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Agroforestry

Agroforestry is a collective name for land-use systems and practices for the deliberate growing of trees and crops on the same piece of land. In its broadest interpretation, agroforestry can include the planting of trees and shrubs around a farmstead for beauty and shade, or the management of public forests for timber and livestock grazing, mushroom and berry production, or fisheries [5]. The International Centre for Research in Agroforestry (ICRAF) estimates that approximately 1.5 billion people make use of agroforestry products in developing countries, with Africans making the most use followed by Asians and Latin Americans [2].

Agroforestry combines agriculture and forestry technologies to create more integrated, diverse, productive, profitable, healthy and sustainable land-use systems [7]. Agroforestry also includes tree and shrub plantings on the farm or ranch that improve habitat value or access by humans and wildlife, or that provide woody plant products in addition to agricultural crops or forage. Agroforestry is distinguished from traditional forestry by having the additional aspect of a closely associated agricultural or forage crop [6]. 'Crops' may include both plants and/or animals in the broadest interpretation. These may be monoculture tree crops (rubber plantations, oil palm, fruit orchards where both agricultural products and wood fiber are produced) and other pure stands of trees (e.g. woodlots, trees on boundaries, fodder banks). 'Trees' may include shrubs and other woody perennials.

Key in all definitions of agroforestry is that the trees are grown deliberately for a purpose, along with the plants and/or animals, and that they are not merely remnants left over from land clearing or conversion.

Importance of Agroforestry Systems

In general, agroforestry systems are more efficient than other farming systems. Agroforestry optimizes the benefits from the biological interactions created when trees and/or shrubs are combined with crops and/or animals. The benefits from agroforestry are both environmental and economical. Canada, for example, estimates an 8%–10% crop yield increase on protected land due to shelterbelts and 0%–15% heating and cooling cost savings from trees planted around farmsteads. In addition, Canada has nearly six million hectares of farm woodlots with an annual value of approximately $13 million [3].

Agroforestry helps to conserve and protect natural resources by sequestering carbon, mitigating non-point source pollution, controlling soil erosion, and creating wildlife habitat [1]. These benefits substantially contribute to the economic and resource sustainability of agriculture.

Agroforestry Inventory Needs

From an inventory perspective, farmers and planners need to know what crops they can grow or gather, what crops they have available, their use and market, the crop condition, and the potential of the land to increase production [4]. Farmers and planners also need to know whether trees increase or decrease seasonal production and income. To decide this, records are needed of tree and crop yields and returns over time.

Farmers and planners need to know what trees and crops grow best together. This requires research, experience, and observations in natural settings. Land managers need soil surveys to understand depth, texture, and chemical properties. Farmers need long-term studies on impact of cropping on soil productivity.

Global estimates of the land area under agroforestry or of the productivity of agroforestry enterprises are lacking, since inventories of agroforestry resources are either missing or incomplete. The diversity of definitions and types of agroforestry systems that are used, the undefined responsibilities for inventorying the resource, and the difficulty in discerning the resource base itself all contribute to the underdeveloped state of agroforestry inventories.

There are at least 40 different published definitions of agroforestry and more than 30 types of agroforestry systems [5], making it difficult to discern which lands are strictly agricultural or forested from those which are agroforested. Existing information and summary statistics are scarce and scattered in many different locations and in many different formats.

Agroforestry inventory at the government level falls between the functions of the Ministry of Agriculture or the Ministry of Forestry. As such, the inventory of agroforested lands may be overlooked.

Lands may be counted twice or inadvertently omitted. Surveys conducted by agriculture departments seldom tally trees on farmlands unless they are part of an orchard. Similarly, foresters usually measure only trees in their inventories. If crops are also present on the land, they are ignored. Consequently, part of the resource base will be incomplete.

In addition, while agricultural and forest lands are easily identified and separated, agroforested lands could take on the characteristics of either. This creates problems in site inventories. Most domesticated vegetation is grown in even-aged monocultures. The number of species and expected variation among plants are small. Therefore one can get by with fewer samples than one could with the same plants occurring in the wild. If the crop resource is planted in the wild, agroforestry inventory becomes more complex.

Agricultural crops change more rapidly than trees and other woody plants. Therefore, the scheduling of agroforestry inventories must be coordinated with the (1) timing of crop rotations to maximize benefits of shade, nitrogen, moisture, etc.; and (2) timing of product introduction to markets. For agriculture, the inventory results remain valid only until the crops are harvested and sold. In contrast, forest inventory data may be usable for years.

Inventory Techniques

Inventory of agroforestry lands may use techniques similar to agriculture or forestry (*see* **Forest inventory**) [4]. Tools that may be used to gather data include personal interviews, questionnaires, use of remote sensing (aerial photography, airborne video), and field sampling. Agricultural surveys often use a questionnaire or a specific survey sampling scheme. Agricultural surveys of large areas often depend on an areal frame, wherein the sampling units are areas of land, commonly called segments (*see* **Sampling, environmental**). The entire land area of the population to be surveyed is divided into sampling units, and a sample of these segments is selected. For agriculture, the population may be the number of farmer fields in a given province and the sampling unit may be an individual field. A map of the fields is required for such a design. Fields and crops are easily distinguished using aerial photography and other forms of remote sensing.

Monitoring requires making the same observations at the same location but at different points in time. For naturally occurring vegetation, one often uses permanent plots. This should be true for agroforestry also. For agroforestry surveys, nested plots may be useful, wherein the herbaceous vegetation is measured in small plots within larger plots used to measure trees.

Regardless of whether the survey uses an interview, questionnaire, or statistical sample, the name and address of the land owner and farmer, the location of the field, the size of the field (or plot expansion factor), crops grown (woody and herbaceous), kinds of trees/crops present, their average height, and percentage crown cover typically must be recorded. From the vegetation data, biomass possibly can be computed. Coupled with soil and climate data crop yields can be modeled (*see* **Crop yield modeling**). It is helpful to record the date of the survey and the name of the person conducting it.

Finally, in designing the data collection effort for agroforestry it is important that both trees and crops be inventoried to gauge fully their economic and environmental role (soil and watershed protection, enhancing biodiversity, carbon sequestration, etc.). Considering all characteristics of the land and the resource, the costs of conducting agroforestry inventories should be intermediate between those for agriculture and those for forestry.

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