

## Silviculture and community forestry: looking backwards, looking forwards

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Silviculture is about the deliberate manipulation of a forest to achieve defined objectives. It can be thought of as the art of producing and tending a forest. The notion of “appropriate” silviculture is very important when considering silviculture for community forests because silvicultural approaches and prescriptions need to be appropriate for local users while also ensuring that they promote the long term sustainability of the forest. Experience suggests that not all community forests require the application of sophisticated silvicultural regimes or the use of inventory data to schedule yields. Many can be managed perfectly well by the application of very simple silvicultural regimes and little or no need to collect inventory data. The needs of the most complex situation (sophisticated silvicultural system and inventory) should not be the model for all community forestry silviculture. At best, conventional silvicultural regimes and inventory practices require major revision for community forestry. It is clear that community forestry will achieve its full potential only if a holistic view is taken and a number of enabling conditionalities are met. These include: secure tenure, an enabling regulatory framework, strong governance, viable technology (including appropriate silviculture), adequate market knowledge and a supportive bureaucracy. These all need to be present for community forestry to operate at its full potential to deliver the biophysical and socio-economic outcomes that are expected of it. Viable technology, including appropriate silviculture informed by good science, is one of these important conditionalities but it is not the only one. Sustainable outcomes require much more than the application of technical forestry.

**Key words:** Community forestry, indigenous knowledge, Nepal, silviculture

All forms of forestry occur in the context of social arrangements such as institutions, rules and tenurial arrangements. One difference between conventional forest management and community forestry is that conventional forestry tends to emphasise technical arrangements whereas community forestry is explicitly concerned with the integration of social and technical aspects. This paper concentrates on some of the technical arrangements for community forestry, while not losing sight of the fact that both need to be integrated in order to produce socially and ecologically sustainable outcomes.

During the early years of the evolution of community forestry, particularly in Asia, progress was limited by a lack of knowledge of the social/

institutional and governance arrangements needed to promote effective community-based forest management systems. As a result, most efforts went into exploring these arrangements and designing enabling policies and laws as well as building the capacity of forestry technicians to support community forestry. There is now a solid body of knowledge on the social/institutional and governance aspects of community forestry. To some extent, similar advances were not made in developing appropriate technical systems for community forestry, and there is a surprising lack of a coherent body of knowledge on this subject, although there are some exceptions (for example RGoB, 2016).

One of the major principles underlying the purposeful management of forests is that they can

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be manipulated to provide a variety of goods and services. For example, forests can be managed to provide a single product such as timber, or a mix of products such as timber and non-timber products (e.g. fodder, fuel wood, vines, foods and medicines, animals, and water), and ecosystem services<sup>2</sup> (e.g. watershed functioning, spiritual and recreational values). The deliberate manipulation of a forest is known as silviculture<sup>3</sup>, which can be simply thought of as the art of producing and tending a forest.

Knowledge of the ecological conditions that control and influence tree and forest growth, is required when deciding on appropriate silvicultural practices for any application. Establishment of trees and forests, particularly if natural regeneration is being relied on to produce a future crop, requires an understanding of the site requirements and environmental conditions that are conducive to good growth for individual species. For example, some trees (including many pines and colonising rainforest species) require open conditions with little shade to regenerate and grow, while others (such as many primary rain forest species) require shady conditions to prosper. If a forest consisting mainly of species tolerant of shade is to be harvested and then regenerated, then a silvicultural system is required that removes relatively few individuals per unit area, so that shady conditions are retained to encourage regeneration and growth of the preferred species. By contrast, if a forest consisting primarily of species intolerant of shade is to be harvested then a silvicultural system is needed that results in relatively large areas being cut so that regeneration of the desirable species is encouraged by the creation of exposed sunny conditions. Many pines, eucalypts and Acacias fall into this latter category.

Decisions on silvicultural practices are generally supported by data on things such as area of the forest, size class distribution of trees and volume of timber. Such data are collected through forest inventory<sup>4</sup>, which refers to techniques to collect

data on forest condition to enable harvesting decisions to be made. The basic purpose of applying silvicultural techniques to a forest is to manipulate it to produce desired goods and services, while the purpose of using inventory tools and techniques is to gather the data/information needed to determine and regulate the yield of the goods and services coming from the forest with sufficient accuracy so that they can continue to be produced in the long term (*i.e.* sustainably). This paper will critique silviculture and forest inventory in relation to community forestry, particularly as they relate to the notion of sustainability<sup>5</sup>.

### **The origins and application of modern silviculture**

Many of the contemporary technical approaches to forest management evolved in Germany in the mid-19th Century. As noted by Cassells *et al.* (1988), at this time, German forests had experienced a long history of purposeful management. When trees had reached a desired degree of maturity they were cut, the forest was regenerated and the trees grown for a new cycle, leading to a new forest ready for harvesting at some future date. By having equal volumes of timber in each forest age class – the so-called normal or regulated forest – the harvest each year or at each interval could be approximately equal. However, it is important to recognise that some centuries of previous forest utilisation had produced the conditions that had allowed the development of the relatively even age class distributions which made this particular form of regulated forestry practical.

Under most conventional forestry regimes, sophisticated forest inventory systems are used to determine standing timber volumes and to schedule yield. Such approaches to forest inventory can work quite well when applied to stands of trees that are relatively uniform, are evenly distributed across the forest landscape and where good information is available on

<sup>2</sup> Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other nonmaterial benefits. (SOURCE: Millennium Ecosystem Assessment, 2005 [www.millenniumassessment.org](http://www.millenniumassessment.org))

<sup>3</sup> The art and science of controlling the establishment, growth, composition, health and quality of forests and woodlands to meet the targeted diverse needs and values of landowners and society on a sustainable basis. IUFRO (2005) *SilvaTerm Database*.

<sup>4</sup> A survey to determine, on a given area, data (such as condition, composition and constitution of the forests, soil conditions, water course, location, access, and topography) for...management, or as a basis for forest policies and programmes. Adapted from IUFRO (2005) *SilvaTerm Database*.

<sup>5</sup> The achievement and maintenance in perpetuity of high-level annual or regular periodic output of the various renewable resources without impairment of the productivity of the land (Clawson and Sedjo, 1984)

growth rates and area. The manipulated forests in Germany referred to above fall into this category, as do many plantations, particularly well managed industrial-scale plantations. Under these circumstances the application of inventory techniques to determine stocking rates of different species and to schedule harvesting is likely to achieve useful results.

Classical approaches to silviculture and forest inventory tend to work less well in forest types that are characterised more by their heterogeneity than their uniformity. Situations where tree stocking rates vary across the landscape pose considerable sampling problems with collecting reliable inventory information. The question of representativeness of sampling plots and the determination of the effective area<sup>6</sup> of the productive forest are aspects of particular concern. Simply establishing a couple of inventory plots, measuring the trees in the plots and extrapolating the resulting figures across the landscape is unlikely to produce reliable data that can be used with sufficient accuracy to determine standing volumes or to schedule yields. The application of data determined in this fashion can lead to spurious and misleading results. There is a real danger of falling into the trap of “confusing numbers with facts”. The use of numbers confers a degree of respectability and legitimacy to the exercise, even if the numbers have little meaning. An example of the way that the application of inventory data led to inappropriate decisions is shown in Box 1.

### Indigenous silviculture

The experiences in Germany during the 19th Century referred to above led to the codification of silvicultural practices and inventory techniques and this body of knowledge became the basis for much of the curriculum of forestry schools throughout the world. As a result, they have become part of the “psyche” of foresters the world over, and, to a large extent, understanding and applying this knowledge defines the forestry profession. There is an implicit assumption that this body of “scientific forestry” knowledge must be applied if forests are to be managed sustainably. This assumption has been increasingly challenged in recent years with the recognition that forests have been subject to manipulation and management by rural communities for centuries. It is becoming increasingly evident that many of the world’s so-called pristine or virgin forests have been shaped by centuries of deliberate human manipulation. Even though the approaches applied have not been codified into a coherent body of knowledge, there are sufficient examples from different parts of the world to demonstrate that indigenous silviculture is a reality and its application produced valuable forest landscapes for contemporary society. Details are given by Peters (2000) for the precolumbian Americas, Rackman (1986) for England, Netting (1981) for Switzerland, Michon and de Foresta (1995) for Indonesia, Fairhead and Leach (1996) for West Africa, Wickramasinghe (1995) for Sri Lanka and Lourandos (1997) and Gammage (2011) for Aboriginal Australia.

#### **Box 1. Example of the use of inventory data which produced incorrect and misleading figures for scheduling forest harvesting**

*Wombat Forest, Ballarat, Victoria, Australia (adapted from Petheram et al. 2002)*

In 1990 the sustainable yield from Wombat Forest (primarily mixed species dry sclerophyll eucalypts) was determined to be 70,000 cu.m. per year from a net area of 50,450 ha, but in 1996 this was reduced to 58,000 cu.m. per year from a net area of 42,430 ha. In 2000 the sustainable yield was further reduced to 40,000 cu. m. per year from 36,680 ha and finally it was reduced to 8,600 cu.m. per year. Thus, since 1990, the sustainable yield (determined from the application of inventory data) was progressively reduced from 70,000 to 8,660 cu.m. per year.

**Lesson learned:** Even though seemingly good quality inventory data was available for a single forest value, timber from many years of measurement of permanent yield plots, the application of that data failed to adequately reflect the real life situation of the forest in terms of determining the sustainable timber supply.

<sup>6</sup> The area available for harvesting. Some parts of the forest may be too steep, degraded/regenerating or close to water courses and not available for harvesting.

A clear conclusion from an analysis of these examples of indigenous silviculture is that illiterate and uneducated people in many parts of the world have applied silvicultural techniques of varying complexities to manipulate forests to produce the forest goods and services that were of value to them, and to sustain the forests for future generations. They did not need to apply what we now refer to as “scientific forestry” (such as inventory, yield regulation, etc.) to achieve their objectives. This is not to say that the application of scientific forestry might not add value to community forest management, but it should be emphasised that, in many situations, it is not a prerequisite for the sustainable management of community forests.

### **Appropriate silviculture for community forestry**

The notion of “appropriate” silviculture is very important. If community forests are to be managed for local benefit and if their management is to be truly in the hands of forest users, then it follows that the approaches to silviculture and forest inventory also need to be in the hands of the community rather than under the control of the forest management agency. Silvicultural prescriptions need to be appropriate for local users while also ensuring that they promote the long term sustainability of the forest.

When considering what type of silviculture is appropriate for community forestry, it is unsurprising that one quickly comes to the conclusion that there is no one answer to this question, rather there are many answers depending on a number of factors specific to the forest in question. Among the most important of these factors are the aims and objectives of forest management and the type and condition of the forest in question. To a large extent, these two factors go hand in hand and need to be considered together when determining an appropriate silvicultural regime.

Defining the aims and objectives of forest management goes some way to setting the scene for deciding which silvicultural practices will be needed to deliver the desired mix of forest products. In many situations, particularly for newly established community forests on degraded land, the prime purpose of management is often to afford protection to a regenerating forest, and to

provide limited subsistence goods such as grass and fuel wood. In such situations, sophisticated silvicultural systems are unnecessary, and in particular, the application of inventory techniques will add nothing to the ability of communities to manage the forest sustainably. However, in situations where the primary objective is to produce commercial products, particularly timber, there is a greater need to consider collecting sufficient data to schedule yields and to ensure that the silvicultural approaches will ensure that the forest will be managed in a sustainable manner.

Very few community forests are managed primarily to produce marketable timber, most are managed to provide a variety of forest goods and services including timber, poles, fuel wood, fodder, wild food, building materials and water. Community forestry often involves uneven aged mixed species forests managed for different products and services. In addition, it involves communities as managers, or co-managers with forest management authorities. At best, conventional silvicultural regimes and inventory practices require major revision for community forestry.

The type and condition of the forest is also an important consideration in determining what sort of silvicultural regime will be appropriate, and what type of inventory data (if any) will be necessary to schedule yields. In the example given above where a newly established community forest covers a largely degraded landscape, the silvicultural system would be protection oriented possibly for a decade or more. In such a situation, no inventory would be necessary as it would add nothing of value to the decision making processes. On the other hand, if the forest is a mature stand of trees with commercial potential, then more sophisticated information might be needed and more sophisticated silvicultural treatments needed if there was a desire to maximise timber production and ensure sustainability.

Because most community forests exhibit a wide range of age and size class distributions, we need to be careful in applying conventional silvicultural and inventory approaches that may not be well suited to the conditions.

To obtain a sense of the range of silvicultural possibilities (from simple to sophisticated) that

**Table 1: Indicative requirements for silvicultural regimes and inventory data for various combinations of forest type and management objectives**

Type of forest	Objectives of forest management			
	Protection	Subsistence goods	Subsistence and some commercial goods	Commercial timber and NTFPs
Silvicultural and inventory needs				
<b>Young plantation</b>	Simple silvicultural regime; No inventory	Simple silvicultural regime; No inventory	Medium silvicultural regime; No inventory	N/A
<b>Old plantation</b>	Simple silvicultural regime; No inventory	Simple silvicultural regime; No inventory	Sophisticated silvicultural regime; Simple inventory	Sophisticated silvicultural regime; Simple inventory
<b>Degraded natural forest</b>	Simple silvicultural regime; No inventory	Simple silvicultural regime; No inventory	N/A	N/A
<b>Shrub land</b>	Simple silvicultural regime; No inventory	Simple silvicultural regime; No inventory	N/A	N/A
<b>Mature natural forest</b>	Simple silvicultural regime; No inventory	Simple silvicultural regime; No inventory	Sophisticated silvicultural regime; Simple inventory	Sophisticated silvicultural regime; Simple inventory

*N/A—not applicable*

need to be considered, we could think of a matrix of the two key elements of aims and objectives of management and type and condition of the forest (Table 1). However, we need to recognise the multiple use nature of most community forests, and that this matrix is somewhat simplistic—the real situation will invariably be more complex.

This table suggests that relatively few of the combinations shown require the application of sophisticated silvicultural regimes or the use of inventory data to schedule yields. The remainder can be managed perfectly well by the application of very simple silvicultural regimes and little or no need to collect inventory data. There is nothing intrinsically bad about complex silvicultural regimes or detailed inventory systems. However, simple systems are suggested as being appropriate, not because villagers cannot perform complicated tasks, but because, in many cases, complicated systems are not needed to produce useful products without jeopardising the long term sustainability of the forest. The needs of the most complex situation (sophisticated silvicultural system and inventory) should not be the model for all community forestry silviculture. In other words, do not make things more complicated than necessary.

Indigenous systems of silviculture are often dismissed by forestry professionals as being too simple to ensure sustainable management of a forest. However, experience in many countries has shown that indigenous systems of silviculture can be very effective, particularly when focused on protection, production of subsistence goods or subsistence and some commercial goods. Dugan and Pulhin (2007) cite an example from Japan (Japan Agency of Forestry, 1995) where villagers in Gifu Prefecture limit their annual allowable cut to one tree per ha per year. They have followed this simple silvicultural procedure for more than 100 years and their forests remain intact and productive. However, the literature on such indigenous silvicultural systems is still quite limited and community forestry would benefit from further research into these systems under a range of socio-economic and biophysical conditions. In many places simple silvicultural systems have been developed in collaboration between local communities and forest management agencies (Gilmour and Fisher, 1991 and Gilmour *et al.*, 1989).

As forests grow and mature, for example when a young plantation matures or a shrub land becomes a productive natural forest, there may

be a need to increase the level of sophistication of the silvicultural regime and to collect relevant inventory data to assist in scheduling sustainable harvesting. In such circumstances, forest management agencies tend to promote either the adoption of complex 'scientific' forest inventory systems or to attempt to simplify complex inventory approaches so that they are, in the view of forestry technicians, more suited to use by local people. In relation to the former approach, there may be administrative reasons for a certain level of complexity (for example, a requirement by the forest management agency to carry out inventory) but this should not be confused with a silvicultural need to ensure sustainable forest management. In relation to the latter approach, simplifying inventory techniques can often produce poor quality results as the data obtained can be misleading and lead to the application of inappropriate silvicultural practices.

As mentioned earlier the ecological knowledge is needed to establish and manage trees and forests. Local communities might well have sufficient knowledge of the ecological requirements for local trees and forest types, but they will generally need advice to guide their silvicultural practices if species are being used that are not well known locally. Ecological advice would also be needed if there was little local experience in the establishment of plantations. For example, planting locally desirable species on infertile sites is unlikely to produce a productive forest, particularly if the desirable species are not tolerant of open exposed sites. In such situations it might be necessary to opt for a silvicultural system based on planting pioneer species that can survive and grow on the sites and, once these plants are well established, to plant the more desirable species beneath the canopy of the species originally planted.

This leads us to identify several guiding principles that we should keep in mind when deciding what type of silvicultural systems should be designed and applied for community forestry. These are:

- The objectives for forest management should be set by the forest users.
- Silvicultural systems should be based on sound ecological principles.
- Silvicultural systems should be capable of implementation with little or no input

from government or other external service providers.

- Blanket silvicultural prescriptions across an entire forest are generally not suitable because of the diversity of forest condition and management objectives.
- Inventory systems should only be mandated on communities to satisfy clearly defined management needs and not to satisfy government administrative requirements.
- Inventory systems (where needed) should also be capable of being implemented with little or no input from government or other external service providers.
- The role of forest departments should be advisory rather than supervisory.
- Systems should embody the principles of Occam's razor: never opt for something complicated when something simple will produce the same result.

#### **Inventory needs for community forestry**

As mentioned earlier, conventional forest management often requires an inventory to be conducted as an integral part of applying a forest management system – it is part of the knowledge base that foresters usually consider to be essential to their craft. Inventory data (when combined with knowledge of growth rates) can be used to determine sustainable harvest levels. However, as shown in Box 1, this does not necessarily result in accurate information and there are many examples where the inappropriate application of such data has led to decisions which are disastrous for the forest and for key stakeholders such as sawmillers who have invested in new machinery to process timber that was not available. In addition, conventional inventory systems were developed primarily for trees, especially for those being used to produce timber, poles and pulpwood. Such approaches are often unsuited to community forests:

- They do not take into account different assessment techniques that might be needed for the types of forest product that might be of importance to communities e.g. small size timber is often not included because only trees over a certain diameter are measured; NTFPs, wildlife and environmental services are normally not assessed.

- Conventional forest inventory approaches need to be applied by outside experts or local people trained to apply such approaches. This can lead to disempowering local people as the measurements, yield calculations and harvesting prescriptions are decided outside the community leading to a lack of ownership of the results.
- They are complicated and time consuming to carry out—and can easily lead to inaccurate and misleading results when applied to mixed species, multiple aged forests with high variability in stocking rates across the landscape.
- Basic growth rates and ecological information about species and species associations are often lacking or imprecise. Therefore even highly accurate individual plot measurements can frequently not be applied across a forest to determine sustainable harvesting levels with any real precision (Box 1).

In many cases, technical precision is simply not necessary and villagers can harvest forest products sustainably using simple and non-quantitative assessment approaches.

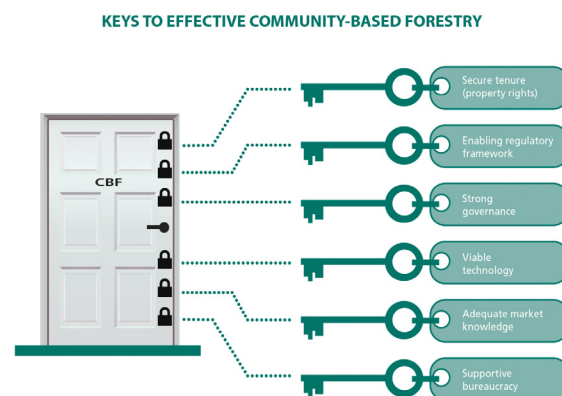
### Constraints to adoption of silvicultural practices

In the late 1980s and early 1990s a substantial amount of work was done in community forests in Nepal to identify silvicultural approaches that were appropriate for the developing forests. This work was not carried out in isolation from community forestry practitioners, and all of it was based on field trials. In addition, considerable effort went into establishing demonstration plots and exposing forestry technicians and villagers to the silvicultural options for the forests that were developing across the Middle Hills. While there was some adoption of the practices, by and large, there was relatively little up-take. This poses the question—why?

As mentioned earlier in this paper, in the early years of community forestry, progress was limited by a lack of knowledge of the social/institutional and governance arrangements needed for effective community forestry. At the time, the major silvicultural activity was protection, and the Forest Department was focused on rolling out community forestry across the Middle hills.

In hind-sight, perhaps the time was not right for either the Forest Department or communities to adopt silvicultural practices and to consider more sophisticated methods of managing forests. Is the time right now?

We should remind ourselves that the application of sound silviculture to community forests will only lead to sustainable outcomes if a number of conditionalities are met. A recent global review of Community-based Forestry (CBF) concluded that the most effective CBF regimes have a number of common “enabling features” and these can guide policy reform (Gilmour, 2016). These enabling features can be likened metaphorically to “keys” that unlock a door, with the analogy being that “opening the door to CBF success” requires both “opening the right locks” and “opening all locks” (Fig. 1).



**Fig. 1. Keys to effective community based forestry (Gilmour, 2016)**

Regardless of the importance of each key, they all need to be available for CBF regimes to operate at their full potential to deliver the biophysical and socio-economic outcomes that are expected of them.

This paper has focused primarily on the development and application of silvicultural practices that are appropriate for community forestry. Viable technology, including sound silviculture, is one of the important “keys” but it is not the only one. It is important to remember that sustainable outcomes require much more than the application of technical forestry.

### Conclusion

Community forestry has always emphasised the provision of multiple goods and services to a range of interest groups. The notion of “appropriate”

silviculture is very important in the context of developing and applying silvicultural systems that require little if any input from government or other service providers. The starting point for considerations of silviculture for community forestry is that community forests will be managed by local communities, so silvicultural systems need to be appropriate for application by local communities. While the notion of “appropriate” is contextual (Anon., 2001) – it does not exclude the management of community forests for commercial purposes.

Many community forests are established on degraded land and the initial management objectives tend to be protection oriented. Forests are generally not able to provide high yields of timber in the early years, although they may provide many other benefits. However, this situation will alter as community forests improve as a result of protection, and silvicultural systems can evolve accordingly. The initial protection oriented management objectives can give way to ones that focus on the production of a wider range of goods and services. Thus, there is a need for adaptability in terms of setting management objectives and determining silvicultural practices in order to allow forest users to learn from experiences and modify their approaches.

In most situations (exceptions might be the full-scale commercial production systems in Mexico - see, for example, Antinori and Bray, 2005) detailed growth and yield estimation is not required to assure sustainable off-take of most forest products (even assuming that reliable information could be collected). In fact, by emphasising appropriate silviculture rather than detailed inventory, communities will be able to utilise forest goods and services without jeopardising the long term ability of forests to satisfy future needs.

Most conventional forestry tends to view sustainable yield in terms of maximising the production of timber on a long term sustainable basis. It is more useful to think of managing community forests in terms of optimising the whole process, so that the yield of products and the social arrangements needed to manage the forest can both be sustained. Ultimately, what is important is that:

- The productivity of the forest is maintained or improved; and

- Goods and services of a type, quality and quantity to satisfy the requirements of forest users are regularly available.

Hence, the interaction of social and biological factors needs to be considered when determining suitable silvicultural regimes. There is no point in insisting on the application of sophisticated silvicultural systems and complicated inventory techniques on the basis that this is needed to maximise timber yield, if the system is too complicated to be applied by communities. It would be much better if a sub-optimal approach is taken leading to less than maximum yields, but the use of a system that can be understood and applied by community groups.

Communities can apply their extensive local and site-specific knowledge to the process of identifying and monitoring silvicultural activities. Experience has shown that silviculture in community managed forests can be sophisticated in a way that differs from the sophistication resulting from the application of traditional forestry science. However, government forest departments do have an important role to play. They need to act as technical advisers and facilitators of participatory silvicultural processes so that the best of forest science and local knowledge can be integrated. Long-term data collection and analysis of permanent sample plots in community forests can assist forest departments to be in a better position to suggest management options for communities, particularly for commercial timber utilisation. This could allow for a better combination of subsistence and commercial objectives in community forestry in the longer term.

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