

## Guidelines for assessing and developing the tree seed and seedling sector

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### Key messages

- Having effective tree seed and seedling delivery systems is key for enabling tree growers to plant trees to provide needed products and services.
- The situation of tree seed and seedling supply in most places is currently inadequate, however, with growers often using planting material of unknown history and poor performance.
- To make improvements, conducting a sectoral assessment of the current situation is the starting point. How to do this is explained in this brief, and we outline steps that build on the assessment.

### Summary

In this brief, we describe what is involved in undertaking a sectoral assessment of tree seed and seedling delivery systems. This assessment is a starting point for improving the current poor situation for tree seed and seedling supply that typically prevails. While there is no one-size-fits-all approach, elements of general relevance for assessment have been identified. Surveys that determine the germplasm that is available and is being planted are important. The mapping of the stakeholders involved in the sector to describe the major models of supply is also key. Assessing the policy and regulatory landscape around supply, the capacity of the stakeholders involved and the funding supporting the sector is also needed. Assembling all of this information into a sectoral overview is the final step to inform action. In addition to describing in this brief what is involved in sectoral assessment, we outline how the assessment can be built on to more effectively supply tree planting material.

plant trees to enhance livelihoods, support biodiversity and combat climate change. Current systems – outlined in Box 1 – are, however, generally highly suboptimal, with growers often using planting material of unknown history and poor performance. Genetically, planting material is often neither matched to the conditions of the planting site nor to the planting purpose; and, physiologically, seed is often of low viability. In addition, typically the seeds and seedlings of only a few tree species are available for planting, whereas broad species diversity would better serve planters needs and landscape restoration targets.

To improve the supply situation, understanding the tree seed and seedling sector as it currently exists is important, and this brief provides guidance on how this understanding can be achieved. Although it is important to note that there is no one-size-fits-all approach to undertaking such a sectoral assessment, we have identified elements of general relevance for assessment based on our own practical experiences working in the tree seed and seedling sector. Although our experience has mostly been in Africa and Asia, the approach laid out in this brief is of general relevance for the tropics, and many aspects are relevant for temperate regions too.

### Introduction

Effective tree seed and seedling delivery systems are key for enabling farmers, foresters and other tree growers to

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Ultimately, it is for the reader to decide which aspects of the assessment method laid out in this brief are relevant for them to apply, and at what scale. What work needs to be done 'from scratch' depends on whether some relevant information has already been

### Box 1. Defining tree seed and seedling delivery systems

Tree seed and seedling delivery systems are the pathways, with their component parts, by which growers obtain tree planting material. Included are the seed sources, and the distribution mechanisms of seeds and seedlings that are derived from them. Included too are the stakeholders involved in supplying the planting material, and the networks, policies and rules related to delivery.

Efficient delivery systems are currently rarely found, but when they do occur, they typically share a number of features. These include good practice in tree seed sourcing, and the effective propagation and distribution of high-quality, source-identified tree seedlings. Well-defined, complementary roles for stakeholders are also a feature, as are well-founded policies and regulations that support effective stakeholder relationships and sectoral investments.

We have found that, in tropical nations, three basic models for tree seed and seedling supply dominate: (i) the decentralized model, where there is a strong role for communities and localized entrepreneurs in tree seed and seedling delivery; (ii) the non-governmental organization (NGO) model, where NGOs mostly distribute tree planting material; and (iii) the government model, which is founded on national tree seed centres effecting supply. How these models work together, however, is often uncoordinated and inefficient.

For readers interested in learning more about these delivery system models and the concepts involved, please refer to our earlier publications, especially Graudal and Lillesø (2007), Graudal et al. (2021), Kindt et al. (2023) and Lillesø et al. (2011, 2018, 2021). Colleagues at Bioversity International have also set out a framework for understanding and assessing tree seed delivery systems (Atkinson et al. 2021). In addition, for readers interested in exploring case studies of the application of the elements of sectoral assessment described in this brief, see ICRAF (2024) for examples from the Provision of Adequate Tree Seed Portfolios in Ethiopia project (PATSP0).

collected, in which case the focus is to fill knowledge gaps. The human and financial resources that can be committed to undertake a sectoral assessment will be limited, and this too will be a factor in determining what work should be done. Rarely will it be possible to acquire a perfect understanding of the prevailing situation, meaning that pragmatism will be needed in interpreting findings.

After here presenting the elements of a sectoral assessment, we outline how it can be built on to improve the delivery of tree planting material.

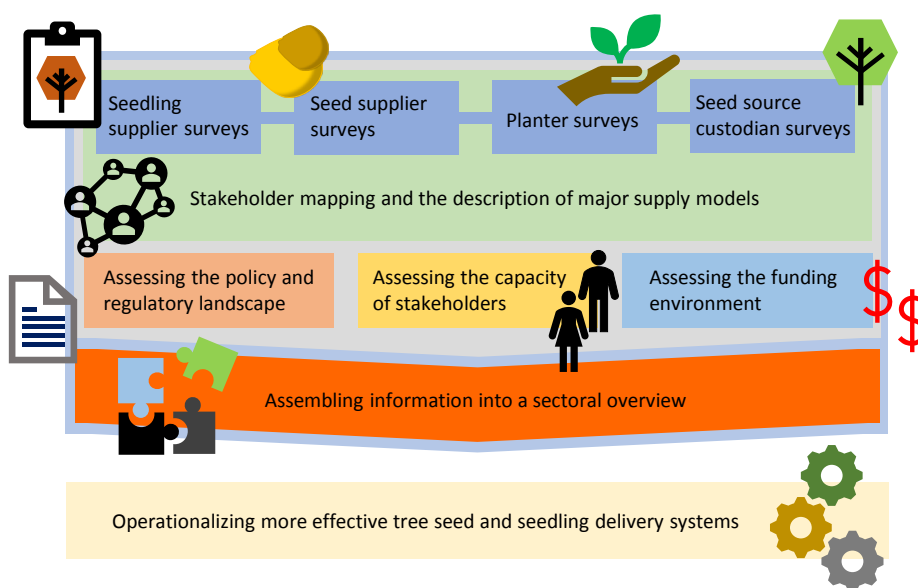
## Elements in tree seed and seedling sectoral assessment

In this section, we describe the elements of a sectoral assessment that are also illustrated in Figure 1. These elements do not all need to be undertaken in the order in which we present them, and for efficiency many may be conducted in parallel. However, of the tree seedling supplier, tree seed supplier, tree grower and seed source custodian surveys described, starting with the survey of seedling suppliers is advisable. This is because seedling suppliers (nurseries) often act as a bridge between seed suppliers and growers, and so they provide an initial broad insight of the supply situation. In addition, the step of stakeholder mapping that we describe should not take place until after these surveys. Naturally, the last step of all assessments is the assembly of the sectoral overview.

### Surveys of seedling suppliers, seed suppliers, planters and seed source custodians

Important topics to cover in surveys of tree seedling suppliers, tree seed suppliers and tree planters are described in Table 1, which also provides information on how to do surveys. For all of these surveys, understanding the source of the tree germplasm is important because it is a key determination in the success or otherwise of planting (Box 2).

Seedling supplier surveys are done to understand what tree seedlings are being supplied to growers. Topics covered include: the range of species supplied; from where the seeds of seedlings are obtained; the characteristics of the suppliers; their finances; their key challenges; and any trends in supply and demand.



**Figure 1. Possible elements in a sectoral assessment of tree seed and seedling delivery**

Note: Each of the elements shown in the schematic is explained in this brief. As noted in the text, however, there is no single set approach to assessment, and the reader will need to decide what is appropriate for their situation.

Seed supplier surveys are carried out to understand what tree seeds are being supplied to seedling suppliers (and directly to tree growers when growers establish trees from seed or raise their own seedlings for self-planting). Topics covered are similar in nature to the survey of seedling suppliers, except the focus is on the seeds.

Planter surveys are undertaken to understand what trees are being planted. The topics covered can be stratified similarly to seedling supplier and seed supplier surveys. Information is thus collected about the tree species being planted (and additionally for what purpose), and from where the planting material for these trees comes. Information is also collected about the characteristics of growers; the costs (in money and labour) they face in obtaining planting material; their key challenges; and any trends in planting.

In these surveys, it is important to explore the gap between demand *per se* – that is, tree growers’ aspirations of what they would like to plant (and what trees the suppliers of seedlings and seeds would like to be able to supply) – and actual practice (reality), as closing this gap represents an objective of a more efficient tree seed and seedling sector. It may also be that growers do not have a clear idea about what trees to plant, which suggests market communication failures that a more efficient sector will address.

As well as seedling suppliers, seed suppliers and growers, the seed source custodians who are responsible for the seed sources should be surveyed (these custodians may or may not be the same as the seed suppliers). This is to understand what seed sources exist (Box 2), who looks after them, if and how sources are being used and managed, and what their capacities to supply seed are.

### Stakeholder mapping and the description of major supply models

Stakeholder mapping involves working out the roles, responsibilities and relationships of the voluntary community groups, entrepreneurs, NGOs, tree seed centres, investors, government regulators and other stakeholders involved in the tree seed and seedling sector. A crucial component is to work out the main tree seed and seedling flows between the various stakeholders, so that major supply models can be defined (see Box 1). Mapping explicitly explores collaboration and competition between stakeholders, both among stakeholders of the same type and between stakeholders of different types.

Such mapping requires that the different stakeholders are convened. Workshops can be held where the findings of the surveys already described in this brief are presented as an entry point for cross-stakeholder

**Table 1. Features of tree seedling supplier, tree seed supplier and tree planter surveys**

Information to collect	Seedling supplier (nursery) surveys	Seed supplier surveys	Planter surveys
On species	What species' seedlings are being supplied to planters and in what quantities?	What species' seeds are being supplied to seedling suppliers and in what quantities?	What species are being planted, for what purposes and in what quantities? Do growers know what to plant?
On where seeds and seedlings come from	Who are the seed suppliers? What information on where seed for seedlings came from is provided by nurseries to growers? How much seed is collected by the seedling suppliers themselves and from what sources?	What is the source of the seed? What information on source is passed on to seed suppliers' clients?	How much is the self-collection of tree seed and seedlings practised? How much do planters know about the source of planting materials obtained from seedling and seed suppliers?
On stakeholder characteristics	Is the supplier working alone or within a group? Are they linked to particular planting projects and, if so, in what capacity? Are they certified to practise and what standards are applied? What is their motivation? What is their gender? What is their access to clients, market information and decision-support tools?	Is the supplier working alone or within a group? Are they linked to particular planting projects and, if so, in what capacity? Are they certified to practise and what standards are applied? What is their motivation? What is their gender? What is their access to clients, market information and decision-support tools?	What is the size of the grower's landholding and their tree planting capacity? Do they represent or are they linked to particular planting projects? What is their gender? Are they connected to tree product markets?
On finances	How much can seedlings be sold for? Is a premium chargeable for higher quality seedlings? What are their costs, returns and turnovers?	How much can seed be sold for? Is a premium chargeable for higher quality seed? What are their costs, returns and turnovers?	What costs are involved in obtaining planting material? Is there a willingness to pay a premium for higher quality material?
On key challenges	What key bottlenecks are faced in obtaining tree seed to raise seedlings, and in reaching tree planters? Are these, and any other barriers faced by nurseries, gender-specific?	What key bottlenecks are faced in obtaining tree seed and in providing this seed to clients? Are these, and any other barriers faced by seed suppliers, gender-specific?	What key bottlenecks are faced in obtaining tree planting material? Are any barriers gender-specific?
On trends	How has access to seed of different tree species changed?	How has access to tree seed sources changed?	How have growers' demands for tree seedlings changed?
Survey methods	'Field' interviews and group discussions with a cross-section of representative suppliers. Inventories of seedlings sold, seed still waiting for sowing and nursery stocks. For checking physical seedling inventories, visit nurseries just prior to seasonal seedling dispatches.	'Field' interviews and group discussions with a cross-section of representative suppliers. Inventories of seed sourced, seed sold and seed stocks.	'Field' interviews and group discussions with a cross-section of representative growers. Inventories of trees planted.

Note: For more information, please see the section titled "Elements in tree seed and seedling sectoral assessment".

**Box 2. Sources of tree germplasm**

Knowing the type of tree seed source provides an indication of the genetic quality and availability of the seed, and this helps direct sectoral interventions. Five types of tree seed sources are outlined in this box.

**Immediate seed sources**

**Seed from natural tree stands:** here, seed is collected from trees in their natural state. Such trees have the potential to be genetically high-quality and immediate sources of seed of a wide range of species. For legal, and practical, reasons they may be difficult for tree seed collectors to access, however, and they are therefore generally underutilized as seed sources. Important sectoral interventions may be to identify more of these sources and support access to them.

**Seed from farmland trees:** here, seed is collected from trees in farmers’ fields. Most often these are planted, although sometimes they are remnants of natural stands. Such trees are broadly accessible and immediate sources of seed of a limited to medium range of species, and they often dominate current seed provision. The origin of planted farmland trees is generally unknown, however, so the genetic quality of the seed collected is considered to be low. Sectoral upgrading will typically reduce dependence on farmland trees by supporting other source types.

**Seed from plantation trees:** here, seed is collected from trees in (typically) commercial forestry plantings. Such trees are immediate sources of large quantities of seed of a narrow range of species. When the origin of the trees establish in the plantation is unknown, the genetic quality of the seed collected is considered to be low. However, the origin of the trees is more likely to have been recorded than for planted farmland trees, in which case a higher genetic quality may be assigned to collected seed. A useful sectoral intervention may be to take efforts to establish origin to upgrade quality status.

**Future seed sources**

**Seed from seed orchard trees:** here, seed is collected from trees planted and managed for seed production. The trees are genetically high-quality seed sources because they are of selected germplasm of known origin. Sectoral upgrading will typically involve planting more seed orchards, supporting their management, and ensuring access to them. The new orchards only become seed sources when the trees mature, however, which may take years.

**Clonally propagated ‘seed’ from mother block trees:** here, the ‘seed’ is the clonal propagule collected from mother block trees planted for propagation. The trees are typically genetically high-quality propagule sources because they are of selected germplasm of known origin. This type of source is important where true-to-type propagation of trees is required, and when trees have recalcitrant seed. Sectoral upgrading will typically involve planting more mother blocks of clonally propagated trees, supporting their management, and ensuring access to them. Refining propagation protocols is also an important activity. The new mother blocks only become ‘seed’ sources when the trees are of the right age for propagation, however, which may take years.

Note: For further information on tree seed source types, see Lillesø et al. (2011).

discussions. These workshops should encourage stakeholders to begin to consider how their roles in the sector might change to support more effective collaboration, as this is likely to be core to sectoral development (see more in the section titled “Operationalizing more effective tree seed and seedling delivery systems”).

**Assessing the policy and regulatory landscape**

Assessing the policy and regulatory landscape involves understanding the rules and regulations that directly govern or otherwise affect the tree seed and seedling sector. It is necessary to understand the specific impacts on the operations of particular stakeholders, as well as the impact on the sector as a whole, in terms

of whether the rules and regulations are enabling or not for delivering tree seeds and seedlings. In this last regard, it has been noted that existing sectoral policies and regulations sometimes have unintended negative consequences, and identifying these hinderances is crucial for sectoral reform.

Desk reviews should first establish the policies on rural development, biodiversity and climate change that provide context for the operation of the tree seed and seedling sector. Following that, interviews of policy makers should explore the specific governance framework for the sector. Interviews with a broad cross-section of sectoral stakeholders then provide an understanding of whether and how policies and regulations are applied, and their effects. Stakeholder workshops can then explore further the advantages and disadvantages of the policy and regulatory

environment. These workshops should encourage stakeholders to begin to envision a more effective policy and regulatory landscape (see more in the section titled “Operationalizing more effective tree seed and seedling delivery systems”).

### Assessing the capacity of stakeholders

Assessing the ability of stakeholders to support effective tree seed and seedling delivery systems involves looking at both human and structural capacities. This allows key strengths to be identified that can be amplified to enhance the sector, as well as key gaps where new capacities need to be gained for effective functioning.

A training needs assessment determines the skills and knowledge capacities of stakeholders. This involves one-on-one interviews and group discussions with the members of stakeholder institutions. It also includes observations of day-to-day activities for those stakeholders involved practically in seed and seedling supply. Inventories of equipment and facilities of these latter stakeholders informs on structural capacity. During these activities, discussions with stakeholders can begin to consider how existing capacity strengths could be further exploited, and how capacity gaps may be filled, perhaps identifying relevant local educational institutions and equipment suppliers in the last instance.

### Assessing the funding environment

Assessing the funding environment is about understanding current and predicted future investments in tree planting, and the opportunities and challenges this poses for the tree seed and seedling sector. This informs on the scale of investment needed in the sector to meet planting targets, and on how sectoral funding should be most appropriately allocated and managed to maximize impact.

Desk reviews and interviews with government planners and investors – including philanthropic parties and private companies as well as government investors – inform on the scale, location and timing of planned plantings and the associated investments that are being made. Reviews and interviews also establish the identities of the tree species required for planting, and the extent to which the delivery of planting material to growers has been considered. During interviews, discussions with planners and investors

can reinforce the importance of considering seed and seedling delivery systems for reaching intended tree planting impacts.

### Assembling information into a sectoral overview

Bringing the elements of a sectoral assessment together into a sectoral overview is the final step in the assessment process. Desk synthesis by sectoral experts of all the information collected during the assessment is the first requirement. This initial synthesis, highlighting any apparent discrepancies in the assessment, should then be presented in a workshop setting to all major stakeholders. Supported by knowledgeable workshop facilitators and the sectoral assessment team, the major findings of the assessment should then be settled upon. Interventions that address key sectoral constraints and take advantage of existing sectoral strengths should then be identified and prioritized by the assembled stakeholders. The recommendations for intervention should be framed within an action plan that is a living document that is regularly updated.

### Operationalizing more effective tree seed and seedling delivery systems

Recommendations from the sectoral assessment may include specific interventions to enhance tree seed sourcing; guidance to address policy and regulatory failings; appropriate training and infrastructural investments; and measures to better channel and coordinate tree planting funds. Testing the effectiveness of these interventions for bringing about positive change is an important part of the implementation process, and where success is proven the lessons can be further scaled.

Allocating more appropriate institutional roles and responsibilities to the stakeholders involved in the sector, and transforming their relationships, are likely to be important factors in operationalizing more effective tree seed and seedling delivery systems. Facilitating discussions among stakeholders to reach agreement on role reallocations in support of a more operationally effective and equitable sector overall is therefore likely to be crucial. New policies, new capacity building measures, and new incentives broadly, should all support genuine cross-institutional engagement and institutional evolution.

Although there are no definitive rules, previous sectoral assessments provide pointers for typically important role reallocations (Lillesø et al. 2021). Generally, NGOs should be encouraged to move away from providing free tree seedlings to growers, as this then allows space for incipient local commercial seedling suppliers to flourish. NGOs should typically instead be encouraged to help build the accounting, networking and communication skills of the commercial suppliers.

Another pointer is that tree seed centres should be encouraged to focus less on the direct provision of seed to seedling suppliers, to provide space for local commercial seed suppliers to operate. Tree seed centres should typically instead be encouraged to build the capacity of local commercial seed and seedling suppliers to collect, store and handle tree seed, and to raise tree seedlings. Crucially, tree seed centres should also be enabled to provide greater support to local commercial seed suppliers to access and develop genetically high-quality seed sources.

Other measures to support local commercial seed and seedling suppliers may include policies that favour them as providers of planting material in national tree planting programmes; the development of pragmatic, ‘good enough’ quality standards that are not hard barriers to their market entry; and putting in place communication channels for supporting their cooperation and that lower barriers to market information.

Whether such interventions are appropriate in a particular case will become evident through the sectoral assessment.

## Acknowledgements

CIFOR-ICRAF’s collaborative work with partners on tree seed and seedling delivery systems receives significant financial support. The Green Climate Fund (GCF), with its Readiness Programme, invests in the development of Climate Appropriate Portfolios of Tree Diversity in Burkina Faso (R-CAPTD). GCF also invests in tree seed and seedling delivery systems through the IUCN-led Transforming the Eastern Province of Rwanda through Adaptation project (TREPA). Support also comes from Norway’s International Climate and Forest Initiative through its funding of the Provision of Adequate Tree Seed Portfolios project (PATSP0) for improving Ethiopia’s tree seed supply; from Germany’s International Climate Initiative through its funding for the Right Tree in the Right Place project (RTRP-Seed)

for improving native tree species’ seed supply in sub-Saharan Africa, with a focus on Ethiopia, Kenya, Rwanda and Uganda, and some activities in Burkina Faso; and from the Bezos Earth Fund that invests in tree seed and seedling delivery systems development in Kenya and the Lake Kivu and Rusizi River Basin. In addition, CIFOR-ICRAF gratefully acknowledges the support of the EU and broader CGIAR funding partners. Our thanks also to three reviewers of this brief.

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