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Using case studies for enhancing capacity in managing forest genetic resources

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Abstract

Forest trees are long-lived species with high genetic diversity that is crucial for their survival, regeneration and adaptation. However, forest managers and conservationists are often not well informed about the relevance of genetic aspects to population viability. Lack of understanding of forest genetic resources (FGR) therefore constrains conservation of tree species, increases genetic risks in subsequent generations and hinders adaptation to climate change. Examination of tertiary forestry education curricula shows poor or no coverage of FGR issues, while biology teaching is often devoid of the social and practical realities. A vicious cycle is looming in which teaching and understanding of FGR and its importance to conserving and using forest tree species—in protected areas and in production landscapes—becomes increasingly marginalised. We describe a case study-based approach to teaching and learning about FGR use and conservation, based on real research results and subsequent recommendations. Designed to promote 'FGR-friendly' decision-making, the Training Guide covers practical issues in forest and tree conservation and management of both global and local relevance. Each case study provides genetic, ecological and socioeconomic information as a basis for students' analysis. Teacher's notes, PowerPoint presentations and videos give background information to each case. The guide is intended for both tertiary education and on-the-job training. The material has proved popular with trainees and is flexible and easy to use in a range of formal and informal learning situations. Case study based modules are currently available in English, Spanish, French, with Russian and Chinese in preparation.

Keywords: forest genetic resources education, training, sustainable forest management, case study approach

Introduction, scope and main objectives

The recently published State of the World's Forest Genetic Resources highlighted the grim reality of declining populations of important tree species due to a variety of threats (FAO 2014a). The Global Plan of Action is a call for governments, international organisations and others to respond before it is too late (FAO 2014b). Forest trees are long-lived species with high genetic diversity that is crucial for their survival, regeneration and adaptation. However, forest managers and conservationists are often not well informed about the relevance of genetic aspects to meeting their objectives. Such professionals lack a recognition of the importance of FGR (Salcedo *et al*. 2009), while negative perceptions persist within the wider public about words like 'genetics' and 'cloning', associated with GMOs (genetically modified organisms), tissue and human cloning (Petersen 2001; Condit 2010). Lack of understanding of forest genetic resources (FGR) therefore constrains conservation of tree species, increases genetic risks in subsequent generations and hinders adaptation to climate change. Despite serious knowledge gaps with respect to biology and ecology of many tree species, the body of information available in the scientific literature is rapidly expanding. If people do not appreciate the importance of, or do not understand how to interpret or apply research results, the many research-derived implications and recommendations for conservation and use of genetic resources will remain in journals, gathering dust, while populations of trees continue to decline, limiting their potential both evolutionary and for use.

Amongst the Global Plan of Action's 27 strategic priorities, priorities 21 and 24 identify the need to establish and strengthen educational capacities on the conservation and sustainable management of FGR (FAO 2014b). The challenge is how such capacities can be effectively and sustainably built. An abundance of science-based information addresses conservation questions. For example, a search for the phrase "*this research has important implications for conservation*" in PubMed on 7/4/2015 revealed some 979 articles, a rapid increase from 666 for the same search on 14/11/2012. While an increase in the use of open-source publication means increased and wider availability of research results, examination of many such articles shows that access to information remains limited for a variety of reasons. One issue is language, both the excessive use of technical jargon that non-specialists do not understand and the dominance of the English language that is problematic for non-English speakers. Secondly, researchers' recommendations often show a clear lack of understanding of the practical realities of day to day management and conservation and are therefore unlikely to be implemented. Conversely, those people who are in a position to make a difference to the conservation or sustainable management of forest genetic resources are rarely trained in genetics, so they need information in a format that is understandable to non-specialists, and in a language they can understand.

There is a need for educational approaches that facilitate learning, making genetics approachable and relevant to a broader audience, while also placing genetic issues in broader and diverse managerial contexts. Typically FGR textbooks after an introduction, have a chapter full of equations which scare away the uncommitted, while the extensive use of molecular studies can further convey the impression that the subject is only for the high-tech scientist. A wider issue also noted in ecology is the speed at which research gets included into text books. For example, with respect to the shift in ecological understanding from the equilibrium paradigm to one of non-equilibrium that occurred over the past two decades, Wallington *et al*. (2005) observed that "*very little of this shift was reflected in ecology textbooks until recently, and hence many conservation managers practicing today were trained in the "old school" of thought*". So, how can relevant capacity and understanding in FGR be sustainably built? There was no 'off the shelf' publication that helps facilitate training on FGR conservation and management in a context relevant to current land-use scenarios and the livelihoods of rural people.

Why is this Training Guide needed? Sustainability of capacity building

SeedSource was a multi-year (2005–2010), multi-institution project involving a team of scientists (UK, Brazil, Costa Rica, Ecuador, France, Italy, Germany) studying genetic resources of neotropical trees. The goal of the project was to provide best practice for sourcing tree germplasm for use within degraded landscapes to ensure the use of best adapted material, that maximises production, without eroding genetic and ecosystem diversity and long term adaptive potential (www.seed-source.net/overview.html). At the start of the project a survey on seed collection practices in Central America and southern Mexico showed that little or nothing remained of previous efforts to strengthen tree seed banks and tree seed management and supply through a previous multi-million dollar project (1992–2001; Mesén 2006). Most project-trained personnel had left state seed banks, while the majority of seed sources identified and managed during the project had been abandoned by seed banks. Forest genetic conservation/improvement activities had also disappeared in recent years, though there were new initiatives from state/research orgs in some countries (Mesén 2006).

The impact of capacity building initiatives, whether by national and international organisations, is cast into doubt if they are not sustainable beyond a project's life, especially if most potential users of dissemination outputs are unaware of their existence or not equipped to understand them. In response to the survey findings a decision was made to shift the principal target group to tertiary education teachers, with the reasoning that they show a greater stability of personnel. This was confirmed by a survey in Latin America which showed that 62% of teachers had been in their institute for 10 years or more (Cordero 2012). As the teachers are themselves involved in capacity building this would also give a higher chance of mainstreaming more complex concepts and messages into general curricula of forestry and natural resource programmes. Thus there would be a higher probability that both training and materials would be used beyond a particular project.

Methodology/approach

Teaching of forest genetic resources

To understand current status, resources and limitations to teaching related to FGR in Central/South America, workshops were held in Costa Rica, Honduras, Ecuador and Nicaragua, as representative of the range of education capacity within the region (SeedSource 2006). Workshops had 13–25 teachers from universities and technical colleges involved in teaching any of: tree improvement, nurseries, silviculture or ecology. Workshop participants outlined ideal characteristics of forestry-related didactic materials for students and teachers and where they sourced such information. Seed collection and management materials were also grouped by utility to students or teachers, with strengths and weaknesses identified for transferring information. No differences were found between countries, with respect to courses and educational levels offered, computing/documentation access, or teaching aids. There were huge resource differences between individual institutions and educational levels within each country. In general, access to forest genetic information was poor and available sources of information were not well known (e.g. Bioversity International's booklets on the conservation and management of FGR: www.bioversityinternational.org/e-library/publications/detail/forest-genetic-resources-conservation-and-management-overview-concepts-and-some-systematic-approaches-vol-1/).

In the workshops teachers advised against introducing specific courses on FGR, with curricula generally being rigid and requiring long lead-in times for changes. There was enthusiasm for and consensus on teaching about FGR issues across a range of existing courses, where teacher initiatives allow for the introduction of FGR concepts in specific lectures/seminars within courses (e.g. ecology, natural resource conservation, silviculture, forest tree seeds/nurseries) without formal curricula modifications. For this to be possible they recognised the need for suitable training material that makes FGR training relevant, attractive and accessible, both in language and readability, to non-specialists. Such material should include teacher notes and help teachers to realise they can cover aspects of FGR in their courses, though in some cases they may need training workshops on the use of this material.

Forestry education at a professional level has shown a decline during the last 20 years, in both developed and developing countries (Van Lierop 2003; Temu *et al*. 2005, Encinas *et al*. 2009, Innes and Ward, 2010), with a significant reduction in financial support to higher education, low student enrolment (Van Lierop 2003; Miller 2004; Innes and Ward 2007), and an inability to capture talented students (Nair 2004; Innes and Ward 2007). Within institutions currently teaching forestry, the multidisciplinary nature of FGR, the wide range of skills necessary to plan and carry out conservation plans at national, landscape or local scales, a lack of trainers and training materials, and technical barriers (Geburek and Turok 2005) all contribute to the lack of prominence of FGR in programmes and courses. Similar to forestry education, there is a perception that FGR teaching is in decline and has been affected by changes to global forestry paradigms and competition from other academic disciplines. Casual observation suggests that tertiary education curricula currently address FGR in one of the following ways:

- FGR is not taught—despite new research tools and a dramatic increase in research
- FGR is taught in Forestry courses in the context of tree breeding (e.g. plus trees, seed stands, etc)
- FGR is taught in Biology and Environmental Sciences courses, but without a socioeconomic /managerial context that allows students to see the relevance of genetics.

To test the observations a web-based review and survey was carried out with tertiary education teachers in Latin America (Cordero 2012). Results indicated that FGR themes are taught across a diversity of programmes in Latin America (Forestry, Biology, Natural Resources, Ecology, Environment and Agronomy). Suggestions of a decline in enrolment in FGR-related courses appeared to be unsubstantiated, perhaps resulting from a focus on declining enrolment in forestry programmes while overlooking enrolment trends across the other programmes. A positive impact of this trend is that female enrolment in FGR-related courses was higher than average in forestry higher education, with stable or slightly increasing enrolment trends. Most FGR-related courses dedicated less than 40% of their time to FGR topics (mode: 20–30% of hours), while nearly half were optional courses, particularly in Biology and Natural Resources undergraduate and postgraduate programmes.

An unexpected finding from the study was that teaching FGR in elective courses, or in those where the number of hours dedicated to the topic amounts to less than 40% of the syllabus, has more advantages than teaching FGR in compulsory courses or in those where FGR is the main/sole focus of the course: it allows more flexibility since it is easier to change the syllabus of elective than core courses and stresses the importance of teaching FGR in a broader context. Additional advantages are permanence within curricula (as FGR topics can be moved across courses or even programmes) and, in this study, a balanced enrolment ratio by gender when courses were optional. Also, on elective courses, smaller class sizes allow more effective teaching and while fewer students are reached, the ones that enrol tend to be keener on learning about FGR topics. The second situation—integrating FGR aspects into other courses—allows a new topic or approach to be taught in a range of existing courses, often without formal curriculum review. Hence, a teacher can respond rapidly to emerging training needs.

Results

Contents of the Forest Genetic Resources Training Guide

The Forest Genetic Resources Training Guide (Boshier *et al* 2011) was conceived as a way of bridging the gap between research and action. It facilitates a problem-oriented approach to teaching and learning, consisting of modules on important topics in the conservation and sustainable use of forest genetic resources (see Box 1). It has a global geographic scope, covering issues of both global and local relevance. Case studies within each module are based on published research using the actual data and visual teaching resources to examine the relevance and use of tree genetic information in the formulation and implementation of conservation and management actions (see Box 1). Targeting non-specialists, the Guide can be used in a range of education settings or on-the-job

training. The Guide demonstrates the value of FGR for responsible decision-making in forest and natural resource management. Placing genetics in a wider context (e.g. social realities and policy contexts) challenges teachers and students to think about where genetic perspectives are (or are not) relevant to management and conservation. Use of the case studies will help learners to ask relevant questions related to genetic issues in various forest/tree management situations and at a policy level.

Box 1: Topics of currently available modules and case studies

Module 1. Species conservation strategies
- 1.1 *Leucaena salvadorensis*: genetic variation and conservation
- 1.2 *Talbotiella gentii*: genetic variation and conservation
- 1.3 *Shorea lumutensis*: genetic variation and conservation

Module 2. Trees outside of forests
- 2.1 Conservation of tree species diversity in cocoa agroforests in Nigeria
- 2.2 Devising options for conservation of two tree species outside of forests

Module 3. Seed supply chain
- 3.1 Genetic bottlenecks in the restoration of *Araucaria nemorosa*
- 3.2 Tree planting on farms in East Africa: how to ensure genetic diversity?

Module 4. Forest management
- 4.1 Impacts of selective logging on the genetic diversity of two Amazonian timber species
- 4.2 Does selective logging degrade the genetic quality of succeeding generations through dysgenic selection?
- 4.3 Conserving *Prunus africana*: spatial analysis of genetic diversity for non-timber forest product management

Module 5. How local is local? *Under development*

The materials associated with each case study include:

- *The Case study*—introduces the exercise to be assigned to the students and presents information from research on the species concerned (Fig. 1).
- *Teacher's notes*— give extensive tips on how to prepare and run the exercise and discuss the main learning points that students should be able to derive from the case study. It also includes a commentary to the PowerPoint presentation.
- *Additional background information*—used to introduce the case study to the students. It includes a video (for most case studies) and a PowerPoint presentation.
- *Reference materials*—include PDF files of key publications relevant to the case study.

The case studies are designed to be used as teacher-led, interactive class exercises. Only two to three hours are required for each case study, which can be split into two shorter sessions, making them easy to use within existing courses. Typically the teacher introduces a case study using the provided video and PowerPoint presentation. Students work in groups of 3–5 to discuss the case study amongst themselves, responding to specific questions and developing a management or conservation strategy. Each group presents its strategy verbally to the class, supported by writing of the main points on large paper or in a PowerPoint presentation, allowing for questions or comments by the rest of the class and the teacher. Gradually, the materials are also made available in Spanish, French and Russian.

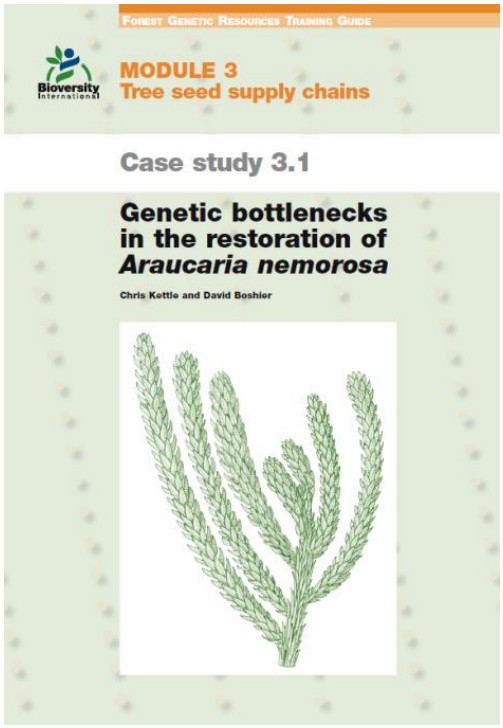

Fig. 1: Case studies and supporting materials are available at http://forest-genetic-resources-training-guide.bioversityinternational.org

Discussion

The Guide is flexible both in terms of which case studies are used and in how they are used. Thus case studies can be used independently or grouped together. A course can be custom-designed for any length of time between a day and a semester, using case studies as required for a particular purpose. The teacher can tailor the use of the Guide to meet specific needs in different learning settings, such as:

- Selecting one case study from a module as an introduction to a particular topic to strengthen an existing course in the Forestry curriculum at undergraduate or postgraduate level.
- Selecting one case study from a module to show the application of molecular research to real life conservation/management issues as part of an existing course in a Biology curriculum at undergraduate or postgraduate level
- Using a case study for conducting tutorials for small groups of students (1–4 students)
- Using case studies as a basis for student special assignments which might form part of the assessment of an existing course
- Using all case studies of a module for a deeper study of that particular theme within a postgraduate programme
- Using several modules for a more complete coverage of current issues in forest genetic resources, perhaps as a new course in the curriculum
- Using individual case studies for on-the-job training of working professionals
- Training-of-trainers, e.g. forestry, biology, natural resources, ecology and agronomy lecturers
- Selecting a sample of case studies from different modules, depending on geographic interest, particular conservation issues, class size and availability of time
- Learning about genetic resources issues in a different geographic region: although the case studies use data and examples from a tropical environment, extensive testing shows that they are suitable for students from tropical and non-tropical countries alike.

Conclusions/outlook

Testing the Training Guide and reaching target groups

All individual case studies have been tested in one or more of eight training courses (170 people) in different parts of the world under various auspices (Bioversity International, Instituto Nacional de Investigaciones Agronómicas–Spain, Instituto Nacional de Tecnología Agropecuaria–Argentina, Instituto Forestal–Chile, SeedSource), as well as in a university tutorial setting. This testing has provided plenty of feedback which has led to many improvements. The response to the case studies has been universally positive with typical comments such as "*we were not taught about FGR—our lecturer said genetics is not important. Now I understand why genetics is important.*"

Development of further modules and translation of existing ones will continue as and when further funding for this initiative is available. A continuing challenge is to find effective ways to promote these training resources, increase the number of downloads from the Training Guide website, and facilitate their uptake among a range of users, and so help to fulfil priorities 21 and 24 of the Global Plan of Action on FGR (FAO 2014b).

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