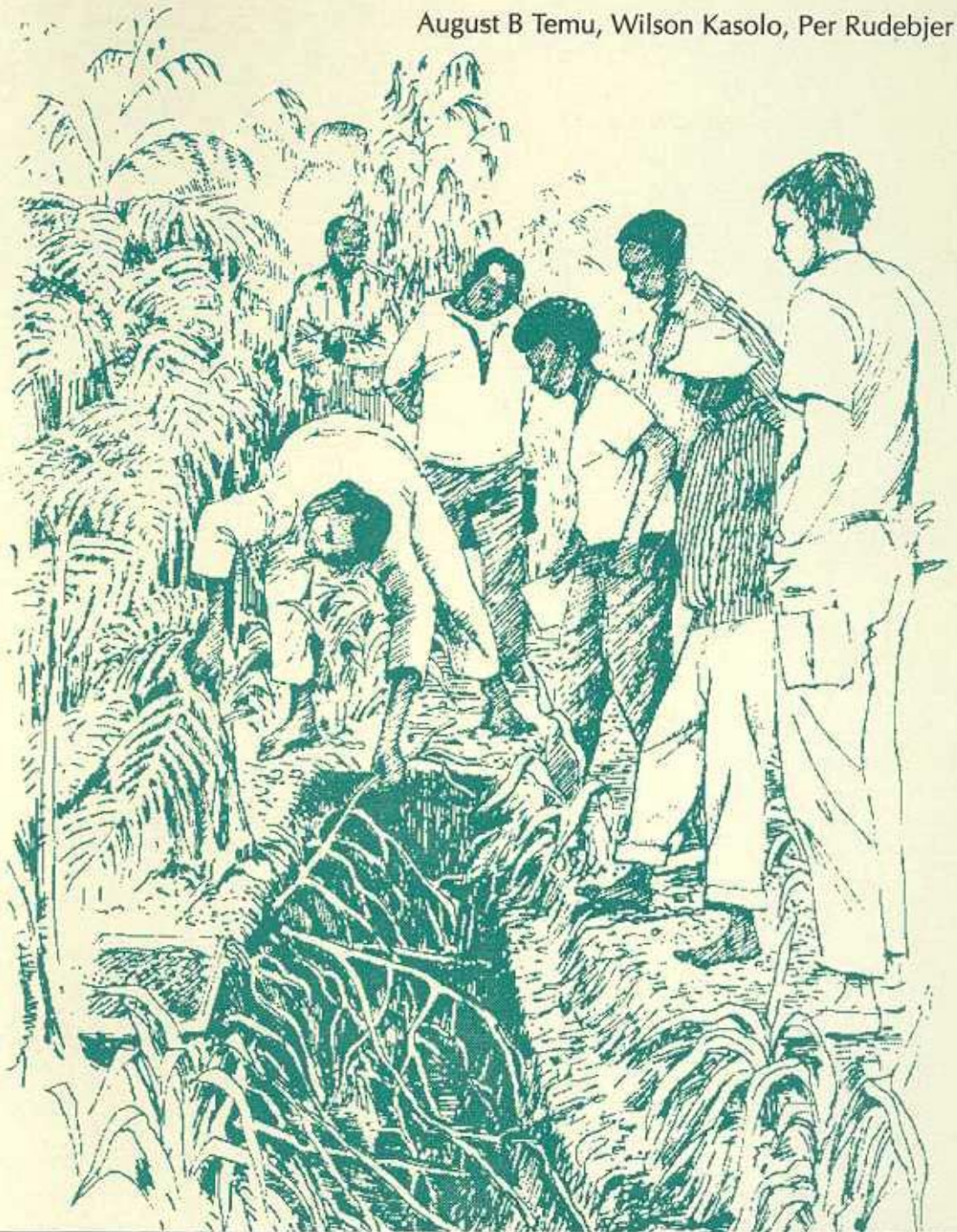
Training and Education Report No. 32

Approaches to agroforestry curriculum development

August B Temu, Wilson Kasolo, Per Rudebjer



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Contents

Preface

Agroforestry is a relatively new area of study as compared with other land-use sciences. Many educational institutions are now incorporating agroforestry into their land-use programmes, especially agriculture, forestry and livestock management. Agroforestry is also featuring prominently in refresher courses, seminars and workshops. At the postgraduate level, many universities support agroforestry for thesis research. There are few institutions that teach agroforestry as a full programme.

The agroforestry proportion and content in curricula differs widely among institutions. This is partly because of the different approaches needed to incorporate agroforestry into the programmes. The African Network for Agroforestry Education (ANAFE) has been monitoring some of the approaches followed by universities and technical colleges in Africa. Using their collective experience, we have developed a framework to identify key agroforestry components in curricula. The framework is not a model, rather it should serve as a guide and source of ideas for institutions wishing to develop separate agroforestry curricula or to incorporate it into existing programmes.

A good curriculum is not static. It is a dynamic instrument that is able to capture new knowledge and experiences without altering its main objectives. This document provides a synthesis of the experience gained by ANAFE members in developing agroforestry curricula.

Ester Zulberti
Director of Training and Information

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1

Introduction

The process of developing a curriculum is as important as the outcome. The main players in the process are also important because they influence the results. A good curriculum begins with characterization of the graduates in terms of the job they are expected to do, and therefore the competencies that they must acquire. A curriculum should have clearly defined objectives, subjects to be taught, learning methods and evaluating mechanisms. The subjects should be presented in a logical sequence. The syllabus of each subject should form a logical sequence of topics, beginning with fundamental principles and ending with practicals, such as fieldwork and case studies.

Normally, a curriculum should last for at least one full cycle before its objectives and structure can be reviewed meaningfully. For instance, a curriculum for a two-year programme should run for at least two years before it is reviewed. This provides an opportunity to produce at least one batch of graduates whose field performance can be evaluated and used in the review.

Many educational institutions are beginning to teach agroforestry. In the majority of cases, they adopt and adapt curricula used for short courses and expand or contract them as desired to meet the time allocated for teaching them. Others simply build their curricula by assembling topics from available literature. These approaches are practical, but their outcomes lack objectivity and may even be inconsistent with the broad objectives of the programme. Such unintended outcomes can be avoided if a systematic approach is used.

This document consists of three main parts: in the first part we discuss how agroforestry is being taught in African colleges and universities; the second part reports on different methods of curriculum development used by ANAFE members; and in the last we present a framework for an agroforestry curriculum.

We have deliberately avoided listing the multitude of topics and subjects that could be taught under agroforestry. We feel strongly that due to the inter- and multidisiplinary nature of agroforestry, the contents of any given curriculum are highly influenced by the discipline(s) hosting the agroforestry programme as well as the social, economic, cultural and environmental milieu. Thus, a framework provides the necessary flexibility. Our work begins with the characterization of the ways agroforestry is being taught in colleges and universities.

2

How agroforestry is being taught

Agroforestry links disciplines

Agroforestry is a collective name for all land-use systems and practices where woody perennial plants are deliberately grown on the same land management unit as agricultural crops and/or animals, either in spatial mixtures or in temporal sequence, with significant interactions between the woody and the non woody components (Lundgren 1987). This definition shows the multifaceted nature of agroforestry as a land-use system involving agricultural crops, woody plants and animals as components. The objective of this chapter is to present and analyse the ways colleges and universities teach agroforestry, and use the findings to guide future action.

Many disciplines must collaborate for the successful development of agroforestry. Collaboration facilitates the identification of the best possible combinations and management of the different components, while taking into account growth requirements for each component for production optimization and sustainability. Agronomy, forestry, animal science, soil science, sociology, economics, anthropology, rural development and related biological and social sciences are, therefore, disciplines that must work together for the proper development and implementation of agroforestry education.

Interestingly, it is the diversity of these disciplines that poses the greatest challenge in developing agroforestry curricula. While agroforestry is common in many disciplines, it finds a home in none of them. At the same time, agroforestry is rarely taught as a separate programme. This has important implications when we try to identify niches where agroforestry can be hosted and resources (human and other) to teach it.

A systematic approach to teaching agroforestry in colleges and universities started in the early 80s and is undergoing rapid changes. However, little has been documented on the processes used to incorporate agroforestry into curricula, much less to justify the contents. In 1994, ANAFE carried out studies in 10 sample colleges and nine universities in eastern and southern Africa. The objectives of the studies were:

- to evaluate the content of agroforestry curricula in the sample institutions
- to asses the participation of various disciplines in teaching agroforestry
- to identify and advise institutions on opportunities for strengthening the content and delivery of agroforestry
- to share the findings with institutions interested in agroforestry education

Agroforestry curricula in colleges and universities

A summary of the status of agroforestry curricula in the sample colleges and universities is given in tables 1 and 2 respectively. The sources of this information were university handbooks, catalogues, prospectuses, calendars and college and university staff contacted through mail and during visits and workshops.

Table 1. Status of agroforestry curricula in sample colleges

College	Programme, duration	Way agroforestry is taught	Contact hours
Botswana College of Agriculture	Forestry & range management: Certificate, 2 years	Topic in: Integrated production systems	90
Wondo Genet Forestry College, Ethiopia	Forestry: Certificate, 2 years Diploma, 3 years	Separate course	37
Kenya Forestry College	Certificate, 2 years Diploma, 1 year	Separate course	94
Egerton University, Kenya	Diploma, 2 years Degree, 4 years	Separate course	45
Malawi Forestry College	Certificate, 2 years Diploma, 3 years	Separate course	60
Natural Resources College, Zambia	Certificate, 2 years	Separate course	44
Uyole Agricultural College, Tanzania	Certificate, 2 years Diploma, 2 years	Separate course	50
Forest Training Institute, Olmotonyi, Tanzania	Certificate, 2 years Diploma, 2 years	Topic in: Community forestry	60
Nyabyeya Forestry College, Uganda	Certificate, 2 years Diploma, 2 years	Separate course	120
Natural Resources Development College, Zambia	Diploma, 3 years	Separate course	40

Table 2. Status of agroforestry curricula in BSc programmes

University	Programme	Agroforestry course	Length
Awassa College of Agriculture, Ethiopia*	BSc agriculture, 4 years	Introduction to agroforestry	2 credit hours
Moi University, Kenya*	BSc forestry, 4 years	Agroforestry	2 course units
Egerton University, Kenya*	BSc natural resources management, 4 years	Agroforestry	30 h lectures, 30 h practicals
Bunda College of Agriculture, Malawi	BSc agriculture, 5 years	Agroforestry I (optional)	40 h
Makerere University, Uganda*	BSc forestry, 4 years	Agroforestry	1 course unit
Botswana College of Agriculture	BSc agriculture, 4 years	Part of: Land evaluation and management	30 h (total)
Sokoine University of Agriculture, Tanzania	BSc forestry, 3 years	Part of: Silviculture	2.7 credit hours (total)
University of Zimbabwe	BSc agriculture, 4 years	Basic elements are taught. Review planned 1995	4 h lectures, 3 h practicals
University of Swaziland	BSc agriculture, 2 years (after 3-year diploma)	None, review in 1995	

* Universities with separate courses in agroforestry
** One credit hour or course unit is equivalent to 30 lecture or 60 practical hours, or a suitable combination of the two.

In all but two colleges, agroforestry is taught as a separate subject. This provides an excellent opportunity to manipulate the course content. There was no explanation on the argumentation behind this practice. However, the process followed was more or less the same for all colleges. The initiative came from staff after they had been exposed to agroforestry in short courses or at meetings and workshops. Their recommendation to start teaching agroforestry were supported by policy-makers, resulting in the introduction of an extra subject or modification of an existing one. In a few cases, as in the case of Uyole Agricultural College, policy-makers initiated the exercise.

Of the nine universities in the study, five had separate agroforestry courses, three taught agroforestry as part of other courses and one did not teach agroforestry at all.

It is apparent that there is enthusiasm by forestry as well as agricultural institutions to teach agroforestry. In agriculture, the subject is taught by departments of crop science, agronomy or soil science. In forestry, it is taught under forest biology, silviculture, community forestry, social forestry and forestry extension. In both agriculture and forestry disciplines, there is little or no interdepartmental collaboration in teaching the subject. This is true even for institutions that teach both agriculture and forestry on the same campus.

Agroforestry content in curricula

Subject matter coverage (tables 3 and 4) is based largely on materials used by ICRAF for short courses and, to a lesser extent, agroforestry promotional materials. Socioeconomics was introduced into the curricula in the early 90s, and coverage is quite superficial and theoretical. The overall structure of agroforestry courses typically follows the ICRAF research organization: characterization and impact (including diagnosis and design), multipurpose tree species, component interactions and agroforestry technologies. This structure is not particularly suited for educational programmes where development of scientific principles should precede discussion of practices and technologies.

Table 3. Frequency of main agroforestry topics in the curricula of 10 colleges

Topic	No of institutions
Introduction to agroforestry	9
Agroforestry systems and sub-systems	6
The role of agroforestry in soil and water conservation	5
Agroforestry components, and their interactions	5
Agroforestry in land-use systems	4
Agroforestry tree species (multipurpose trees)	4
Socioeconomic factors in agroforestry	4
Diagnosis and design	4
Monitoring and evaluation	4
Agroforestry technologies	3
Planning and management interventions	3
Tree nursery establishment and management	3
Classification of agroforestry systems	2
Agroforestry farming systems	2
Agroforestry extension planning	1
The role of agroforestry in socioeconomic development	1

The practical aspects are very weakly covered. This is partly due to the lack of resources to access agroforestry facilities off campus. However, all the institutions have ample land to experiment and practice agroforestry. There is a growing interest by research institutions to collaborate with universities, and some agroforestry experiments are beginning to show up on campuses. This was evident particularly at Sokoine University of Agriculture, where agroforestry research has been conducted since 1977, and more recently at Bunda College of Agriculture. All the other universities have mechanisms in place and have started to develop research and demonstration sites. This is a very positive development for strengthening agroforestry education and research.

Table 4. Agroforestry content in the curricula of five BSc programmes

Topic	No of institutions
Introduction to agroforestry: principles, objectives, practices, concepts	5
Practice and management of agroforestry systems	4
Agroforestry in land-use systems	4
Socioeconomic aspects of agroforestry systems	4
Planning agroforestry interventions: diagnosis and design methodology	3
MPTs—selection, identification, establishment, products	3
Ecophysiology and agroforestry systems—competition, interaction between tree and crop	2
Agroforestry for soil conservation	2
The importance of agroforestry in sustainable agriculture	1
Agroecological conditions	1
Specific agroforestry potentials in various ecological zones	1
Livestock and fish in agroforestry systems	1
Utilization of agroforestry products	1
Agroforestry to combat desertification	1
Agroforestry for energy supply	1
Distribution of trees: agroforestry technologies	1
Improvement of agroforestry practice	1
Extension programmes	1
Role of government and NGO nurseries	1
Bioeconomic evaluation of agroforestry systems	1
Agroforestry research: examination and evaluation of projects	1
Case studies on agroforestry	1

Whereas colleges and universities are making commendable efforts to incorporate agroforestry into their curricula, the following additional observations are pertinent:

- Clear distinction is not made among production systems, agroforestry technologies and agroforestry practices
- Definitions of agroforestry terms are not clear. There is a lot of overlap, obscurity and sometimes contradictions in the curricula
- There is no evidence of serious efforts to arrange and present the various topics in a logical sequence
- In most curricula, learning objectives are not spelled out
- There is no established pattern for the design of an agroforestry curriculum
- In some curricula, there are gaps in important areas, for example, multipurpose tress, component interaction, livestock, agroforestry extension and agroforestry research

These issues were presented and discussed at various agroforestry education workshops. The following mechanisms for improvement emerged:

- Organize curriculum review and development workshops for educators to work out rational methods and processes for incorporating agroforestry into curricula
- Train trainers in curriculum development
- Develop a framework for developing agroforestry curricula

These recommendations lead us to further analysis of the approaches used in curriculum development. Four curriculum development workshops were organized and data were gathered on the processes used. Chapter 3 analyses the findings.

3

Methods and experiences in curriculum development

It is necessary to begin by recognizing that small-scale farmers integrate their production and therefore have no reason to think of the crops, trees and livestock enterprises separately. Such distinction is made by educational, research and development institutions for historical reasons and to distinguish the professions involved. This has, in many cases, negative effects on the way the different professionals interact at the farm level.

A curriculum is a logical sequence of learning experiences geared at developing specific competencies among the students. Developing agroforestry curricula has been quite elusive since agroforestry is a fast evolving field of science. Agroforestry is new to most training and educational institutions. Therefore, many agroforestry curricula are still young in application (Taylor et al. 1993).

In developing curricula, one important consideration is the state-of-the-art of agroforestry science. Zulberti (1993) reported that, based on surveys carried out in 29 universities in 1990 and 1991, the main limitations to the teaching of agroforestry were:

- lack of clarity among educators regarding the concept of agroforestry
- little coordination among agriculture, forestry and livestock and social sciences
- lack of guides for developing study plans
- absence of textbooks and teaching materials
- uncertainty regarding employment opportunities for agroforestry graduates

Zulberti pointed out further that researchers and educators in agroforestry need to work together to unravel the untested hypotheses in agroforestry. This will remove the paradox of trying to produce agroforestry scientists while the field is still very young and is being developed. It is precisely for this reason that it is much easier for agroforestry to be taught at the post-graduate level (to include research) than at the undergraduate and technical levels.

Asare and Hansson (1990) made an inventory of agroforestry teaching materials and convened a workshop to discuss the results. The workshop established a close relationship between teaching materials and curricula. It counselled educational institutions to consider reviewing whole curricula rather than just adding on agroforestry topics. Such action would help to eliminate duplications and contradictions.

Methods for developing curricula differ widely among different educational systems, countries and regions. At an interregional workshop held in Nakuru, Kenya, in 1994, the participants made an inventory of the various methods in use (Rudebjer and Temu 1995). The inventory showed that there are several ways in which the process is initiated, organized and approved. They are summarized into five main categories:

Top-down approach

Many anglophone countries in Africa have a curriculum development process, particularly at the college level, in which the government plays a major role in both initiating and managing. The educational institutions are involved in the process, but they do not lead it. The final curriculum is passed on to the institutions for implementation. This way, a national policy decision to incorporate agroforestry into, for instance, agriculture at certificate and diploma levels, is rapidly implemented in all institutions teaching agriculture. The critical factors are how well the policy reflects the real needs and how effectively the curriculum development process itself captures the most recent and relevant knowledge.

Faculty-initiated approach

Colleges and universities in francophone Africa, as well as universities in Indonesia, the Philippines and Thailand, are using a curriculum development method where the faculty leads the process and the government approves the result. An example of the process is shown in figure 1. The strength of this method is the wide consultation, involving many stakeholders, through questionnaires and workshops.

Faculty-controlled approach

In Latin American universities, the whole process of initiating, considering and approving a new curriculum is largely controlled by the faculty itself. This autonomous process differs among universities, but in general it has many similarities with the francophone system mentioned above. It also con-

tains many elements of the DACUM (acronym for Developing A CurriculuM) process described below.

It is significant that in all the three processes described above, the users of the graduates, mainly farmers, are given little or no opportunity to influence the curricula. There is also no reference to the need to use multidisciplinary teams to broaden the scope of expertise used to produce the curriculum. For agroforestry, these aspects are particularly important.

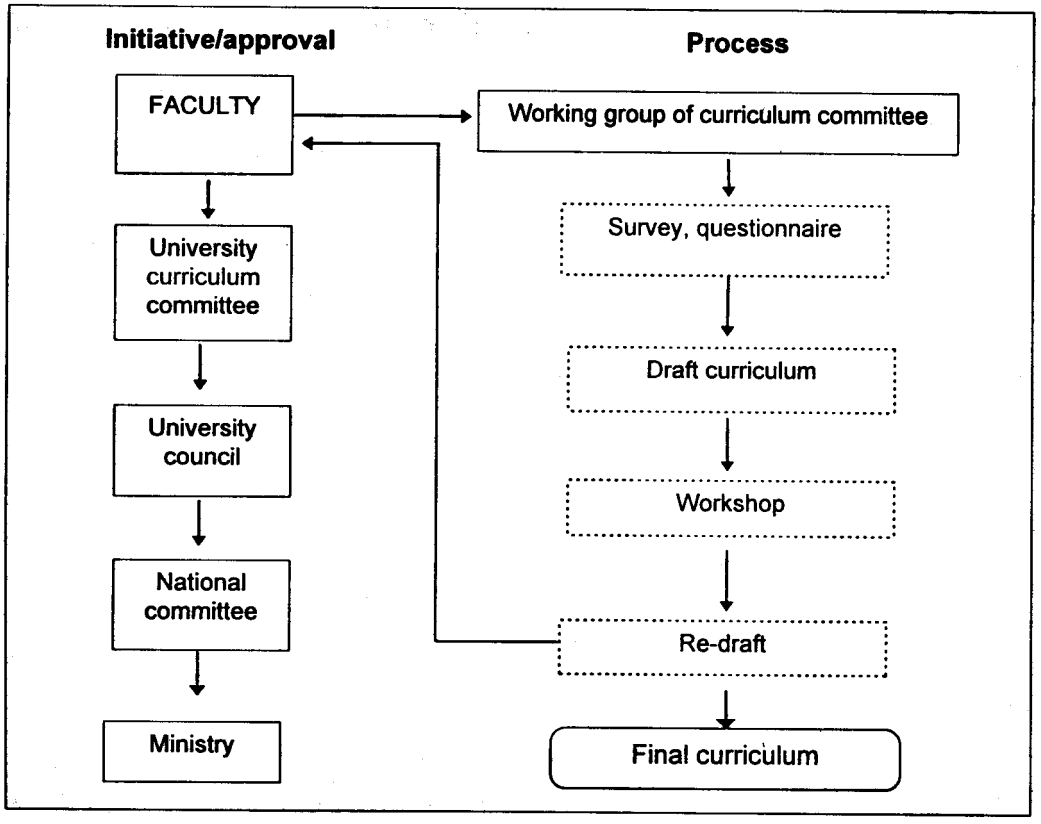


Figure 1. The general curriculum development process in Southeast Asia (Rudebjer and Temu 1995)

Critical events model

Asare and Zulberti (1992) worked with universities to develop a master of science candidate model curriculum in agroforestry. They developed and used a *critical events model* for this purpose (figure 2). The model presents a stepwise approach to what should be done, without identifying the roles of different people and institutions.

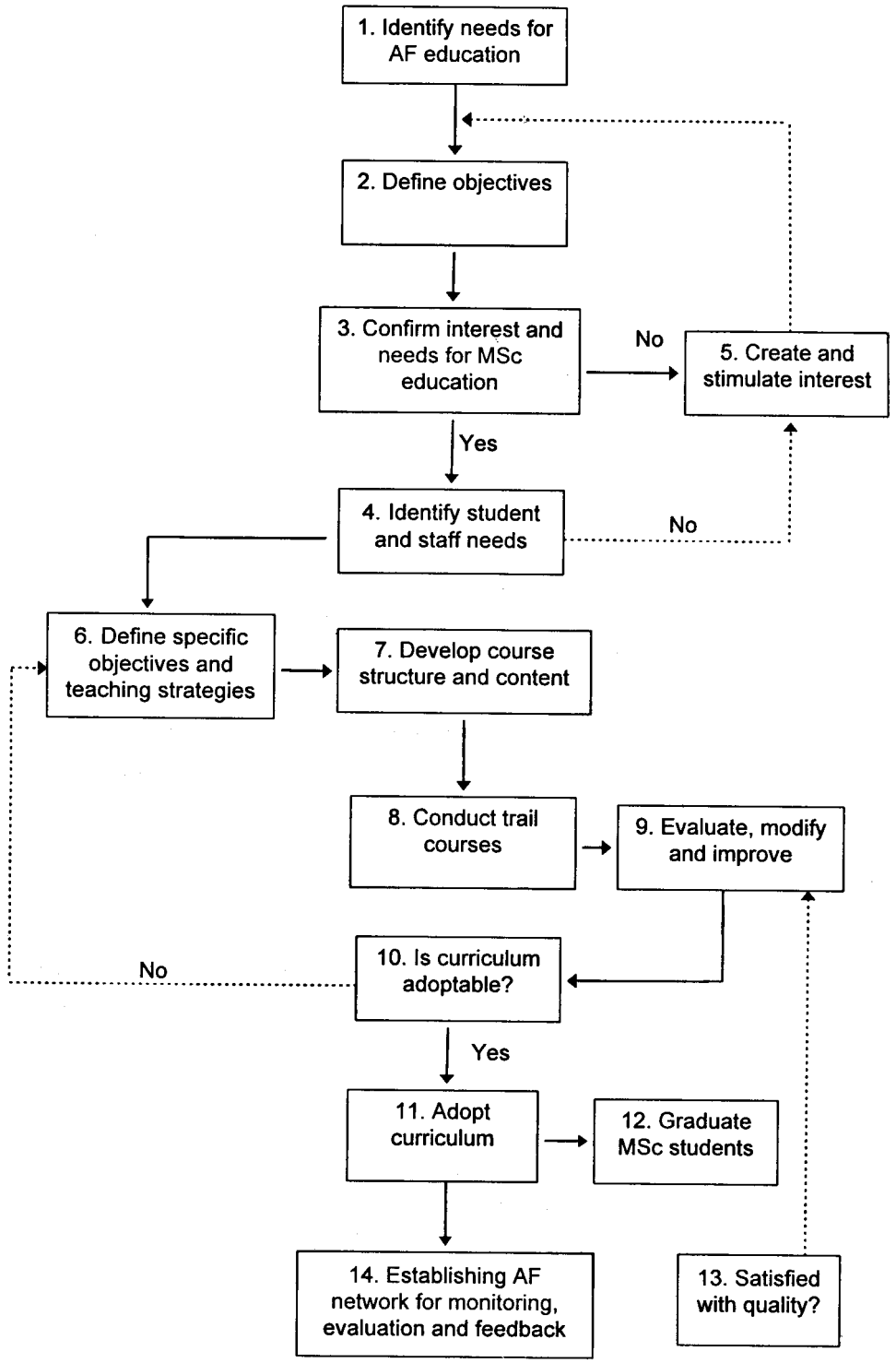


Figure 2. Critical events in the agroforestry curriculum development process (Asare 1992)

DACUM method

The main challenge in designing an educational programme is to identify contents that are truly relevant to both instructional and occupational settings. The DACUM method uses a systems approach to achieve these objectives. The DACUM approach was developed in British Columbia, Canada, in 1968, and has been tested by several educational institutions in Africa and Asia and found very useful in developing and evaluating agroforestry curricula. The text presented here is largely based on Mancebo (1995).

Basic principles

DACUM is a competency-based method of curriculum development. Regardless of whether it is used to develop a short training course or a programme for an entire occupational area, the basic principles remain the same. It places the emphasis on the learners gaining the ability to meet specific objectives formulated according to a set of standards. The method is based on three assumptions:

- Expert workers (especially farmers and extensionists in the case of agroforestry), can define and describe their job more accurately than anyone else
- Any job can be effectively described in terms of the tasks that successful workers in that occupation perform
- In order to be performed correctly, all tasks demand certain knowledge, skills and attitudes from workers.

The process

If an institution is already teaching any of the land-use disciplines, such as agriculture, forestry or range management, a practical approach is to first evaluate the contents of these programmes to see if the additional competencies needed can be achieved by modifying the contents and delivery of some existing subjects. Once a decision has been made to make major changes or develop a new curriculum, the DACUM process is recommended.

The DACUM process has four main components: the selection of workshop participants; the DACUM workshop; data analysis; and course development (figure 3).

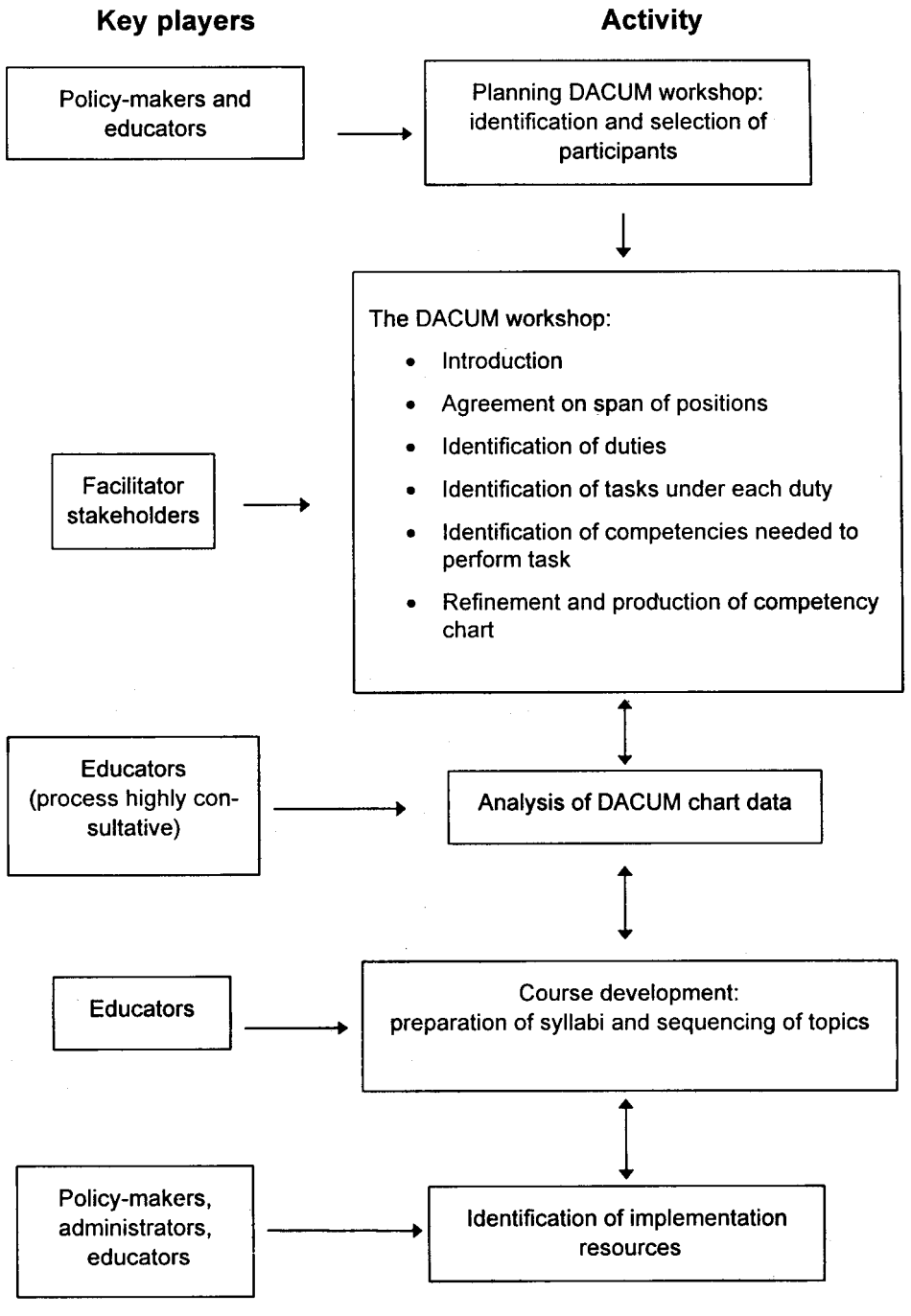


Figure 3. The DACUM process of curriculum development (adapted from Mancebo 1995)

Selection of workshop participants

In the DACUM workshop the participation of all stakeholders is necessary. Stakeholders may be defined as the people and institutions that will be affected by the outcome of a decision. For educational programmes, the stakeholders are the potential users or employers of the graduates. In the case of agroforestry, the stakeholders include farmers, agribusiness persons, policymakers, industrialists, development workers (including agronomists, foresters, livestock experts and NGOs), researchers, educators and the alumni of similar programmes as the one being developed.

The selection of workshop participants requires careful identification of one or two facilitators, a minimum of eight but not more than 15 stakeholder representatives and a recorder. If the goal is to revise an existing programme, instructors may be added to this number of participants. These people are nominated on the basis of their skills. They should be articulate and forward thinking.

The facilitator guides the direction of the meeting by ensuring maximum coverage of each topic and eliciting contributions from all participants. The facilitators' role is critical. She or he should have the ability to elicit specific and accurate skill statements, deal with conflicts in debate and maintain the group's momentum. The facilitator must also be skilled in the techniques of task analysis and group processes and should remain patient even when the work becomes tedious.

The recorder must quickly and legibly print each skill statement exactly as it is phrased by the panel. Like the facilitator, the recorder must refrain from comments that could influence the panel members' views.

The DACUM workshop

The focal point of the process is the workshop where different categories of people interested in the graduates of a particular educational programme are gathered to define competencies required of the graduates. The workshop has six steps:

1. Introduction—to expose all participants to the objectives of the workshop, the process and the expected outputs.
2. Agreement on span of positions—to secure a consensus of workshop participants on the types of jobs and positions to be available for graduates of the curriculum. It is useful to adopt a simple definition of an 'agroforester', such as; *a person with strong inter- and multidisciplinary competence in farm management, especially involving resource-poor farmers.* The base discipline of

such a person is irrelevant. The span of positions may, therefore, cover all aspects of land use, such as land-use officer, agricultural extensionist, etc.

3. Identification of duties – to define the major areas of **knowledge, skills** and **attitude**. These are the basic components of competence. This step could be approached in two ways. One way is where the facilitator draws out the ideas from the participants orally through the brainstorming technique and writes them on the chalkboard. The other way is by using a card system in which the ideas are written by all participants at the same time, then collected and placed on the wall as the first column. Either way, free dialogue and discussions take place. An agreement by the panel members must be arrived at to finalize the list of duties. Those categories agreed upon are listed again on large cards and posted vertically on a blank wall in full view of the panel. An example is presented in table 5.

4. Identification of tasks – to describe in detail what the graduates of the curriculum 'must be able to do'. Focusing on one job or position and duty at a time, skills and behaviour required in each of the categories are specified, each of them starting with the phrase 'the graduate must be able to ....'. The tasks are recorded on cards and posted beside the fitting duty or responsibility. A new chart is made with the tasks forming 'competency bands' along each row. Panelists make sure that each statement is explicit and accurate. The statements are then arranged in a logical learning sequence.

5. Identification of competencies required to fulfill each of the tasks. The method is as described under 4 above. Basically, this means splitting each statement in table 5 into smaller tasks. This sub-division of is explained in figure 4.

6. Refinement and production of the competency chart. Finally, the facilitator solicits the panelists' consensus regarding the accuracy of the chart. They should agree that it correctly reflects the complete set of knowledge, skills and attitudes required in that occupation. This is the main workshop output.

Table 5. An example of a competency chart

	Span of positions				
General areas of competence	**Land-use officer**	**Agricultural extensionist**	**Rural development officer**	**Agri-business person**	etc.
Extension work	1. Coordinate land-use advice to farmers 2. Elicit farmer participation in planning and appraisal 3. ...	1. Assist farmers to plan, implement and monitor agroforestry projects 2. Interpret research findings for farmers 3. Train farmers 4. ...	1. Relate agroforestry systems to other development areas 2. Collect and use indigenous knowledge 3. ...	1. Evaluate the business in agro-forestry products 2. Evaluate farmer preferences 3. ...	
Farming systems analysis	1. Evaluate impact of a farming system at the water-shed level 2. Provide advice on land-use policy 3. ...	1. Identify niches for agroforestry technologies 2. Choose compatible agroforestry interventions 3. ...	1. Evaluate and advise on trends in resource endowment 2. ...	1. Assess the business potential for agroforestry technologies 2. ...	
Soil and water conservation	1. Identify soil types 2. Survey and map soil and water resources 3. Recognize and control environmental degradation 4. ...	1. Interpret soil maps 2. Relate soil capability to crop production 3. Recognize practices which are risky to conservation 4. ...	1. Inter-relate the use of water and soil resources 2. Advise on potential conflicts on resource use 3. ...		
etc. ...					

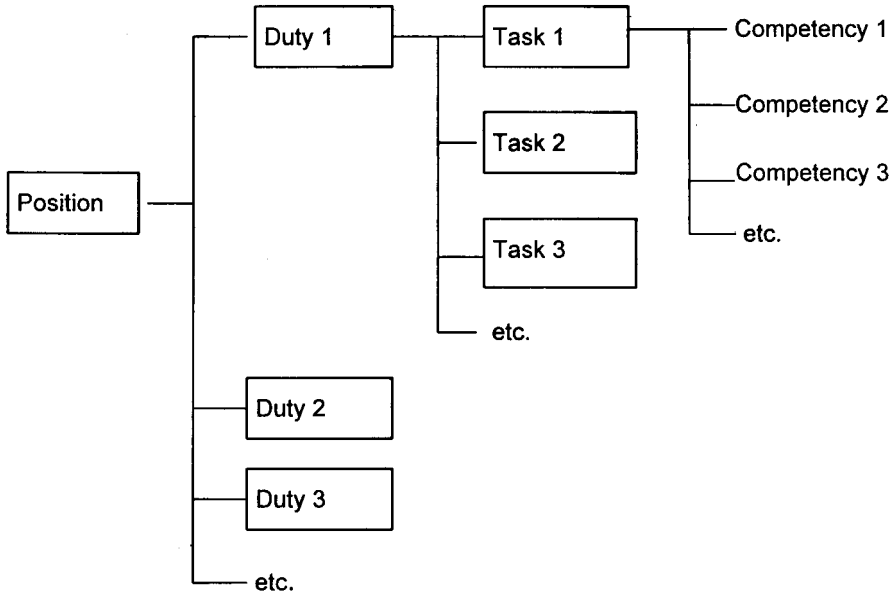


Figure 4. Steps analysed in the DACUM workshop

Analysis of data gathered

The materials generated at the workshop are subjected to an analysis whereby the information recorded on the cards is transferred to individual sheets of paper. During this process, the component tasks are restated as behavioural objectives. After this process, subject matter specialists are asked to interpret the statements in terms of subjects that enable the student to achieve the desired behaviour.

Course development

Estimates of teaching time are made and a sequence of subjects to be taught is developed, paying attention to the areas of competence identified. Thereafter, meetings of the teaching staff and stakeholders are held to review the proposed course. Once the latter is ratified by the group, detailed subject syllabi are prepared. Within each subject it is useful to have a logical teaching sequence of the topics identified. We recommend the use of matrix analysis for this purpose. The latter is described by Kasolo and Temu (1995). This is quite important because it allows 'learning to proceed as an educational continuum rather than discrete events' (Blackburn and Pletsch 1989).

At this stage of curriculum development, it is useful to compare the curriculum with existing curricula to identify topics that have been duplicated and to

establish complementarity. Through such exercise, it is possible to find topics that are already being taught. Such topics are examined in detail and modified to ensure that their coverage serves the objectives of the curricula in which they occur.

Delivery resources

A curriculum is incomplete without a statement on the resources required to implement it. The human, material and financial resources needed are estimated and scheduled to guide policy-makers and administrators on the total commitment and its spread over time. This is the final stage in the DACUM process, after which the curriculum is ready for formal approval and implementation.

Experiences from DACUM workshops

The DACUM method has been tested in Asia and Africa. In this section, some results from workshops conducted at the University of the Philippines at Los Baños, Botswana College of Agriculture, Lesotho Agricultural College, Africa University in Zimbabwe and an interregional curriculum development workshop for Africa, Asia and Latin America are presented. Thirteen possible spans of positions (table 6), and 26 competencies (table 7), were identified in these workshops.

Table 6. Possible jobs for graduates of agroforestry training programmes.

Job/positions	UPLB	IRW	BCA	LAC	AU
Agribusiness manager	x		x	x	x
Extensionist	x	x		x	x
Trainer			x	x	x
Land-use planner			x	x	
Researcher			x	x	x
Beekeeping officer			x	x	
Range manager			x	x	x
Forester			x	x	x
Agriculturist			x	x	
Livestock officer			x	x	
Rural developer		x	x	x	x
Land husbandry officer			x	x	
Horticulturist			x	x	

Key: UPLB–The University of the Philippines at Los Baños, IRW–Interregional Curriculum Development Workshop for Africa, Asia and Latin America, BCA–Botswana College of Agriculture, LAC–Lesotho Agricultural College, AU–Africa University in Zimbabwe

The wide range of jobs in table 6 is an indicator of the complexity of the job of an agroforester. The job cuts across all land-use activities on farm-land and includes some aspects of networking, research, training, conservation and agribusiness management.

To provide a clearer profile of the agroforester, participants at the five workshops listed the general areas of competency (table 7). This is important information from which we can derive the objectives of agroforestry education and training. The table serves as a good *shopping list* for institutions planning to develop agroforestry curricula. The wide range of competencies reflects the complexity of an agroforestry curriculum. The analysis shows that the following topics have to be included in a curriculum to capture the competencies:

- introduction to agroforestry
- farming systems analysis
- components of agroforestry
- agroforestry technologies
- socioeconomics of small-scale farming
- plant, animal and soil science
- planning and managing agribusiness
- extension principles and methods
- monitoring and evaluation of agroforestry projects
- environment and agroforestry
- networking

These generic components have been expanded and incorporated in the framework presented in chapter 4.

Table 7. General areas of competency for graduates of agroforestry programmes

Competence	UPLB	IRW	BAC	LAC	AU
1. Articulating social, cultural and gender issues in technology transfer	x	x			
2. Planning and management of rural development programmes	x				x
3. Characterizing biophysical and socieconomic conditions	x	x			
4. Identifying and prioritizing farmers' needs	x	x			
5. Planning, monitoring and evaluating of agribased projects	x	x	x	x	x
6. Interpreting land-use laws and policies	x	x			x
7. Selecting, designing and implementing agroforestry interventions	x	x			x
8. Training extension agents and farmers	x			x	x
9. Preparing farming master plans	x	x			
10. Financial management	x			x	x
11. Organizing, managing and supervising human resources	x		x	x	x
12. Managing records and information	x				x
13. Identifying, designing and managing on-farm research	x	x		x	x
14. Collecting, analyzing and interpreting data on farming systems	x				x
15. Assisting farmers to secure farm inputs	x	x	x	x	x
16. Managing agricultural enterprises	x			x	x
17. Preparing farming reports		x			
18. Identifying and classifying land-use systems		x		x	
19. Surveying land and soils		x	x	x	x
20. Evaluating farming systems		x		x	x
21. Identifying and controlling farm pests and diseases	x	x		x	
22. Quantifying agroforestry products and benefits		x	x	x	x
23. Managing agroforestry technologies and practices		x	x	x	x
24. Marketing agroforestry products		x	x		x
25. Linking with all land-use disciplines	x	x		x	
26. Identifying research issues				x	x

Key: UPLB–The University of the Philippines at Los Baños, IRW–Interregional Curriculum Development Workshop for Africa, Asia and Latin America, BCA–Botswana College of Agriculture, LAC–Lesotho Agricultural College, AU–Africa University in Zimbabwe

4

Framework for agroforestry curricula

Agroforestry covers a wide range of subjects. Many educational institutions wishing to teach agroforestry have written to ICRAF to seek guidance on the way to proceed. This framework has been developed to assist such institutions and is drawn from the experiences presented earlier in this document. The framework consists of three main blocks:

- Agroforestry principles
- Agroforestry practices
- Agroforestry research and development

Agroforestry principles provide the theoretical base for agroforestry education. Agroforestry practices present the application of agroforestry principles in the farming system, while research and development include aspects involved in creating new knowledge and communicating it to farmers and research and development organizations (figure 5).

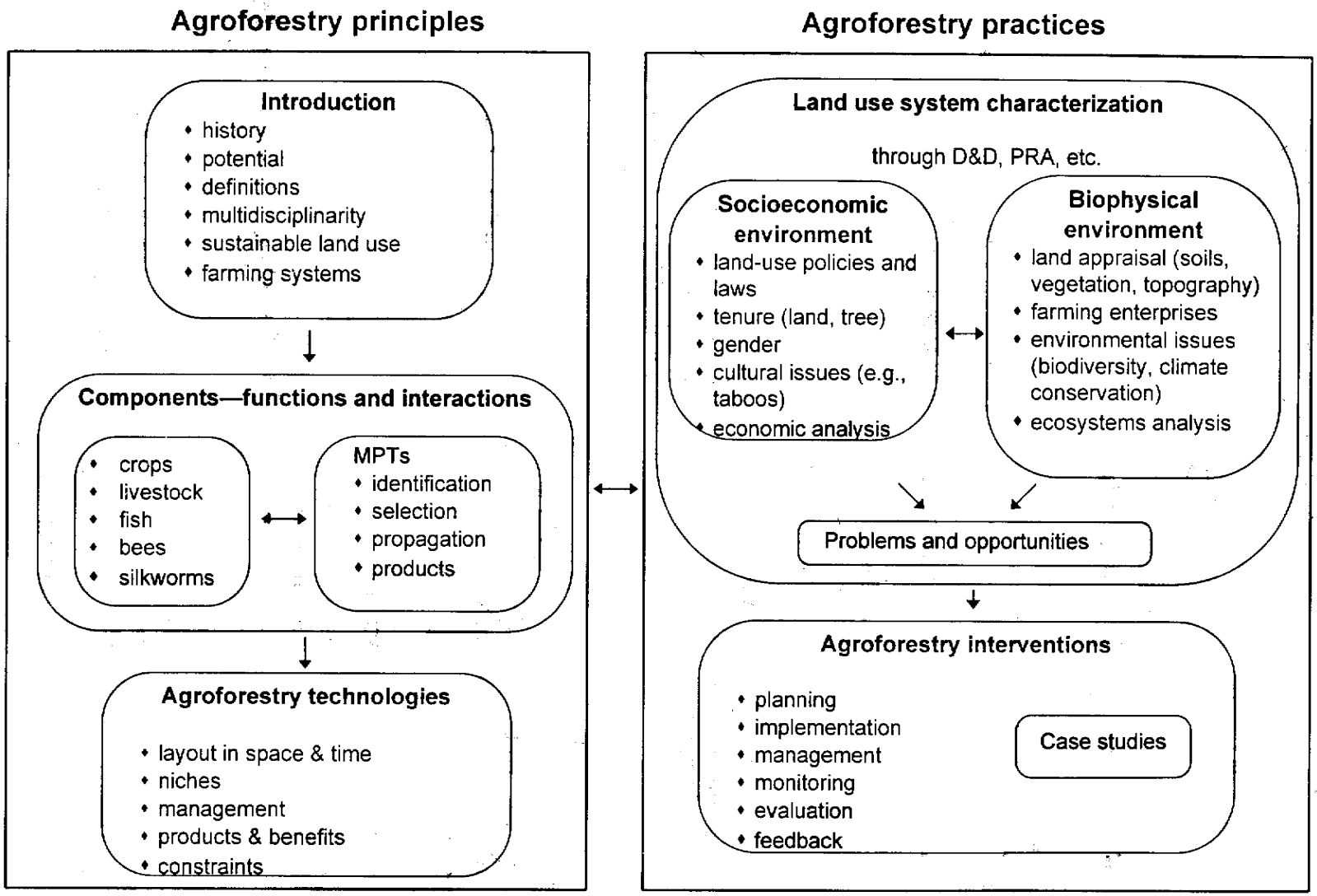
Each block is important, but depth of coverage depends on the level of education. For instance, at the technical level, the development of skills is most important. Thus, practicals should be emphasized. At the postgraduate level, more weight should be given to the development and analysis of principles and research.

Agroforestry principles

Agroforestry principles is aimed at equipping the student with the theoretical backbone of agroforestry. It provides the knowledge of the principles of tree-crop-animal interactions and the various niches where agroforestry has the potential to increase productivity as well as product diversity.

Introduction

In the introduction part, the student is familiarized with the subject. Agroforestry is defined and the basic principles of mixing trees, crops and animals on the same piece of land, in spatial and temporal arrangements, are explained. Since most educational programmes at undergraduate and college


Agroforestry principles
Agroforestry practices
Introduction
history
potential
definitions
multidisciplinarity
sustainable land use
farming systems
Components—functions and interactions
crops
livestock
fish
bees
silkworms
MPTs
identification
selection
propagation
products
Agroforestry technologies
layout in space & time
niches
management
products & benefits
constraints
Land use system characterization
through D&D, PRA, etc.
Socioeconomic environment
land-use policies and laws
tenure (land, tree)
gender
cultural issues (e.g., taboos)
economic analysis
Biophysical environment
land appraisal (soils, vegetation, topography)
farming enterprises
environmental issues (biodiversity, climate conservation)
ecosystems analysis
Problems and opportunities
Agroforestry interventions
planning
implementation
management
monitoring
evaluation
feedback
Case studies

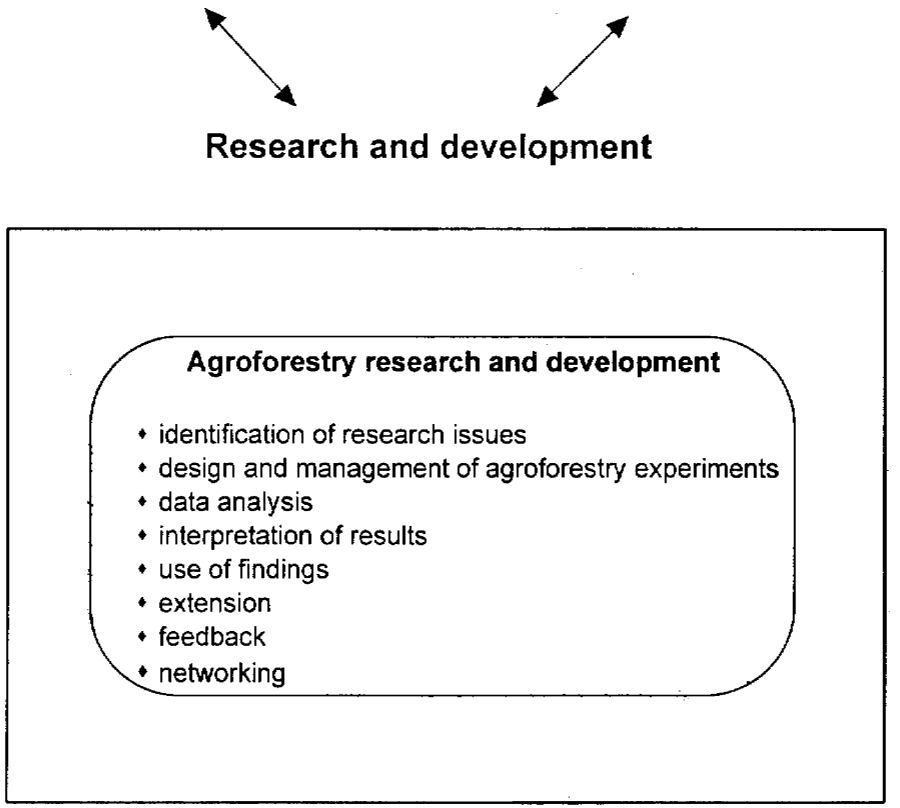


Figure 5. Framework for agroforesty curricula

levels follow sectoral lines, it is essential to establish inter- and multidisciplinary thinking among the students.

Most agroforestry technologies are derived from traditional land-use practices. It is, therefore, important to put agroforestry in its historical perspective. What can agroforestry do that mono-crop land-use systems cannot? Agroforestry as an alternative land-use system is evaluated. Sustainability of land-use systems is discussed in the context of what values agroforestry might add to the land and thereby to the farmer.

Components: their functions and interactions

This section describes in detail the different components of agroforesty systems—crops, trees and shrubs, livestock—and others such as fish, bees and silkworms. The functions of each component are discussed. The interactions between the components are given considerable attention, describing the principles of competition for light, water and nutrients.

Special emphasis is given to the knowledge of multipurpose trees and shrubs, and how they interact with the crop and animal components. The role of multipurpose trees in the conservation of germplasm and biodiversity should be discussed. Opportunities for the domestication of valuable indigenous multipurpose trees should be presented. Indigenous knowledge, especially concerning the choice of multipurpose trees and production technologies, should be highlighted. Teaching should cover processes and issues on how multipurpose trees are identified and selected, what products they can provide, and how they can be propagated. It is also appropriate to give forestry students an introduction to agriculture and livestock production, and vice versa.

Agroforestry technologies

Agroforestry components are combined to form different agroforestry technologies. For each technology, the students should know the layout in space and time, the niches where a certain technology is suitable, and how it can be managed. The output from the system—products and other benefits—as well as the constraints of a certain technology, should also be discussed.

Agroforestry practices

In agroforestry practices, the practical aspects of agroforestry are discussed. How can a land-use system be characterized? What are the problems and what are the opportunities for agroforestry as an intervention?

Characterization of land-use systems

Understanding how a particular land-use system works from both biophysical and socioeconomic points of view is fundamental for the adoption of agroforestry. The characterization methods, for example, diagnosis and design, participatory rural appraisal, rapid rural appraisal, and similar methods are, therefore, an important part of the curriculum.

Each agroforestry technology has biophysical and socioeconomic boundaries. The biophysical environment includes land, soils, topography, vegetation, farming systems and farm enterprises. Environmental issues, such as biodiversity, conservation and climate, are included here. Ecosystems analysis, an exposé of the consequences of tree-crop-animal interactions at the macro level should also be addressed. These effects are better discerned at the watershed level. The use of tools, such as aerial photographs, GIS and satellite imagery, should be included, whenever they are available.

Soils, being the main medium in which agroforestry interaction takes place, have to be studied thoroughly. It is necessary to make good coverage of soil physics, chemistry and biology. Nutrient management under natural and man-made systems and land husbandry should be addressed.

The socioeconomic environment deals with the social, cultural and economic setting—land-use policies and laws, aspects of tree tenure, gender issues and taboos. The economic analysis of farming systems in terms of financial costs and revenues, labour and other costs and benefits is important. With this knowledge, it is possible to identify problems more accurately and to choose more acceptable solutions. For instance, it may be necessary in some situations to make certain policy decisions regarding resource endowment before agroforestry interventions can be a meaningful option. This would be true where, for instance, ownership of trees on farm-land is disallowed.

Agroforestry interventions

Theoretical knowledge can at his point be combined with data from characterization of the land-use systems to produce a workable agroforestry solution. Teaching is focused on how new agroforestry technologies are introduced on farms or traditional ones improved. Teaching should focus on how to plan and implement agroforestry projects, management of the system, monitoring and evaluation. The practical aspects are essential. It is convenient for the students to have access to demonstration sites. An opportunity to develop one on campus should be explored. Case studies should be used to demonstrate known successes as well as failures.

Research and development

Agroforestry experiments are unique, particularly in the choice of plot sizes, variables to measure, methods of analysis and interpretation of results. Many agroforestry technologies are new and still not fully understood, and many traditional ones need to be better known. Graduates of professional programmes need to be able to distinguish agroforestry experiments from those in the traditional land-use disciplines.

Students should learn and practise methods used to capture indigenous knowledge and identify research agenda from farmers' perspectives. Intensive fieldwork involving farmers and development workers is necessary. The curriculum should cover procedures for identifying agroforestry research issues.

Finally, for successful collaboration with farmers, skills in extension are needed. Free flow of knowledge among farmers, researchers, educators and development institutions is crucial. Graduates should know what institutions, networks and processes are involved in getting the agroforesty technologies from the experimental station or the classroom to the farmers' fields. Practical skills in communication and feedback are essential.

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