

Plantation Forestry in Sub Saharan Africa: Silvicultural, Ecological and Economic Aspects

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Abstract

This paper discusses the potentials of meeting the wood demand and achieving SFM in Sub-Saharan Africa (SSA) through the establishment of forest plantations. The paper reviews forest plantation ownership and distribution patterns in SSA and the factors –silvicultural, ecological, and economic that affect supply and demand for wood at both domestic and international markets. The risk associated with investing in forest plantations and their susceptibility to pest and disease attacks are highlighted. But with sound silvicultural practices these fears are allayed. Ecological sustainability is in most situations ensured, but there are risks associated with burning logging slash after harvesting. It is found that efficiency in plantation management and success in achieving sustainable wood supply depends to a large extent on whether the plantations are owned and managed by the public or the private sector. Many public sector managed plantations are poorly managed and not profit-oriented. They have other environmental and social services and benefits as objectives. Many benefits from such activities are not easily quantifiable in monetary terms and therefore cannot be used to determine the profitability of the plantations. Thus, in financial analysis, most public sector owned and managed plantations are unprofitable and not economically viable because these important benefits are excluded in the calculations. Private owned forest plantations are well managed and aim at profit maximization and therefore integrate plantations to wood processing plants to improve the form and value of wood and make the wood products more competitive in both domestic and export markets. As a way forward, a number of actions are listed to ensure long-term viability of forest plantations in SSA.

Key words: Sub-Saharan Africa, plantation forestry, sustainable forest management

Introduction

Large-scale plantation forestry in various countries of Africa was preceded by species and provenance trials, mainly of exotic tree species, in the period between late 1800 and mid 1900. Successful results from these trials led to large scale planting mainly using exotic tree species from the mid 1900s. The justifications for plantation development have been the growth superiority and product uniformity attributes of plantations over those of useful, but normally slow growing, but ecologically superior indigenous tree species in mixed and less intensively managed stands. Plantations also have the ability to provide affordable wood for industry and wood-based products for consumers. In addition, tree plantations are often the most rational way of producing some non-wood forest products, for rehabilitation of degraded areas and improvement of watersheds, and for meeting environmental quality objectives such as windbreaks, shelterbelts and, more recently, carbon sequestration.

The production performance of the plantations that have been established varies. In some situations, outstanding performance of up to 30-40 m³ha⁻¹yr⁻¹ has been observed while poor performance as low as 1–2 m³ha⁻¹yr⁻¹ has also been noted (Zobel *et al.*, 1987; Tiarks *et al.*, 1998; FAO, 2001a; FAO, 2003a; FAO, 2003b). The variability is mainly due to species/provenance selection, genetic improvement, species-site matching and management practices (Kanowski, 1997; Vichnevetskaia, 1997; FAO, 2001a; FAO, 2001b).

In 2000, the total plantation area in Africa was just over 8 million ha or 4.3% of the global plantation area (FAO 2001b). The annual rate of planting in the same year was estimated at about 194 000 ha or 4.4% of the world total. Africa's total plantation area and the annual planting area are the lowest among all the continents.

Plantation programmes in many African countries have faced serious challenges and have been on the decline, particularly in the last two decades. Land use conflicts, concern about the negative

ecological impacts of plantations, weakening public forest services as a result of diminishing priority given to them in the face of economic reforms such as structural adjustment programmes, and declining donor interest in funding forestry activities are among the many factors that have contributed to this.

In the light of these developments, many countries are reassessing their plantation programmes with a view to map out the way forward in improving the performance of the forestry sector in general and plantations in particular. It is in this context that the "lessons learnt on sustainable forest management in Africa" (SFM I) project commissioned a study to analyse the performance of plantation forestry in Sub-Saharan African (SSA) countries. Specifically the study seeks to identify factors that contribute to the long-term economic, social and environmental viability of forest plantations; determine the extent to which forest plantations help to overcome the problem of supply of wood and determine the replicability of success stories and the necessary and sufficient conditions for promoting plantation forestry in Africa to achieve sustainable management. This paper summarises major findings from this study.

Current State of the Plantations

Purpose, Ownership and Tree Species

Plantation development generally has a dual purpose. It could produce wood on a large scale for industrial and commercial uses or on a small scale for domestic and non-industrial uses. In Africa, industrial plantations cover 3.4 million ha; non-industrial plantations 3.3 mill ha; and unspecified 1.4 mill ha (FAO, 2001b). The industrial plantations provide the raw material for commercial wood processing, including construction timber, panel products and furniture, and pulpwood for paper. In contrast, non-industrial plantations are aimed, for example, at supplying fuelwood, providing soil and water conservation, wind protection, biological diversity conservation and other non-commercial purposes.

The ownership of plantation forests in Africa extends from governments and large industrial corporations to individual farmers. Industrial plantations are 52% publicly owned, 34% privately owned and 14% other or unspecified (FAO, 2001b). For non-industrial plantations, 62% are publicly owned, 9% privately owned and 29% other or unspecified (FAO, 2001b). Thus, in Africa with the exception of South Africa (where about 72% of the plantations are owned by companies and small growers), plantations are mainly owned by the government (CIFOR, 2000). However, due to prevailing restructuring programmes, plantations will increasingly be under private, or quasi-private, ownership and management (Kanowski, 1997).

In Africa, *Eucalyptus* is the mostly widely planted genus covering 22.4% of all planted area, followed by *Pinus* (20.5%), *Hevea* (7.1%), *Acacia* (4.3%) and *Teak* (2.6%) (FAO, 2001b). The area covered by other broadleaved trees and other conifers is, respectively, 11.2% and 7.2%. Unspecified species cover 24.7% of the total area (FAO, 2001b). Overall, the great majority of the planted area consists of exotic species chosen for their capability to grow rapidly to produce wood of desired quality (Zobel *et al.*, 1987; Tiarks *et al.*, 1998).

Generally, many countries in SSA have their forest plantations dominated by a few tree species. For example, in Ghana, *Tectona grandis* covers 50% of the planted area (FAO, 2002a), while in Kenya, *Cupressus lusitanica* and *Pinus patula* occupy 45% and 31%, respectively, of the total area (MENR, 1994; FAO, 2001c). In Congo, 75% of the area is occupied by *Eucalyptus* while in Nigeria, 42% of the plantation area is occupied by *Gmelina arborea*. In Swaziland, 76% of the planted area is under *Pinus patula* (FAO, 2002b). Given the low species diversification, pest and disease outbreaks could result in considerable problems, as has already been the case in a few instances (FAO, 2001c).

Plantation Management

Public and Private Sector Plantations

Case studies on plantation forestry done for the commissioned report (Chamshama and Nwonwu, 2004), which cover public sector industrial plantations (Kenya, Côte d'Ivoire and Ethiopia), public sector industrial energy plantations (Ethiopia and Senegal) and private sector industrial plantations (Congo, South Africa, Swaziland and Zimbabwe), show that the type of ownership has significant impact on the quality of management and productivity. Overall, government owned industrial or energy plantations suffer from replanting backlogs, low expansion rates of new planting areas, low intensity site preparation techniques, poor quality trees due to use of low quality seeds, low survival due to poor species-site matching and delayed/low intensity weeding, neglected or irregular pruning and thinning, fire and insect problems, illegal felling and forest encroachment. Only in Zimbabwe (Zimbabwe Forestry Commission) and Côte d'Ivoire (Société de Développement des Forêts—SODEFOR) are government plantations found to be well managed. Factors that have contributed to the poor state of most public sector plantations include: corruption, poor forest policy and legal frameworks, weak forest departments, budgetary constraints, inefficiency in revenue collection, lack of relevant research output, lack of political support and political instability (Chamshama and Nwonwu, 2004).

Nearly all public sector plantations were initially established with donor support. After this ceased,

funding of the plantation management activities reverted to the governments. Due to inadequate financial allocation, most forest management activities were neglected resulting in poorly managed forest plantations.

Privately owned industrial forest plantations are common in South Africa, Swaziland and Zimbabwe. These plantations are very successful and have achieved high productivity due to careful site selection, intensive cultural practices, selection of best species/provenances and genetic improvement through research (Chamshama and Nwonwu, 2004).

Trees on Farm

The case study on industrial wood production by small farmers in the central highlands of Kenya demonstrated an increasing trend of tree cover and species diversification on privately owned farms (Anyonge *et al.* 2004, Holding *et al.* 2001, Chamshama and Nwonwu 2004). Farmers grow more trees to protect themselves from shortages of wood to meet the demand for timber, construction poles, charcoal and firewood and, more recently, for an emerging timber market following a temporary ban in 1999 on the sale of timber from Government owned forest plantations. Production of trees on farm (TOF) is also increasing in other countries of SSA, especially where farmers own or have very secure tenure to their land like Uganda, Ghana, Rwanda and Burundi (AfDB, EC and FAO 2003a, b, c, d). TOF are thus playing a significant role in the livelihoods of communities and national economies. Despite this, there are many problems to overcome, including low quality of trees due to use of low quality seed linked to inbreeding and poor selection of trees for seed collection (Matano and Ogwenyo 2004) and low availability of quality planting stock/seed (Kigomo 2001, Simmons 2004), poor tree management (pruning, pollarding and thinning) (Anyonge *et al.* 2004, Simmons 2004), poor prices, lack of markets and lack of or limited value addition (Holding *et al.* 2001).

Out-grower Schemes

The case study on out-grower schemes in South Africa shows that such schemes have been used successfully by the forest industry to bring in private landowners as either individuals or communities to put their land into wood production under cost-effective arrangements for both the growers and the companies (Chamshama and Nwonwu 2004). The forestry companies provide financial (credit, seedlings, fertilisers and chemicals) and technical support (supervision, management and extension services) to the out-growers. For the out-growers, the scheme provides employment, income and opportunity to engage in subsistence agriculture. The companies in return are guaranteed steady supplies of wood raw materials without being involved in land acquisition.

The viability and attractiveness of this plantation development option are demonstrated by the increased involvement of private landowners and communities in South Africa and the rapid rate of increase of growers in the country (Edwards 2000). However, with one buyer, farmers may risk setbacks in income earnings in situations of weak markets for industrial products as well as when buyers are few and collude in pricing. Further, studies show that though there is increased income by farmers from the partnership, it is not yet enough to lift the very poorest out of poverty.

Forest Plantations in Arid and Semi-arid Areas

Findings on the case study on forest plantations in Senegal showed that in the arid and semi-arid areas of the Sahelian zone, government and communities establish plantations mainly for fuelwood production as well as to improve environmental conditions, which include combating desertification and fixing sand dunes (Chamshama and Nwonwu 2004). Eucalypts, neem (*Azadirachta indica*), *Casuarina equisetifolia*, *Prosopis juliflora*, *Parkinsonia aculeata*, *Leucaena leucocephala*, *Acacia senegal*, *Faidherbia albida* and Australian acacias have been the main species used (Boye, 2000). Often, however, field survival has been low due to the harsh conditions as well as trampling by livestock. Also, the plantation projects have often depended on donor support, which has not been regular. Due to the harsh conditions, land use conflicts and irregular funding, planting rates are in most cases below the set targets (Boye, 2000; FAO, 2000).

Ecological Sustainability

While in some instances new areas will be opened up for plantations, future wood needs will, in most situations, have to be obtained from existing sites, i.e. through second and subsequent rotations. The productivity of these will have to be maintained or increased to meet the increasing domestic and international demands for wood and wood products. This can only be possible if ecological sustainability is ensured. This is discussed below.

Plantation Forest long-term Site Productivity

Maintaining or increasing plantation productivity can be achieved by:

- confining harvesting of forest products to stem wood, which generally represents a small export of nutrients from a site (Zobel *et al.*, 1987; Evans, 1992; 1996; FAO, 2001d);
- proper harvesting planning, which, among others, includes careful re-use of extraction routes to minimise compaction and erosion (FAO, 2001d);
- slash retention on site after harvesting (i.e. avoiding slash burning or raking) (FAO, 2001c; Mgasha *et al.*, 2006); and

- appropriate soil conservation measures to reduce nutrient losses due to erosion (Evans, 1982; Vichnevetskaia, 1997; FAO, 2001d; 2002a).

One of the few studies on productivity of second and subsequent rotations of forest plantations is that by Evans (1996) in Usutu, Swaziland. Evans found that there is no evidence of yield decline in three rotations *P. patula* as a consequence of plantation forestry practices.

In SSA, only stem wood is harvested, resulting in small export of nutrients. However, harvesting planning is often poor, and slash burning after harvesting is common. These practises jeopardise long-term site productivity.

Biodiversity in Forest Plantations

The ability of plantations to improve biodiversity is important for plantation sustainability. Recent studies in SSA forest plantations reveal the catalytic effect of forest plantations on the regeneration of native woody species under their canopy and their subsequent succession as well as increased flora and fauna diversity in the plantations (Evans, 1992; Bernhard-Reversat, 2001; Senbeta and Demel, 2001; Senbeta *et al.*, 2002; Cossalter and Pye-Smith, 2003). There are, however, species differences with this effect, and it is influenced by the proximity of the plantation to any existing natural forest. Also, delayed or omitted silvicultural operations, like pruning and thinning, as is common in most government owned plantations, may result in reduced biodiversity of shade intolerant species.

Pests and Diseases in Forest Plantations

There are claims from some environmentalists and other members of the society that growing trees in plantations, and especially exotics, is dangerous because they are inherently vulnerable to diseases and insect attacks and climatic fluctuations. Partly as a consequence of this, the topic has received wide review (Zobel *et al.*, 1987; Evans, 1992; FAO, 2001c; d; Cossalter and Pye-Smith, 2003; Nair, 2003). Nair (2003) in a detailed review on pest outbreaks in tropical forest plantations posed the question "Is there a greater risk for exotic species than for indigenous tree species?" The author looked at the experience of nine species and genera widely used as exotics. He found out that no generalisation is possible for exotics as a group although more species seem to be at a lesser risk. The empirical data also showed that pest outbreaks also occur in plantations of indigenous tree species and sometimes even in natural forest stands. His conclusion on pests, which may as well apply to diseases, is that while plantations are at greater risk of pest outbreaks, plantations of exotics are at no greater risk than plantations of indigenous tree species because the exotic status is only one among the many determinants of pest outbreak. FAO (2001c), in a review of pest and disease problems of

forest plantations, noted that while there are several examples where plantations have faced major disease or insect problems that have stopped the use of a particular species or clones, overall, diseases and pests have not caused such widespread damage as to seriously question plantation silviculture as a practice.

Susceptibility to pests and diseases has been shown to occur under the following situations (FAO, 2001c):

- Failure to give proper attention to species/site matching i.e. "offsite planting", resulting in trees growing under stress;
- Use of planting stock from a narrow genetic base;
- Failure to maintain optimum stocking levels and tree vigour through intermediate cuttings;
- Dependency on one or two species in plantation programmes.

Plantation damage by monkeys, rodents and livestock has been reported (FAO, 2001c). However, substantial damage has often been localised and temporal.

Plantations and Water Resources

The hydrological effects of trees, and particularly the effects of plantations (especially those of Eucalypts) on water yields and flooding, have caused much controversy. The relationship between forests and water resources is a complex matter since the real contribution of forests and plantations to water regimes varies with topography, soil type, local climate, the type of tree involved and a variety of other factors which exert their own particular influence (Cossalter and Pye-Smith, 2003). Environmentalists often criticise large-scale plantations on the grounds that they reduce the amount of water that flows through the water catchments.

When it rains, both natural forests and plantations immediately intercept some of the water, which eventually evaporate back to the atmosphere, some will be absorbed by the soil and the excess water runs off. Trees and other plants take up a portion of the rain that filters into the soil and some of this is transpired back into the atmosphere. Some water not retained by the soil will reach the ground water table and head for watercourses and springs.

Studies show that run-off increases dramatically when new plantations are established after clear-felling a natural forest. Clear-felling also leads to more water downstream. Plantations, especially those consisting of fast growing trees, soon retain more water than primary forest, thus reducing the water available to those living downstream (Cossalter and Pye-Smith, 2003).

Invasive Exotic Species

Many exotic tree species are economically very important and contribute in enhancing the

production of a variety of forest products. However, a few species introduced intentionally have become established in the wild and have spread at the expense of native species thus affecting the entire ecosystem diversity (FAO, 2003c). Notorious examples of such invasion by alien woody species include *Acacia mearnsii* in South Africa, *Prosopis juliflora* in northern Kenya and *Leucaena leucocephala* in parts of Tanzania. Substantial costs have been incurred in South Africa to remove invasive species along watercourses. Great care is required to ensure that such species serve the economic purposes for which they were introduced, and do not escape and cause unanticipated negative effects on native ecosystems (FAO, 2003c).

Profitability and Viability of the Plantations

The financial viability and profitability of a plantation programme depend very much on whether it is owned and managed by the public or the private sector (Chamshama and Nwonwu, 2004). In the West, East and Central Africa sub-regions, the public sector controls plantation development and management. The inefficiency and the non-clarity of purpose of the public sector have led to mismanagement of plantations. Such plantations are, in many instances, neglected and predisposed to illegal felling, are associated with low quality and productivity which are due to neglect, poor seed quality and damaging attacks from pests and diseases. The pricing system of the products, be they timber, poles or fuelwood, is not always done through markets guided by forces of supply and demand to fix competitive prices.

All factors combine to make many public sector-grown and managed plantations not financially viable and profitable.

Further, many public sector managed plantations are not profit-oriented. They have other environmental and social services and benefits as objectives. These target watershed protection, conservation of land and biodiversity, and creation of employment. Many benefits from such activities are not easily quantifiable in monetary terms and, therefore, cannot be used to determine the profitability of the plantations. Thus, in financial analysis, the public sector owned and managed plantations are unprofitable and not economically viable because these important benefits are excluded in the calculations.

The private sector dominated plantation forestry programmes in Southern Africa (mainly in South Africa, Zimbabwe and Swaziland), has been demonstrated to be profitable. This is mainly attributed to the integration of the plantations with wood processing companies. The latter add value to the products and produce multiple products. This widens their scope and depth, markets and distribution of such products.

The financial viability and of the forest plantation industry in the three countries in this sub-region is demonstrated as follows:

- In South Africa, over the period 1980 to 2000, profitability analysis performed on the industry showed that the nominal value roundwood sales rose from Rands 165 million in 1980 to Rands 2,574 million in 2000. This represents an increase in monetary value of Rands 2,409 million or almost a 1460% increase. Pulpwood recorded the biggest increase in value of Rands 819 million or 3006.6% (Goldsmark, 2000);
- The FAO Global Forest Resource Assessment report indicated a net export earning of approximately US \$ 4 million from pulpwood in Zimbabwe in 1998 (FAO, 2001b); and
- Also in 1998, Swaziland recorded a net export earning of US\$ 62 million from the export of plantation-grown wood pulp (FAO, 2001b).

Trade in forest products in Africa

Export of forest products is an important source of income for a number of African countries. Between 1980 and 2002, the value of African forest products exports increased from about US\$ 1.6 billion to about US\$ 2.9 billion (Tieguhong and Nair, 2004). During the same period, global exports of forest products increased from about US\$ 57 billion to about US\$ 133 billion (Tieguhong and Nair, 2004), registering a much faster growth rate than that obtained in Africa. Most of the exports originate from 9 countries in West, Central, and Southern Africa, which together accounts for nearly 90% of the value of African exports. Industrial roundwood, sawnwood, and wood pulp, are the main exports.

African imports of forest products have also registered an increase between 1980 and 2002, from about US\$ 1.8 billion to US\$ 2.2 billion (Tieguhong and Nair, 2004). As is the case for exports, Africa's share in global imports remains a modest 1.6% of the value of global imports. Two important features of forest products imports are that paper and paper products account for a major share of the imports, and in 2000 it accounted for 53% of the African import bill; and a small number of countries—in North Africa (Algeria, Egypt, Morocco and Tunisia), West Africa (Nigeria, Côte d'Ivoire and Senegal) and Southern Africa (South Africa) accounts for most of the imports.

Africa is a net exporter of primary products, especially industrial roundwood and sawnwood. Almost all countries, except South Africa, are dependent on imports to meet the demand for paper and paper products. Most formal trade in Africa is with countries outside the continent; there is very limited intra-regional trade. The latter is due to a number of factors, including poorly developed transport between African countries, particularly

between the West and Central African forests and the North African consuming centres. This makes it cheaper for most North African countries to import from Europe. Also inefficient border procedures are important market access impediments.

Lessons Learnt

The main lessons learnt from the case studies of public and private sector industrial plantations and the public sector energy plantations in selected areas in SSA are summarised in the sections that follow:

(a) Capacity to meet present and future Requirements:

- With the exception of South Africa, plantation health and productivity in SSA have been on the decline in the last twenty years, mainly due to declining management capacity, know-how and commitment to funding public forest services;
- In some of the semi-arid regions of Africa there are inherent limitations to forest plantation growth potential. And in many less dry areas, where the growth potential is reasonable, there are limitations due to land use conflicts, mainly associated with grazing animals and increasing demands for water;
- There is insufficient reliable monitoring and analyses of consumption and supply, demand consumption and trade patterns in many forest products in Africa;
- There is a growing trade imbalance in wood and fibre products as well as deficits of these and other forest products in individual African countries; and
- Unless present production, processing and trade trends are reversed, SSA will increasingly rely imported wood and fibre-based products.

(b) Investments in Plantations:

- The potential of plantations to contribute to wood production is underestimated as a result of the many plantation schemes that have either failed or deteriorated because of drastically reduced support to their management, wrong location and no forward integration to industry, or establishment without proper demand analysis;
- With few exceptions, notably South Africa and Zimbabwe, publicly owned plantations have been unsuccessful or downright failures because of lack of resources and interest, corruption, no integration to users, and low productivity for their sustainability;
- Private plantations have often been successful due to market integration, profit generation, secure tenure in some countries, motivated

and skilled management. South Africa and Swaziland are leaders in this;

- In many countries, land and tree tenure systems often prevent and/or discourage private investments in forest plantations making it difficult to attract both local and foreign investors; and
- There is a trend in currently developed forest policies in many countries to promote privatisation of less successful public plantations, but there is as yet limited experience of this; there appears to be some hesitation in the private sector to take on such opportunities, partly because of limited experience in managing plantations and unwillingness to enter into long-term investments in situations of political uncertainty.

(c) Growing Trees outside Forests:

- Production on farms of timber and other wood for "independent" sale is increasing very rapidly in countries and areas where farmers own or have very secure tenure to their land. The potential appears very high for this to become an important addition to national wood production and income generation. However, there are many problems to overcome, for example those related to insufficient know-how and marketing; and
- Well organised farmers and forest industry that takes a long-term view and responsibility have created many win-win situations in out-grower schemes in South Africa. However, because such schemes are often operate in an "imperfect market" environment with few buyers (and in some cases only one buyer), farmers may risk low prices due to collusion of buyers. Further, such farmers also operate in weak markets for industrial products.

(d) Improving technical know-how:

- Many failures of plantation projects are often due to Knowledge gaps for example in matching species and provenances to sites and uses, improper plantation establishment techniques, silvicultural and harvesting management, how to protect trees from damage caused by various agents, and handling conflicts between plantation forestry and other demands on land and water resources.

(e) Addressing Environmental Concerns:

- There is strong opposition against the use of exotic monoculture plantations from some environmental organisations, particularly those outside Africa. However, claims about the

ecological fragility and damaging effects of such plantations are only partly justified; and

- Most plantations established for environmental reasons in dry areas (e.g. for wind protection or dune fixation in the Sahel) are expensive and often depend on outside donor funding, and, therefore, have a poor record of sustainability.

The Way Forward

For long-term viability of forest plantations in SSA, the following actions are necessary:

- Establish better national and sub-regional methods and mechanisms for predicting supply and demand for wood and fibre products and for monitoring trends in these. Use such statistics in the economic sub-regional groupings on the continent (SADC, EAC, ECOWAS, etc) as bases for promoting trade in wood-based products between African countries;
- Promote and expand the local use of plantation wood (rather than wood from natural forests) based on high yielding species with known utility that are backed by research and technology, and where proper analyses of the economics of the plantations have been made;
- Initiate studies and processes that seek to change/revise tree and land tenure systems in ways that promote and encourage individuals, communities and companies to make long-term investments in economically and ecologically sustainable forest plantation establishment and management;
- Establish pilot programmes for privatising public/government plantations and monitor their development carefully so as to guide the process of privatisation on a larger scale;
- Develop and promote public-private plantation partnerships to exploit the comparative advantage of both sectors;
- Create and strengthen incentives for private tree planting by farmers and provide inputs (at a price), technical backstopping and market supply and demand information through extension services; and
- Launch sub-regional specific research programmes on any relevant aspects of tree species used in plantations including germplasm improvement, silviculture, environmental benefits, impacts on soils and biodiversity, pest/disease prevention, wood utilisation, economics (both of products and services), etc—rather than duplicate such programmes in all sub-regions and/or national institutions.

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