SUSTAINABLE FOOD PRODUCTION IN SWEDEN - TO GROW AND EAT FROM PERENNIAL INTERCROPPING SYSTEMS – RESULTS FROM A PARTICIPATORY LEARNING AND ACTION RESEARCH PROJECT

Johanna Björklund[1*], Karin Eksvärd[2], Christina Schaffer[3]

[*]Correspondence author: johanna.bjorklund@oru.se

(1) School of Science and Technology, Örebro University, Örebro, Sweden (2) Inspire Action Research AB, Knivsta, Sweden (3) The Department of Physical Geography and Quaternary Geology, Stockholm University, Stockholm

Background

Agroforestry has a long history in the Nordic countries (Eichhorn et al 2006). Semi-natural pastures containing trees, shrubs, grasses and herbs as well as forest grazing, have had an important role in the economy of the households and for society at large, since the beginning of settled agriculture. Today such systems account for a large part of the agrarian biodiversity.
There is a fast growing interest in agroforestry among actors, engaged in the development of sustainable food production systems. Promises are so far mainly based on studies in tropical areas, showing that such systems optimize the production of food and other ecosystem services such as carbon sequestration, maintenance of biodiversity and nutrient recycling (Pretty et al. 2006; Jose 2009). There is, however, a growing body of research on production, economy and ecosystem service generation in silvo-arable systems combining trees for energy and timber with annual crops in European countries (Dupraz et al. 2005, www.agroforestry.eu, visited 160110).

Research from tropical areas shows that complex multi-strata systems are advantageous when it comes to generation of ecosystem services (Jose 2012; Montagnini and Nair 2004). The density of perennial plants is crucial for the carbon sequestration potential, and research also indicates that the diversity of perennials is important (Steinbiess et al. 2008.). Montagnini and Nair (2004) argue that to be efficient carbon sinks, the system ought to be composed of mainly perennial crops. In intensive system of intercropping of perennials and annuals, this potential is substantially less or negative (ibid.). Jose (2012) concludes, that key design components for high conservational values of agroforestry systems were the multiple species and vegetative strata, a minimal management intensity and long rotation periods, as well as a natural disturbance regime (e.g. tinning to reduce tree density). Complex perennial multi-strata systems are furthermore advantageous when it comes to improve the use of nutrients, land and water (Tilman et al. 1996). The three-dimensional vegetation cover above and below ground; facilitate an efficient exploration of available niches (ibid.).

This places temperate edible forest gardens, in the forefront when it comes to generation of ecosystem services. These systems are designed to maximize the possible diversity and to optimize useful interaction between all plants as well as with soil biotic and abiotic factors to provide an optimal combination of food production and ecosystem service (Jacke and Toensmeier 2006).

Research on e.g. production potentials, management strategies and scaling issues in a northern temperate climate are however urgently needed. Studies also show the importance of case studies of so-called "tree-based ecosystem approaches" and action research in different landscapes, for agroforestry to be further developed and implemented on a larger scale (Villemen et al 2013). To meet these challenges a participatory learning and action research (PLAR) project comprising 13 smallholders and two researchers with expertise in environmental science and in participatory methodologies, started in 2012 in southern Sweden.

The overall aim of the work in the project has been to develop agroforestry systems and evaluate their potential to combine high production of food while being resource-efficient and generate important ecosystem services such as carbon sequestration and maintenance of biodiversity.

Project main objectives were furthermore to: 1) Provide practical and theoretical knowledge for the development of agroforestry systems in agricultural and subsistence farming in Sweden. 2)

Assign appropriate methods for multidisciplinary analysis of agroforestry systems from a sustainability perspective. 3) Identify types of systems that could provide important contributions, as well as relevant combinations of species and varieties to be included. 4) Study how the inclusion of highly productive agroforestry systems may operate in the Swedish agricultural system; institutionally, economically, socially and culturally.

Material and methods

The participants in the group jointly decided on research goals, and accomplished the actual research. This has been done through workshops, telephone conferences, field visits to each other's farms, practical implementation at farms at established research sites and in discussion with invited experts.

Establishment of research sites

The group decided to focus on edible forest gardens as one of the systems studied. Thirteen forest gardens, 60 m^2, with a common design (research sites) have been established in order to study these system's potential production and generation of ecosystem services. The edible forest garden had a three dimensional design, including plants in the following strata; Medium to large canopy trees (> 10 m)– alder (*Alnus glutinosa*), Small trees and large shrubs (4-9 m)– apple trees (*Malus domestica*) and hazelnut (*Corylus avellana*), Shrubs (<3m) – Siberian pea tree (*Caragana arborescens*), silverberry (*Elaeagnus commutata*), buckthorn (*Hippophae rhamnoides*), saskatoon (*Amelanchier anifolia*), dwarf quince (*Chaenomeles japonica*), Herbaceous perennials (< 3m) – garlic mustard (*Alliaria petiolata*), mentha (*Mentha spp.),* mallow (*Malva spp.)* and comfrey (*Symphytum uplandica*), daylilies (*Hemerocallis spp.*)*,* anise hyssop *(Agastache Foeniculum*), sweet cicely (*Myrrhis odorata)*, oregano (*Origanun vulgare*), good king Henry (*Chenopodium bonus-henricus*), Ground cover plants and creepers – strawberry (*Fragaria × ananassa*) and wild strawberry, wells onion *(Allium fistulosum)* (*Fragaria vesca*), Climbers – vines (*Vitis vinifera*), Caucasian spinach (*Hablitzia tamnoides*), arctic kiwi (*Actinida kolomikta*), blackberry *(Rubus laciniatus)* and Underground layer – common bistort (*Bistorta major Gray)*.

Documentation

Permanent samplings points, inside and outside of the research site, were established the year of plantation (2013). Initial vegetation and basic soil parameters were documented. The documentation furthermore included; in- and outputs, labour hours, photographic documentation at permanent point at set dates and a diary with notations on important observations.

Result and discussion

Presented results are based on the learning in the PLAR group during five years of work. The group decided in an early state that all farmers may manage their research site in a way to provide the best conditions for the establishment of their forest gardens. This resulted in a variety of soil management, soil covering materials and organic matter input. Limitations of not using fertilizers and pesticides were, however, decided on by all.

Learning's from the establishment phase

The research sites have evolved in different ways depending on soil, climate and labour conditions at the various places. In some places much manure and mulch were used, which led to a good establishment of trees and shrubs as well as ground cover. In other locations, no manure was added after planting, and plants have developed more slowly, with the aim of studying the potential for generation soil fertility, using nitrogen fixating plants, deep-rooted trees and shrubs, as well as symbiosis among plants and mycorrhiza.

An early and rapid start of the garden required dedication to the establishment. To carefully select both the species, and their varieties, to be included in relation to desired production of food and fibres, and generation of ecological functions was important. Where to plant the individual plants for possible interaction as well as for the well-being of individual plants was furthermore crucial and required vast practical agricultural as well as specific species knowledge.

Trees and shrubs were possible to plant directly in the grass sward, but before a soil layer could be established weeds ought to be completely gone. Fabric was found to be an effective cover material but relatively costly. Straw attracted voles and rapidly broke down, this also for goes for paper or cartoon. Plastic also broke down fairly quickly and looked untidy.

The forest gardens were mainly established by hand and required very little fossil fuel in addition to the production and transport of inputs used. Labour was needed for watering, especially of the trees, but only during the establishment years.

Experiences in the PLAR group were that the workload decreased after the first few years, but the myth of a work-free food production in an edible forest garden is just a myth. Weeds need to be kept for, plants to be replaced and pruned, and the harvest is to be done.

What can a forest garden produce, of what kind and how much?
In the beginning, the production of the perennials was small and the level of ground cover low. During that time annuals such as pumpkin, squash, strawberries and potatoes, may well be produced. Annuals could be included also at late stages in open areas to create rotation and increase the production of vegetables rich in starch, which forest gardens would otherwise contribute with to only a small degree.

From year three in the establishment there were "salads" from perennial leafy vegetables to harvest throughout the growing season, although the perception of what signify "salad" did change substantial in the group during the time. The perspective on what's a cuisine has clearly been expanded.

The conclusion from the PLAR project experiences so far, is that an edible forest garden in Sweden does not replace the bulk of energy and carbohydrates needed. Instead the production should be seen as part of more sustainable diets.

Conclusions

In the future, breeding and availability of plants and varieties will be important for the development of edible forest gardens in temperate regions. Small-scale machinery for management and harvest is also crucial, as well as more knowledge about nutritional values of different plants and varieties. For forest gardens to be a serious contributor to food production scaling issues without losing crucial ecosystem services will be of special concern.

Edible forest gardens were furthermore appreciated to work well on marginal lands. With main dietary benefits in producing vitamins and minerals in multiple layers with low levels of inputs, while at the same time increasing the amount of trees and bushes in the agricultural landscape contribute to generation of ecosystem services. To establish woodland gardens on large surfaces, however machines for land preparation and planting would certainly be needed.

References:

Eichhorn MP (2006) Silvoarable systems in Europe – past present and future prospects. Agroforest Syst 67:26-50. doi: 10.1007/s10457-005-1111-7

Jacke J, Toensmeier D (2006) Edible Forest Gardens: v. 1 Vision and Theory - Ecological Vision, Theory for Temperate Climate Permaculture. Chelsea Green Publishing Co, White River Junction.

Jose S (2009) Agroforestry for ecosystem services and environmental benefits: an overview. Agroforest Syst 76:1-10. doi: 10.1007/s10457-009-9229-7

Jose S (2012) Agroforestry for conserving and enhancing biodiversity. Agroforest Syst 61:281-295. doi: 10.1007/s10457-012-9517-5

Montagnini F, Nair PKR (2004) Carbon sequestration: An underexploited benefit of agroforestry systems. Agroforest Syst 85:1-8. doi: 10.1023/B:AGFO.0000029005.92691.79

Pretty JN Noble AD, Bossio D et al (2006) Resource-Conserving Agriculture Increases Yields in Developing Countries. Policy Analyses. Environ Sci & Technol 40:1114-1119. doi: 10.1021/es051670d

Steinbeiss S, Beßler H, Engels C et al (2008) Plant diversity positively affect short-term soil carbon storage in experimental grasslands. Global Change Biology, 14: 2937-2949. doi: 10.1111/j.1365-2486.2008.01697.x

Tilman D Wedin D, Knops J (1996) Productivity and sustainability influenced by biodiversity in grassland ecosystems. Nature 379: 718-720. doi: 10.1126/science.1060391

Villemen L, Hart A, Negra C et al (2013) Taking tree based ecosystem approaches to scale. Evidence of drivers and impacts on food security, climate change, resilience and carbon sequestration. EcoAgriculture Discussion Paper No. 10, EcoAgriculture Partners. Washington.