

# **AGROFORESTRY -- GROWING CROPS, LIVESTOCK, AND TREES ON IOWA FARMS AND THE MIDWEST**

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## **Introduction**

Agroforestry is formally defined as a land-use system that intentionally combines trees or shrubs with annual plants and/or animals on the same land area. The combination may exist at the same time or in a sequential fashion (Agroforestry Systems, 1982). The production of diverse agronomic and forestry outputs (hence "agro-forestry") on the same land area is an important feature that may be very practical in trying to strengthen and diversify the primarily agricultural economy of Iowa. While agroforestry is still an emerging food, fiber, and industrial material production system in the American Midwest, it has been proven to be a sustainable system of land use in many parts of the world. Sustainability implies that this land use system is a healthy, economically viable, and environmentally protective technology.

As an integrated production system, agroforestry increases stability through broader economic activity on the farm. With agroforestry, economically beneficial perennials like fruit trees, fuel wood, and leguminous vegetation are incorporated in a farm as source of cash revenue and materials for farm use, and to produce food, fiber, fodder and wood. These woody vegetation can also perform functions like soil improvement, erosion control, windbreaks, buffers in riparian areas to keep agrochemicals from entering streams, corridors to facilitate movement of wildlife or improve their habitat, and as live fences for livestock. Thus, agroforestry can be adapted to suit the individual needs and priorities of farmers and the climatic condition and problems of an area.

In the United States, the idea of mixing forestry and agricultural production was advocated in the early 1900's by Smith (1914) but was practiced much later. The push for re-introducing trees back into the landscape could be pinned down generally as a response to environmental problems. An example is the windbreak program for the Central Great Plains that had been established for erosion control, especially in the 1930's during the dust bowl crisis (Read, 1964). In Iowa, the potential benefits of re-introducing trees into the environment could not be over-emphasized. With 99% of the prairies and wetlands gone and over 80% of forests giving way to other uses, as cited by Schultz et al. (1995), the social, productive, and protective functions of the woody and prairie vegetation have been significantly diminished.

## **Agroforestry Systems in the United States**

There are three traditional agroforestry systems based on structure or major elements, according to Nair (1985). These are agrisilviculture, silvipasture, and agrisilvipasture. Agrisilvicultural production systems involve combinations of agronomic crops and trees. Silvipastoral systems involve combinations of trees and grasses/fodder and/or animals. Agrisilvipasture includes systems that combine agronomic crops, trees, and animals and/or pasture/grass.

Two common agroforestry systems for the temperate zone that have been mentioned in the literature are: (1) grazing and intercropping with managed conifers (silvipasture), mostly found in northwestern and southern U.S., and (2) multi-cropping agronomic crops with hardwoods (agrisilviculture), found in the south and parts of the Midwest such as Alabama, Missouri, and Illinois (Gold and Hanover, 1987).

Literature on silvipastoral systems were mostly for the southern forest range (Burton, 1973; Cramer, 1991; Davis et al., 1984; Lewis et al., 1983; Pearson, 1980, 1983). Reports of agroforestry system studies in the Midwest were mostly about agrisilvicultural systems, such as the multicropping system with soybeans, wheat, fodder/grazing, and black walnut reported from Missouri (Garrett and Kurtz, 1983), and a multicropping systems with black walnut, other tree species, and several field crops in Illinois (Campbell et al., 1989). Integrated forestry-farming activities with black walnut were also cited for Indiana and Missouri (Campbell et al., 1989).

### **Agroforestry Systems Survey in the Midwestern United States**

A survey was conducted in 1990-1991 by the Department of Forestry at Iowa State University (ISU) to determine different kinds of agroforestry and forestry-related systems being practiced in eight Midwestern states: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The survey also aimed to gather initial information for a directory to help foster information exchange among individuals interested in these systems.

A list of systems (Table 1) was prepared for the survey. This list included the three traditional systems mentioned previously, three non-traditional systems (windbreaks or shelterbelts, intercropping of trees and other shrubs or perennials, and boundary plantings), and other specialized systems that involved trees in combination with the production of maple syrup, ginseng tea, mushroom, honey, and other non-wood products. These non-wood products, though grown in a forestry setting, are typical of the diversity of products one would get from an agroforestry system.

Agroforestry was and still is quite new in the Midwest. The unknown population of farmers and forest landowners involved with agroforestry in the region and the large area coverage called for a brief questionnaire and for the use of a network approach to get in touch with the eventual survey respondents. Networking started with foresters, extension agents, and university researchers in the eight states who were contacted for information about people who were involved with agroforestry and forestry-related activities in their respective areas. The names



that were suggested were subsequently contacted and asked to participate in the survey. They were also asked for information about other people doing similar activities.

The list of systems, related information on agroforestry, and a brief questionnaire were sent to all participants. The questions focused on the various components or elements included in the systems or practice (such as tree species used, crops, animals, fruits/vegetables, other products, arrangement of elements), area, approximate time the system or practice was started, and any additional information about the system/practice. From a total of 250 people contacted, 155 respondents participated in the survey.

### **Key Findings of the Agroforestry Survey in the Midwestern United States**

The systems were grouped into three types: traditional agroforestry, non-traditional agroforestry, and other specialized systems. Survey results are presented on (Table 2)<sup>1</sup>. There was a total of 46 traditional agroforestry systems, 61 non-traditional systems, and 97 specialized systems involving trees and non-wood products. The area involved in the systems ranged from less than an acre to hundreds of acres. The activities spanned from hobbies and secondary sources of income (mostly for specialized systems) to research-related and demonstration areas. They included commercial operations, such as maple syrup production, tree-crop farms, and hunting area leases involving hundreds of acres. Some respondents indicated that many other individuals are involved with certain practices, such as windbreak programs, Christmas tree farms, and the specialized systems.

#### **1. Traditional Agroforestry Systems**

##### **A. Agrisilviculture**

Agrisilviculture was the most common system (28 out of 46 traditional systems) reported in the Midwest. There were a dozen silvipastoral systems and six agrisilvipastoral systems. Almost 75% of the traditional systems reported were from four states (Minnesota, Iowa, Indiana, Missouri). These results are consistent with earlier reports (Campbell et al., 1989; Garrett and Kurtz, 1983; Gold and Hanover, 1987) indicating the location of some agroforestry systems in the region, especially for agrisilvicultural systems.

Alleycropping was the most common agrisilvicultural system (16 out of the 28 cases), and included systems that have agronomic crops intentionally grown between rows of trees or shrubs. There were also 8 cases of mixed (not alley) cropping of trees and agronomic crops. The third agrisilvicultural system reported was Christmas tree production with agronomic/horticultural crops planted between rows of young trees (4 cases reported). This last system, a form of alleycropping, was included as a special case because of the nature of the production cycle - i.e., Christmas trees have a much shorter rotation as compared with the usual timber and nut tree species used in other alleycropping systems.

<sup>1</sup>The total number of systems reported here is higher than the total number of respondents because some participants reported more than one system, especially for the specialized and the non-traditional systems.



The crops often planted in agrisilvicultural systems are corn, soybeans, wheat, and oats, and the trees are usually walnuts, pecans, other hardwood species such as oaks, ash, and poplars and evergreen (mostly pine) species for Christmas trees.

### B. Silvipasture

There was a total of 12 agrisilvipastoral systems reported, with each state reporting from one to three cases. Ten of these systems involved cattle and the rest with sheep. Grazing by goats was mentioned but no case was given. The animals were allowed to graze for certain periods of time in mostly natural stands of oak, oak-hickory-maple, other northern hardwood species, and in black walnut plantations. Very little additional information was available from respondents regarding their grazing practices.

Grazing woodlots may be quite common as part of farm operations in the Midwest, but there was a mixed response to grazing of forests in this region. On one hand, strong opinions against silvipastoral systems emphasized the incompatibility of livestock and timber production. These reactions were reminiscent of earlier sentiments calling for the elimination or reduction of woodland grazing (DenUyl, 1945; Lentz and Wright, 1959). In Iowa, for example, grazing was identified to be a major cause of poor stocking in the past (Leatherberry et al., 1992). A survey of public land-use professionals' perceptions of agroforestry applications in the south also revealed that the most common problem from grazing is its effect on seedling survival and soil productivity (Zinkhan, 1993). On the other hand, some practitioners reported grazing of cattle under the trees with no problem at all. Support for this argument included research results cited for Illinois indicating that timing of pasturing cattle in the woodlands could be the key to good woodlot pasture management (Cramer, 1991), and other researchers who wrote about good pasture management in the southern forest range (Donohoe, 1982; Lewis et al., 1983; Pearson, 1983). Based on comments received and reports available, silvipastoral systems still need a lot of research as far as the midwestern situation is concerned.

### C. Agrisilvipasture

Agrisilvipasture had the least reported occurrences with 6 cases, half of which were from Missouri. Four cases indicated the presence of animals, while two systems had pasture/grass only in the area. The trees were mostly black walnut and other northern hardwood species. Some of the grass species were timothy, buffalo grass, and hay, and the animals involved were cattle. Since the survey, there has been a new system established in 1992 in Iowa where the farmer had, in a very complex design, several animals (pigs, chickens, turkeys, cattle), row crops (corn, oats, red clover), and several tree species selected for nut production, for timber, and for animal shelter and windbreaks. This area has since become a popular demonstration farm for visitors and the general public.

## 2. Non-Traditional Agroforestry Systems

The 61 non-traditional systems reported were distributed as follows: field windbreaks or shelterbelts (29 cases), intercropping of trees and shrubs (21), and boundary plantings (11)

(Table 2). Shelterbelts or windbreaks are rows of trees planted in the field mainly to reduce the adverse effects of wind action, such as erosion, loss of soil moisture, and drought stress on crops. Although windbreaks have been encouraged and established for controlling wind erosion since the 1930s (Read, 1964), there has been a reported decline in interest and the considerable removal of those planted several decades back (Byington, 1990). Intercropping of trees and perennial shrubs included combination of two or more tree and shrub species for various purposes, such as for nuts, timber, and fruits. Boundary plantings are rows of trees or shrubs planted to set up a barrier between two ownerships, or to delineate difference in land uses.

A number of species are used for these non-traditional systems, including: oaks, pine (red, scotch, white), ash, walnut, larch, maples, blue spruce, Norwegian spruce, eastern red cedar, Austrian pine, and poplars. Among the shrub species usually planted were osage orange, Russian olive, autumn olive, dogwood, lilac, cranberry, and ninebark. These systems usually consisted of from one to two or more rows of trees and/or shrubs.

Some respondents commented about windbreak programs existing in their area. Additionally, although the numbers reported were not really high, tree-shrub intercropping and boundary plantings were observed to be common in the region. These comments indicated that the number reached by the survey could actually be just a small sample of these non-traditional groups.

### 3. Other Specialized Systems

Not normally considered as agroforestry, this category included several specialized practices that involve growing of trees and the production of maple syrup (41 cases) and mushrooms (15, primarily Shiitake), and the promotion of wildlife for educational/recreational pursuits (30). A few other systems involved production of honey, ginseng tea, cones, ropings/wreaths, and other crafts. Trees, shrubs, grasses, and other herbaceous plants also have been grown as stream buffers and for energy production. A number of respondents reported more than a single system or practice, most of which are either hobbies or additional sources of income.

These specialized systems are significant because they involve trees and the production of some non-wood output or benefit within a forest environment. The practitioners are able to relate forestry with these other production activities. These systems could be possible "transition" systems, as when one wishes to expand ginseng tea and thus start planting them in-between trees on a bigger scale, or when one wishes to increase honey production and starts putting in more boxes for "beehives" and increase pollination in the area. This could be true for most of the non-wood products that are produced within this category.

The fact that these specialized systems are widely practiced in the region is an indication of a positive attitude to having trees on the landscape, and of practitioners who could be more receptive to other innovative options relating to agroforestry.



## **Agroforestry Opportunities in Iowa and the Midwest and IStART**

Schultz et al. (1995) provide one of the early discussions focusing on agroforestry opportunities for the U.S. The authors give an excellent perspective of the types of systems and the problems relating to agroforestry practice in the U.S. They mentioned that the strategic placement of trees in large-scale agricultural activities involving annual crops could be in the form of riparian buffers, alleycropping systems, windbreaks, tree/pasture systems, and forest farming. In particular, the first two systems also reduce non-point source (NPS) pollution and increase the ecological diversity. Schultz et al. also give a more detailed discussion of two sustainable agroforestry systems based on short-rotation woody crops (SRWC): alleycropping and riparian buffer strips.

Several groups of people are involved with agroforestry in the Midwest: farmers, university researchers, local/county agencies, and other private individuals or enterprises. In Iowa, leadership in agroforestry activities is shared between a team of agroforestry researchers and private farmer-cooperators. The research team, called IStART for Iowa State Agroforestry Research Team, is an interdisciplinary group of scientists from several disciplines including forestry, agronomy, animal ecology, soils, geology, sociology, and economics, all based at ISU. The special relationship between researchers and farmers has given further impetus to research and outreach in agroforestry in the state, has allowed the development of various research sites into important agroforestry showcases, has given more opportunities for outreach and public education in agroforestry, and has resulted to the recognition of ISU as a strong leader in agroforestry research in the region.

IStART has undertaken several agroforestry projects within the state and with various farmer-cooperators. Among IStART's projects are (1) an alleycropping system involving SRWC and herbaceous crops that are grown to produce biomass for energy, and that also uses treated municipal sludge as fertilizer, (2) multi-species riparian buffer strips, (3) a shelterbelt-strip cropping project, and (4) traditional SRWC energy plantations. The first two are the projects that have been discussed in detail by Schultz et al. (1995), and are briefly described below.

IStART's alleycropping project involves the application of treated municipal sludge (biosolids) as amendment to the soil in an alleycropping agroforestry system designed to produce biomass for energy. The vegetation species include short-rotation woody trees and energy producing forage crops (herbaceous plants and grasses) that are harvested and used for energy by the Ames Municipal Water Pollution Control Plant. This system also provides for a cost-effective disposal of sludge in an environmentally safe manner (Schultz et al., 1995).

The riparian buffer strip project involves the development of multi-species, sustainable buffer strips of trees, shrubs, and grasses along waterways to study their effects on reducing NPS pollution from nearby farms. Lowrance (1992), as cited by Schultz et al. (1995) reported that wooded riparian buffer strips effectively reduce NPS pollution from reaching stream channels. This project combines SRWC with native shrubs and prairie grasses to form multi-functional buffer strips that serve to: trap above-ground sediment, reduce agrochemicals in the soil water, provide habitat to and corridor for the movement of terrestrial wildlife, increase streambank



stability, slow the peak flows of flood water, provide biomass for energy and wood, and modify the in-stream ecosystem (Schultz et al., 1991, 1993).

Trees have a special place in an agricultural environment such as what we have in the Midwest. As Schultz et al. (1995) proposed, among the solutions to promote a widespread adoption of agroforestry include: the persuasion of farmers to include trees on their farms, a governmental policy concerning agroforestry, an effective outreach program stressing the benefits from an agroforestry system relative to the landowner's objectives, development of markets for the benefits (e.g., fiber, wood, energy), and a strong research base and technology transfer program.

### **Summary and Conclusions**

The three traditional agroforestry (agrisilviculture, silvipasture, agrisilvipasture) and three non-traditional agroforestry (windbreaks/shelterbelts, interplantings of trees and shrubs, and boundary plantings) systems are practiced in the midwestern U.S. The most common traditional system is agrisilviculture that involve the production of corn, soybeans, wheat, and oats, in combination with black walnut, other northern hardwood species, and Christmas trees. The non-traditional systems were established for the protection of fields and crops from the ill effects of natural elements, such as the wind, and to mark field and ownership boundaries. Also common are various specialized systems involving trees and the production of non-wood products or benefits. These specialized systems are important because of the practitioners' understanding of the role of trees in these systems, and because these systems could be transitional activities for would-be agroforestry adopters.

ISART, ISU's agroforestry research team, leads the way in research and outreach activities on agroforestry in the region. Agroforestry showcases have been developed that provide the farmers, landowners, and other researchers some models to emulate on their lands. The sites also serve as demonstration areas to educate the students, other educators, and the general public on the functions of trees, shrubs, and other perennials in an agricultural environment. The diversity of products, multiple species, and the various possible arrangements of the components all promote agroforestry as a very flexible system that the farmer or landowner can modify in order to conform with the general land use objectives for the site.

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Table 1. List of traditional and non-traditional agroforestry systems and specialized systems\*.

#### A. Traditional Agroforestry Systems

1. Agrisilviculture -- combination of agronomic crops ("agri") and trees ("silvi").
  - 1a. Alleycropping -- This is the most common example of agrisilvicultural systems, wherein the agronomic crops are grown between rows of trees or shrubs.
  - 1b. Mixed cropping of agronomic crops and trees
  - 1c. Christmas trees and agronomic/horticultural crops, either spatial or temporal mix
2. Silvipasture -- combination of trees ("silvi") and pasture (animals, pasture, or both).
  - 2a. cattle under trees (black walnuts, pecans, pines, other tree species)
  - 2b. sheep under trees (black walnuts, pecans, pines, other tree species)
  - 2c. goats under trees (black walnuts, pecans, pines, other tree species)
3. Agrosilvipasture -- combination of agronomic crops, trees, and animals/pasture.
  - 3a. Alleycropping with shrubs/trees, crops, grass species, and with animals
  - 3b. Alleycropping with shrubs/trees, crops, grass species, and without animals
  - 3c. Any mix of crops, trees, grass, and animals
  - 3d. Any mix of crops, trees, grass, without animals

#### B. Non-Traditional Agroforestry Systems

1. Shelterbelts/Windbreaks -- plantings of rows of trees, mainly for purposes of reducing the adverse effects of wind action, such as erosion, loss of soil moisture, and drought stress on crops.
2. Intercropping of trees and shrubs (perennial species) -- combination of two or more tree/shrub species. Most common examples are combinations of fruit-bearing shrubs and/or trees.
3. Boundary plantings -- these are rows of trees or shrubs that are planted for purposes of setting up a barrier between two ownerships, or to delineate difference in land uses.

C. Specialized wood and non-wood forest product combinations -- these include combination of trees with non-wood outputs such as mushrooms, wildlife, pine cones, and similar non-wood forest items.

1. Trees and mushroom production
2. Trees and wildlife promotion -- e.g., leased hunting
3. Trees and pine cone production
4. Trees and (ginseng) tea production
5. Trees in combination with other non-wood forest products (e.g., maple syrup, honey)

\* Partly based on a glossary developed by the Winrock International Institute for Agricultural Development for an agroforestry study done in 1990.



Table 2. Traditional agroforestry, non-traditional agroforestry, and other specialized systems reported for the eight midwestern states in the United States.

SYSTEM/STATE	IA	IL	IN	MI	MN	MO	OH	WI	TOTAL
1. Agrisilviculture	5	2	7	1	3	7	2	1	28
2. Silvipasture	3	1	1	1	2	1	1	2	12
3. Agrisilvipasture	0	0	1	0	1	3	0	1	6
(Subtotal)									(46)
4. Shelterbelt/ windbreak	5	4	6	4	4	1	3	2	29
5. Intercropping	0	3	6	3	3	2	0	4	21
6. Boundary planting	0	3	2	1	3	2	0	0	11
(Subtotal)									(61)
7. Other specialized systems	4	11	14	4	19	2	12	31	97
GRAND TOTAL	17	24	37	14	35	18	18	41	204