelterbelts, hedges, orchards, poplar rows bordering agricultural plots etc.

In many places the preservation of these agricultural perceptions will soon disappear. However, their original economic purpose, their contribution to productivity and increased added value on the land, must now be redeveloped - as well as the very practical knowledge of the Tree Management on Farmland.

2.2 Challenges and Chances for agroforestry

Agroforestry calls into question a system that has long been successful in promoting a higher productivity: the strict separation in arable land and forest. Today we know a lot about trees in their native zone (for example in forests or orchards) and little about trees outside their native zone (for example in arable land). Agroforstry can be an answer to the question how to connect two "detached" zones.

As a challenge, the open field situation of trees in agroforestry systems confronts the farmer with other questions than the forest manager.
Examples of frequent questions or special requirements in certain agroforestry systems

- A specific problem in AF systems for high-value timber trees is the fact that birds come and sit on the top shoot which then often breaks.

- High exposure to sun and to more nutrients, can lead to differences in e.g. wood quality, or sensitivity to certain diseases.

- Trees on agricultural plots might also be prone to more drought stress.

- Rooting patterns are influenced by soil tillage practices. Over time, the tree strip should always be kept intact or even become wider (but never more narrow)

- When selecting tree varieties for agroforestry conditions, other criteria might be relevant than in forestry. E.g. for poplar trees leaves should not be too large in size, to avoid breaking of branches by wind. Or varieties might be selected for which the foliage develops later in the season, to avoid competition with crops, etc.

in case of short rotation coppice in AF:

to build tree planting structure taking the space requirements of machineries eg. crop and tree (!) harvesters into consideration

harmonising crops with SRC lifecycle and harvesting periods so that after the end of life of the plantation the existence of the crop doesn't prohibit replanting of the SRC system

The cultivation of fruit trees in agroforestry systems is also different in many aspects in comparison to the traditional orchard:
- The depth of the soil is of greater importance than in the orchard, so that the root systems of tree and subculture do not compete with each other
- High-stem fruit trees are often sold with a crown base height between 1.50m and 2m from the tree nurseries. To ensure that management with big machines is not hindered even in later years, the crown base height must be increased.
- The time window for the mechanized fruit harvest is very narrow in silvoarable agroforestry systems. It is between the harvest of the subculture and the sowing of the following culture. When selecting the varieties, this time window must be taken into account accordingly.
- Fruit trees cannot be treated with plant protection products when there are ripe vegetables or other crops underneath. It is also undesirable that rapeseed is treated with insecticides when rows of flowering cherry trees stand above. The requirements for a well-designed plant protection management are high in the agroforestry system.

In addition to all open questions, it can also be an opportunity for agroforestry to develop knowledge for a circle of users, which has previously been reserved for non-agricultural circles (for example, forestry).
A good example for the generation of knowledge for a new user group are the findings of the forest scientist Alex Shigo.
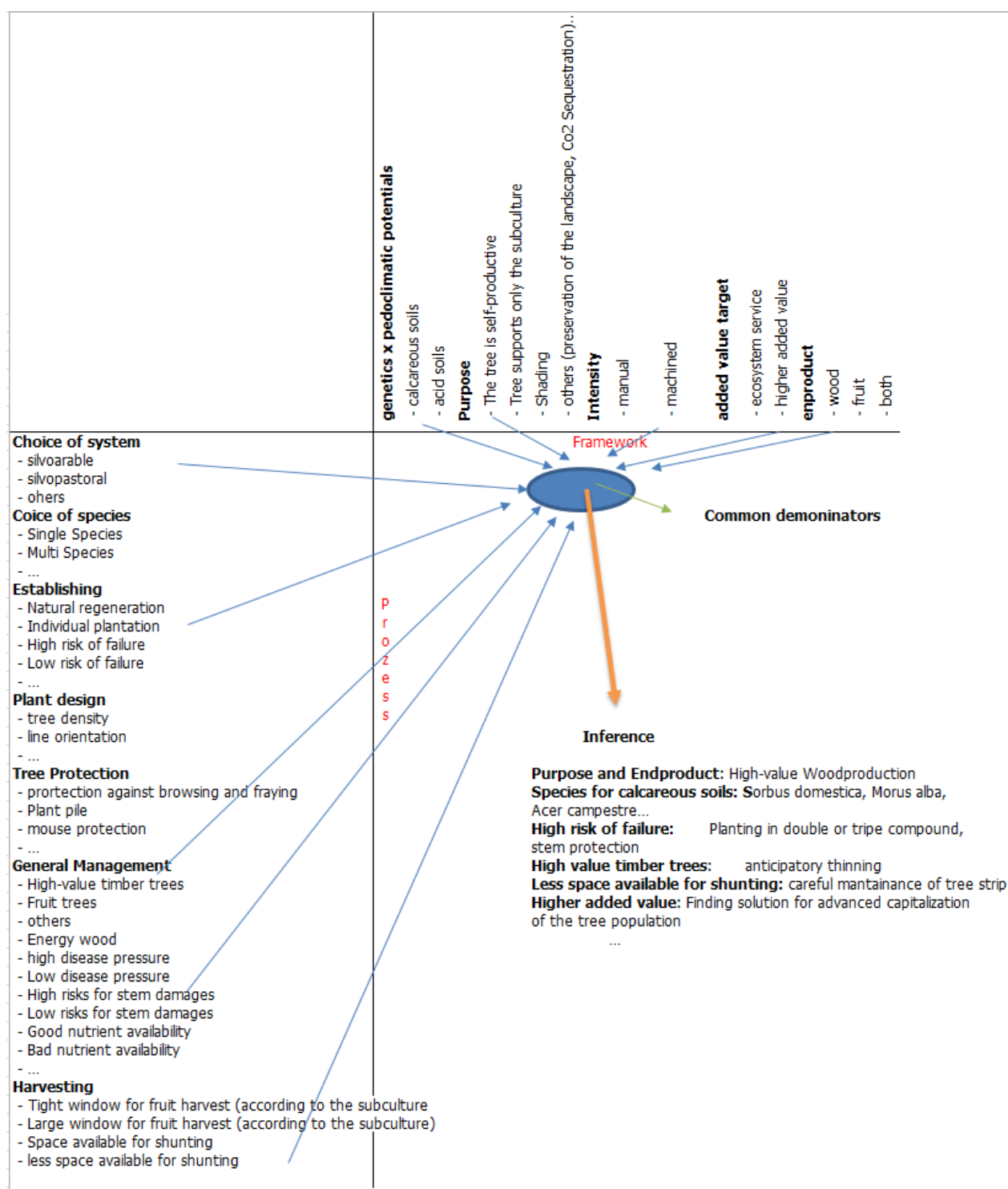In the 1980s, American forestry scientist Alex Shigo developed principles for the pruning of trees, which is today the recognized basis of modern tree care. Shigo discovered that cut-offs on trees healed both from the

outside through overwhelming, as well as inside by scoffing. On the basis of his knowledge, he developed various principles for tree cutting and wound healing. Strict adherence to these principles is immensely important for the production of high quality wood. In fruit growers circles the findings of Shigo are completely unknown. They gain more importance in connection with the use of wood from fruit trees or the double use wood and fruit. (For further information see Literature).

3. System design between framework conditions, functionality and added value.

Agroforestry offers an infinite number of possibilities for variation of trees and subcultures. It is helpful for the farmer to orient himself within a logical framework, which provides him decision-making support for a specific tree management on his farm. A very simple decision-making aid could be built up as follows. On the one hand, we have the process to build up a certain system. On the other hand, the framework conditions (soil, climate) as well as the desired functionality, the purpose of the system, the expected target and the final product. Between these two dimensions, the farmer moves with his practical tree management in the field and here, on the basis of needs and functionality, he has to find the common denominators and define concrete measures.

3.1 Logical framework for a decision-making on specific tree management on farm level

genetics x pedoclimatic potentials
- calcareous soils
- acid soils

Purpose
- The tree is self-productive
- Tree supports only the subculture
- Shading
- others (preservation of the landscape, Co2 Sequestration)...

Intensity
- manual
- machined

added value target
- ecosystem service
- higher added value

enproduct
- wood
- fruit
- both

Framework

Choice of system
- silvoarable
- silvopastoral
- ohers

Coice of species
- Single Species
- Multi Species
- ...

Establishing
- Natural regeneration
- Individual plantation
- High risk of failure
- Low risk of failure
- ...

Plant design
- tree density
- line orientation
- ...

Tree Protection
- prortection against browsing and fraying
- Plant pile
- mouse protection
- ...

General Management
- High-value timber trees
- Fruit trees
- others
- Energy wood
- high disease pressure
- Low disease pressure
- High risks for stem damages
- Low risks for stem damages
- Good nutrient availability
- Bad nutrient availability
- ...

Harvesting
- Tight window for fruit harvest (according to the subculture)
- Large window for fruit harvest (according to the subculture)
- Space available for shunting
- less space available for shunting

Prozess

Common demoninators

Inference

Purpose and Endproduct: High-value Woodproduction
Species for calcareous soils: Sorbus domestica, Morus alba, Acer campestre...
High risk of failure: Planting in double or tripe compound, stem protection
High value timber trees: anticipatory thinning
Less space available for shunting: careful mantainance of tree strip
Higher added value: Finding solution for advanced capitalization of the tree population
          ...

4. What are the main knowledge gaps in practice and what knowledge sources are available?

Knowledge gaps in the process described above: in some cases there is a lack of dissemination of knowledge – other aspects need further research:

Theme/Process	Possible Knowledge gaps or mistakes	Possible reason of knowledge gap	Concrete assignment for research
Choice of Species	- Wrong type and / or variety in the wrong location, wrong type and / or variety for target (fruit, wood, both, energy wood, pollard tree - Walnut trees: lateral, terminal varieties)	- Too little experience, too little knowledge of species No access to advice and information - - Too short-term thinking about crop rotation of subcultures, harvesting time of subcultures - Lack of predictability of climate change effects on the maturity point of cultures	- New breeding of species which are particularly suitable for agroforest systems (disease resistance, flowering, leaf development) ...) - Standard fruit tree: Target-oriented finishing techniques (refinement with or without tree trunk creator, multi-varietal trees with a focus on time-delayed harvest hybrid breeding of certain species - Autochtonous versus selction provenances - ...
Establishing	- Faults in planting (too deep, wrong time, lack of water supply ... bad planting material) No tree protection, no plant pile - Wrong decision for planting system (natural rejuvenation, single-tree planting)– Tree loss, stock gaps	- Lack of experience, lack of information - bad estimation of the environment (danger of browsing and fraying, frost damage ....)	- Decision for a specific planting system and economic consequences in case of late tree loss (single tree planting, natural rejuvenation ...)
Plant Design	- Incorrect alignment - To narrow planting - Wrong type in the wrong place of the	- Lack of experience - Lack of information - No access to advice - Lack of knowledge	- Optimal plant design for different purposes, - development of decision-making aids, development of scenarios - Landscape effect of agroforestry systems

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	parcel (center or edge)	exchange	
Tree Protection	- Positive and negative antagonism of trees and subcultures - Uncertainty about the optimum time of use of plant protection products - Tree damage caused by machines Wrong type on the wrong place (soil ph, frost, disease pressure)	- Lack of experience - Lack of information - No access to advice - Lack of knowledge exchange	- Management aids for the application of plant protection products in agroforestry systems, taking into account the flowering periods of subcultures and tree species - How can incentives be created for tree care over generations?
General Management	- Crown shape - impact on management - Management Green strip - Lack of knowledge about multi-layer production systems (combination of high-stem trees with other interesting shrub species in the understorey (for berry-production, coppice) - Experience gaps in irrigation and fertilization - Underestaminate of the workload	- Lack of experience - Lack of information - No access to advice - Lack of knowledge exchange - Lack of mechanisation - still little technical innovation for agroforestry systems	- Effect of irrigation systems on the root competition in the agroforestry systems - Drainage effects caused by trees in agroforestry systems - Optimal green strip management (mechanisation, robotics, alternative planting) - Effect fertilizer intensity and the open field situation on wood quality - Effects of different soil cultivation systems on agroforestry - Full-cost analysis
Harvesting	- Lack of technical solutions - Management errors harvesting trees and subcultures	- Lack of experience - Lack of information - No access to advice - Lack of knowledge	- Development of technical solutions

		exchange - Lack of mechanisation - still little technical innovation for agroforestry systems	

4.1 Compilation of links and tools

Theme and content	Content and Link	Language
Technical agroforestry knowledge	**www.agroof.net** Brochures, videos, technical leaflets	French
	http://www.agroforst.uni-freiburg.de/ Agroforestry systems with high value timber trees, different technical leaflets	German
	http://www.agroforstkampagne.net/forschung/ Agroforestry systems with energy wood	German
	www.cdaf.be Different Agroforestry systems in Belgium	French
	www.agroforst.ch Agroforestry with standard fruit trees, wild fruit trees and high value timber trees	German
	www.agforward.eu Project-homepage AGFORWARD, technical leaflets and tools	English
	www.agroforestry.eu EURAF, Network, Examples practice	English
Planning Tools	**www.agroforestryvlaanderen.be** a set of modules and leaflets on the design and management of agroforestry systems	Dutch
	www.agforward.eu Toolbox	English
Brochures	**https://agridea.abacuscity.ch/de/A~3048/0~0~Shop/Agroforstsysteme** Brochure "Agroforstsysteme"	German and French
Fruit growing: refining, pruning, plant protection, harvesting	**https://shop.fibl.org/chde/0006-orchards.html** traditional orchards	German, French, English
	https://schlaraffenburger.de/cms/component/content/article/42-obstbaumschnitt/102-pflanzung-und-pflege-von-streuobstbaeumen.html local initiatives, traditional orchards	German
	https://www.agroscope.admin.ch/agroscope/de/home/themen/pflanzenbau/obstbau/pflanzenschutzobstbau.html plant protection recommendations, applied research	German
	http://www.kob-bavendorf.de/Service/krankheiten-und-physiologische-stoerungen plant protection	German

	recommendations, applied research	
	www.fructus.ch swiss association for the promotion of old fruit varieties.	German
	www.arche-noah.at austrian association for the promotion of old fruit varieties	German
	General Information without Links: Description of varieties of tree nurseries Pomologue associations Local initiatives for traditional orchards Nature conservation initiatives Permacultur	
Silvicultural knowledge	**www.waldwissen.net** (Extensive site silvicultural knowledge, species descriptions etc .) **http://www.wsl.ch/forschung/wald/publikationen/index_DE** Publications of the Swiss Federal Research Institute for Forest, Snow and Landscape	German German, French
European cultural landscapes related to trees	**www.agforward.eu**, WP 1 **www.larouteducidre.fr/** Region Cidre Normandie **http://www.zuger-rigi-chriesi.ch/** Hochstammkirschenanbau in der Schweiz **http://www.elsbeerreich.at/elsbeerreich/Elsbeere.html** Region Sorbus torminalis, Austria	Different Languages French German German

5.   How can knowledge gaps be closed and existing knowledge disseminated more widely?

The knowledge about tree management is often present - there is often more a lack of access to knowledge. As arable or vegetable grower with the motivation to establish an agroforestry system, it is difficult to gain access to fruit or forestry knowledge at all. The next difficulty is then the transfer to a system where the traditional knowledge can not be transmitted one-by-one. It urgently needs specially trained consultants who are at home in these different worlds and can provide solutions for very specific questions. However, this is based on the fact that agroforestry is recognized as subject of general agricultural advice. At the same time, agroforestry must also be tackled as a topic in the field of silviculture, fruit growing and energy wood production.

5.1.   General Suggestions for the spread of knowledge

Research must take up the defined needs and, through collaboration in networks, be inspired to new research questions which have a high practical value.
Especially in the field of tree management in agroforestry systems, we need a better transfer of knowledge between different disciplines and between practice and science. More awareness has to be raised with farmers, how crucial tree selection and management is for an economically successful agroforestry story.
In operational groups, consisting of practitioners, agricultural consultants and research, the most important questions about the tree knowledge in AF systems can be discussed and solutions for a better dissemination of knowledge can be developed. In principle, a participatory approach should be pursued. It should be

ensured that practitioners should not only participate as knowledge providers, but also have a real added value and benefit for the further development of their own business!!

Good image and film samples must be placed on websites which ensure a good quality and high professional relevance of the adjusted media.

Everywhere in Europe we find cultivated landscapes with a strong relationship to trees. As already mentioned at the Beginning, the tree was often inseparable connected with agricultural use, and agricultural use was the basis for the development of cultivated landscapes. The traditional region for the production of cider in Normandy, the Walnut-region around Grenoble, the Chestnut selvas in the Ticino, the High-stem Cherry production in the Swiss Midlands, the spanish Dehesas - examples for tree landscapes in Europe very often with an innovative product at the end of the value chain.

Modern agroforestry systems could benefit from the local knowledge that exists in these cultural landscapes about species, varieties and tree management. At the same time, modern agroforestry systems could also represent an opportunity for these cultural landscapes. They could provide perspectives for a broader diversification and a higher risk-sharing through multifunctional utilization possibilities for tree and subculture.

Last but not least, the inclusion of other multipliers is also necessary for the exchange of knowledge on practical tree management in agroforestry systems: tree nurseries, agricultural contractors, nature conservation organizations, administration, eco-control... The transfer of knowledge must also function in these channels, because they often also provide direct consulting functions on the farms.

5.1 Research needs

- New breeding of species which are particularly suitable for agroforest systems (disease resistance, flowering, leaf development)
- Standard fruit tree: Target-oriented finishing techniques (refinement with or without tree trunk creator, multi-varietal trees with a focus on time-delayed harvest, hybrid breeding of certain species
- Autochtonous versus selction provenances
- Decision for a specific planting system and economic consequences in case of late tree loss (single tree planting, natural rejuvenation ...)
- Optimal plant design for different purposes, development of decision-making aids, development of scenarios
- Landscape effect of agroforestry systems
- Management aids for the application of plant protection products in agroforestry systems, taking into account the flowering periods of subcultures and tree species
- How can incentives be created for tree care over generations?
- Effect of irrigation systems on the root competition in the agroforest system
- Drainage effects caused by trees in agroforestry systems
- Optimal green strip management (mechanisation, robotics, alternative planting.
- Effect fertilizer intensity and the open field situation on wood quality
- Effects of different soil cultivation systems on agroforestry
- Full-cost analysis
- Development of technical solutions

6.   Further ideas

Establishing of operational groups in selected traditional tree-landscapes, where old knowledge and new ways of diversification could enrich each other.

Establishing of operational groups, which are oriented to the practical tree knowledge and divided into different system types.

- Tree management for high value timber production in agroforestry systems
- Tree management for fruit and nut production in agroforestry systems
- Tree breeding and variety screening for agroforestry systems
- others

Interactive map with great practice examples, including video-interviews with farmers
Database with demonstration plots
Building up tree nurseries with focus on agroforestry systems

7. Conclusions

This Minipaper wanted to provide a brief overview of practical tree management on farm level in agroforestry systems. Important knowledge gaps were filtered out and perspectives for closing these knowledge gaps were identified. For the research, specific topics were elaborated and measures for implementation in operational groups and other ideas were concretized. In summary, there is not a general lack of knowledge about practical tree management. It is more often a lack of networking between areas that have previously functioned independently: agriculture, forestry, fruit growing and nature conservation.

Literature

Alex L. Shigo: Modern Arboriculture: A Systems Approach to the Care of Trees and Their Associates, 1991
ISBN-13: 978-094356309