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The Potential of *Acacia albida* for Desertification Control and Increased Productivity in Chad

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ABSTRACT

Reforestation using Acacia albida *has been proposed as a mechanism for combating desertification trends in the Sahel. This tree is characterised by a deciduous habit in the wet season; it is valuable for fodder, as a hardwood in woodwork industries, and for enhancing soil fertility of cropland. In a three-year project described in this paper, the establishment of* Acacia albida *plantations in cultivated fields in central Chad is conceived as a focal point to coordinate resource conservation and land development programmes. Several hundred thousand young trees were established and about 2500 farmers and their families participated in the revegetation programme. The success of the project must be evaluated, however, in terms of the prospects for long-term benefit and recognising the sociological problems of assistance programmes.*

INTRODUCTION

Desertification is a deteriorating transition from semi-arid to desert ecosystems with a concomitant reduction in biological productivity. (The degradation process has been variously referred to as desertification, desertisation, desert encroachment, and desert creep.) Le Houérou (1977*a*) considers the problem to be an encroachment of desert landscapes into areas that climatically do not classify as deserts. The Sahelian droughts of 1968–1973 brought world attention to the critical nature of this problem when an estimated 250 000 people may have died and 50% of the livestock perished as a result of the decrease in crop and

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forage production associated with the accentuated degradation process (United Nations, 1977).

Recovery from the drought, as rains returned to 'normal' in the Sahel, received considerably less attention in the media. Nevertheless, although the problems now are not as critical, the underlying trend of deterioration of the fragile semi-arid ecosystem presumably continues.

Most Sahelian ecosystem authorities agree that the basic cause of desertification is man's disruption of the otherwise balanced ecosystem, which is intensified by naturally occurring, periodic droughts (Kassas, 1970; Delwaulle, 1973; Dregne, 1977; Eckholm & Brown, 1977; Glantz, 1977; Hare *et al.*, 1977; Le Houérou, 1977*b*; United Nations, 1977; Ware, 1977). The principal disruptive effects of man on the land's resources are: a replacement of the stable perennial vegetation by more transient annual species, a decrease in litter and soil organic matter, an increase in soil erosion, and the generation of a more xeric, less productive ecosystem.

As populations increase in the semi-arid areas of Africa, man's normal activities for survival place heavier burdens on the resource base, resulting in higher rates of devegetation. Land-use practices most affecting the devegetation process are: the encroachment of shifting agricultural practices into rangelands that are too dry to support repeated cultivation; the concentration of grazing due to an increase in herd size and a systematic discouragement of the traditional migratory grazing systems; the widespread and untimely use of bush fires by the rural populace for traditional and agronomic purposes; firewood gathering and charcoal production, which can be a highly destructive factor near townships.

Agricultural development projects in this part of the world for the most part have been counterproductive in solving the long-range problems of the Sahelian ecosystem, for both technical and social reasons. Misapplied and inappropriate western technology is one cause of the problem, and a general lack of cooperation amongst the various development groups as well as a cultural and language gap between donor and recipient has tended to impede the necessary coordination of development efforts. We concur with the opinion of Baker (1976), Swift (1977) and others that the complex problems of the Sahelian ecosystem cannot be met by single approaches, but rather require an integrated, unified effort on the part of the resource users and developers. This effort must take into account the long-term productivity of the ecosystem, which will often conflict with the immediate needs of the people and their governments.

An innovative rural development project in Chad, 1976–1979, proposed the application of a popular and easily understood concept of revegetation using the versatile *Acacia albida* tree as a means to focus concern and unify efforts of the various agricultural development groups.

Planting *Acacia albida* on marginal farmlands of the Sahel is not an end in itself. The project was designed also to coordinate development efforts and bridge the communications gap between the technical assistance agent and the villager. As the extension worker learns to understand the cultural constraints of the villager and as the villager gains confidence in the extension agent, a more complete land management programme may evolve which could include all aspects of agricultural and livestock production development.

The final goal is a culturally acceptable, ecologically oriented programme for integrated land management. This integrated development approach to ecological stability in the Sahel may be termed an agro-sylvo-pastoral* approach, signifying a unification of efforts.

STATEMENT OF THE PROBLEM

Chad is one of the poorest countries in the world, with a per capita income of less than US $100. It is a landlocked Sahelian country with all of the complex problems associated with a fragile arid ecosystem and an economy based on small-scale subsistence farming and livestock grazing. It has a short growing season, poor soils, uneven rainfall patterns, and is subject to cyclical droughts. During the drought period between 1970 and 1973, agricultural production was reduced by approximately 62% (Government of the Republic of Chad, 1977). Per capita food production, even before the drought, declined 32% from 1961 to 1970.

These trends may be indicative of two developments: an expanding population on a limited land resource, or a degradation of the land's productivity. It is probably a combination of these two factors which results in a poor country getting poorer and less able to feed itself, much less protect its ecosystems from instability and degeneration.

In the Sahel, modernisation is encouraging migration to the cities and the settlement of the nomads. This trend, along with improved medical services, is prompting an increase in localised population pressures with

* Agro-sylvo-pastoral is becoming a popular term used in Francophone Africa to imply the cooperative development efforts of the agricultural (agro-), sylvicultural (sylvo-) and range management (pastoral) disciplines.

consequent growing demands on the adjacent land resources. To meet these expanding demands, development priorities are directed towards projects that will quickly solve immediate problems. The introduction of western technology increases expectations of the land's resources while providing no guarantee of sustained high productivity. This only tends to compound the problems of environmental degradation in Chad. Some examples of development projects in Chad which could fit this counterproductive category are animal traction tilling, borehole development, introduction of cash crops, and irrigation projects.

The traditional method of seedbed preparation in Chad is the simple scratching of the soil surface with a hand implement and dropping seed into the depressions. Farmers who see the higher first year crop yields resulting from animal traction tilling are easily convinced of its merit. There is, in fact, a first year increase in crop yield after ploughing (Charrière, 1978), but repeated plough cultivation and loss of perennial root systems leads to a depletion in soil structure and fertility as the fields are made vulnerable to wind erosion and the organic matter is more rapidly oxidised.

Water developments for the benefit of livestock production have had severe impacts on the ecosystem in Chad. Additional water allows a growth of herd size and encourages locally intense range retrogression around boreholes (Le Houérou, 1980).

The introduction of cotton as a cash crop into Chad has compounded the problems of resource stress. Much of the suitable cropland is devoted to this 'luxury crop', with encouragement from local government. Cotton is now the first crop to be planted on a five year rotation with millet, sorghum, and peanuts. It requires more fertile soil and it removes more nutrients.

The technology of irrigation, with complex pumps that require imported parts and regular servicing, appears out of place in Chad. Without an extensive, easily obtained water supply, irrigation projects tend to build expectations that may be illusory. There are relics of ephemeral irrigation projects that have folded soon after the expatriot technician left. The level of technology applied is rarely understood within the cultural context of the Sahelian villager and thus often not maintained by him. This may eventually be regarded, however, as the redeeming virtue of misapplied western technology in the Sahel: a lack of permanency.

Compounding the problems associated with the application of

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inappropriate western technology, agricultural development projects in Chad rarely cooperate with one another for the optimisation of resource utilisation. Some believe it is a result of interagency jealousy among the host country government offices, or distrust, or lack of communication, or tribalism, or just a basic lack of interest to cooperate at the local ministerial level. These considerations could, and do, impede project coordination, but the technical assistance community is equally at fault for many of the same reasons.

Viewing the problem of desertification in its entirety reveals the prerequisite of balancing resource availability with coordinated resource utilisation. This proper utilisation of resources will only be possible when there is cooperation between the various users. The forester, the agronomist, the soil scientist, and the range manager must work together with the farmer and herder to obtain maximum long-term productivity from the land. The question therefore becomes how to organise the foreign technical assistance programmes into an ecologically sound unit easily understood and likely to be received by the rural villager.

The underlying premise of the Chadian project described in this paper is that a coordinated, cooperative agro-sylvo-pastoral programme may evolve from a central concept of revegetation with a multi-purpose species. The *Acacia albida* is a good example of such a species because of its beneficial qualities relative to agriculture, livestock, and wood production. It is also one of the few tree species in the Sahel that receives some measure of protection from the local population.

CHARACTERISTICS OF *ACACIA ALBIDA*

Acacia albida Del. is also known as *Faidherbia albida* (Del.) A. Chev. In Arabic it is referred to as the haraz. It is a member of the legume family and of the subfamily Mimosoideae. The species is characterized by bipinnate leaves, orange curled seed pods, cream coloured flowers, and thorns (Fig. 1).

It is the fastest growing savanna tree in Africa (National Academy of Sciences, 1975), reaching heights of 3–10 m in 10 years, depending upon environmental conditions (Wickens, 1969). It may grow as a shrub if continually grazed (Wickens, 1969), but usually develops into a tree with a large spreading crown. The mean maximum height is 25 m, with a girth of 5 m (United Nations Development Programme and Food and

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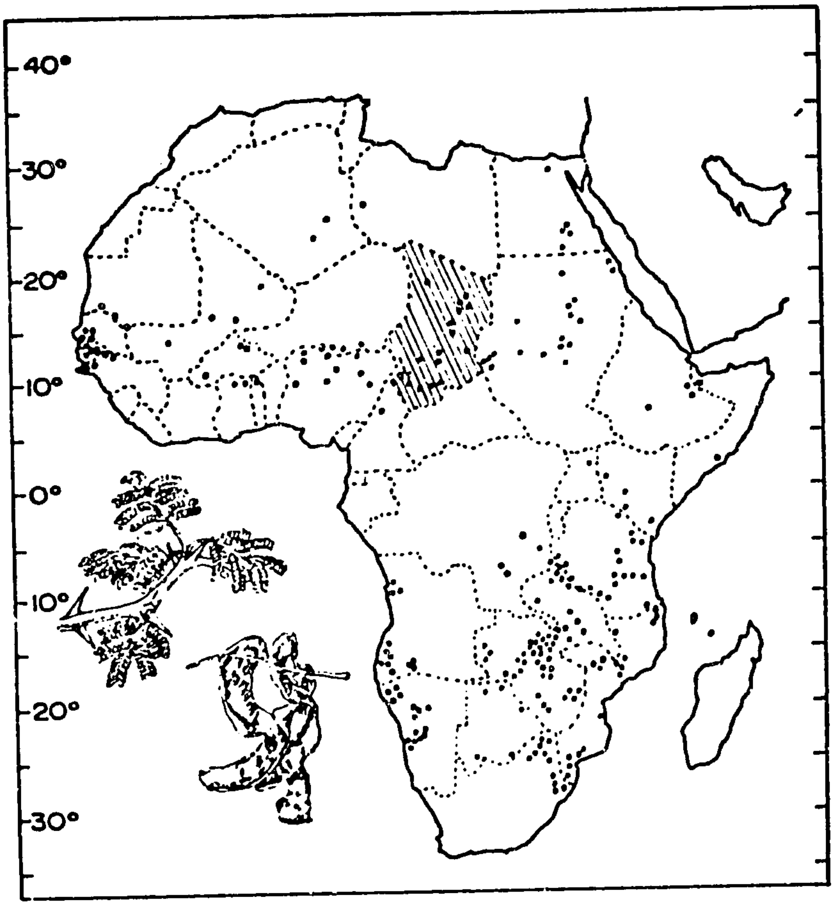

Fig. 1. Distribution of *Acacia albida* on the continent of Africa (after Wickens, 1969), with an inset illustrating foliage and pods.

Agriculture Organization, 1968). It is a long-lived species, with an average life span of 70–90 years in the Sudan and known to live more than 150 years in Zambia (Wickens, 1969).

Acacia albida has an extensive taproot system which develops rapidly to reach an adequate moisture layer. This characteristic makes the species relatively drought-resistant. On coarse alluvial sands of the Sudan, a six-month-old seedling with 8 cm of areal growth had a taproot of 70 cm (Wickens, 1969). A three-year-old seedling excavated in northern Nigeria produced a taproot in excess of 9·9 m (Weber, 1978).

The most unusual phenological characteristic of the species is retention of the leaves during the dry season and shedding of leaves at the onset of the wet season. No other African savannah species is known to possess this reverse deciduous cycle (Wickens, 1969; Weber, 1978).

In Africa *Acacia albida* is found wherever there is a long dry season (Fig. 1): from southern Algeria to Transvaal and from the Atlantic to the Indian Ocean (Giffard, 1964). It prefers a well drained sandy soil with a permanent water table, but will also grow on clay soils (Wickens, 1969); Weber (1978) indicates that it may be found anywhere millet can grow. Typically it occurs on bush-fallow of cultivated fields or land grazed by livestock, and rarely occurs in natural woodlands that have not been exploited by man. Wickens (1969) suggests that this might indicate that *Acacia albida* is an alien species of uncertain origin.

Natural regeneration of the species is both stimulated and repressed by grazing animals. The seed pods are highly palatable and livestock can distribute the seed 150 km from the source. Ruminant digestive juices stimulate seed germination (Weber, 1978). With increased grazing pressure and more intensive cultivation, however, natural regeneration is becoming more difficult for all perennials of the Sahel, including *Acacia albida*.

Because of its beneficial qualities as an important dry season fodder, source of fibre, a shade tree during the hot period of the year, and a preferred location for crop production (McGahuey & Kirmse, 1977), it is a protected species in many parts of the Sahel (Dancette, 1968).

Blancou *et al.* (1977) have shown that browse is a very important component of the dry-season diet for cattle in the subtropics, providing the principal source of protein and carotene. Reports of the crude protein content of *Acacia albida* leaves range from 14 to 17%, and three studies of the chemical composition of pods averaged 12·2% crude protein (Wickens, 1969). The highly nutritious and palatable pods and leaves of *Acacia albida* are readily consumed by all domestic and wild herbivores. Nomadic herdsmen typically lop the branches to provide browse for their stock; the seed pods fall to the ground in March and April during a time of nutrient stress for Sahelian herbivores.

Dense stands of the tree can provide forage equivalence, from pods alone, greater than any other local forage on a per hectare basis (Charreau, 1974; Table 1). A wood savanna in which *Acacia albida* is the dominant tree species is able to stock 20 animal units km^{-2} as compared with 10 animal units when *Acacia albida* is not present (Giffard, 1964).

Extensive research on the soil-enriching properties of *Acacia albida* has been undertaken in Senegal (Charreau & Vidal, 1965; Jung, 1967, 1970;

Dancette & Poulain, 1968), and in Niger by Dougain (1960). All soil nutrient properties were observed to be improved by the presence of the species. Increases from 20 to 100% were found in the nitrogen, available phosphorus, and exchangeable calcium content of the soil (Jung, 1967).

Studies by Dougain (1960) in Niger indicate that on a 10 cm depth basis, which represents about 1500 tonnes of soil ha^{-1}, the nutrient increases due to the presence of *Acacia albida* were equivalent to the following amounts of fertiliser amendments per year: 300 kg nitrogen,

TABLE 1

Fodder Value of Pods of *Acacia albida* compared with Peanut Tops and Mature Native Grass

(Sources: Charreau & Nicou (1971) and Boudet & Riverière (1967))

	Total yield ha^{-1}	*Digestible protein* kg^{-1} *dry weight*	*Digestible protein* ha^{-1}	*Net energy* kg^{-1} *dry weight*	*Net energy* ha^{-1}
Acacia albida pods	2 500 kg	70 g	175 kg	1 448 Kcal	3 620 Mcal
Peanut foliage	3 000 kg	60 g	180 kg	725 Kcal	2 256 Mcal
Mature native grass	4 000 kg	10 g	40 kg	376 Kcal	1 500 Mcal

31 kg phosphorus as P_2O_5, and 24 kg magnesium. The tree also serves as a windbreak which protects crops and native vegetation from mechanical damage and excessive transpiration (Dancette, 1968).

Charreau & Vidal (1965) calculated that under *Acacia albida* trees in Senegal, millet production was 2·5 times that of crops grown in the open and protein content of the grain was up to four times greater. Dancette & Poulain (1968) demonstrated that peanut production can be 36·7% greater under the influence of *Acacia albida*.

The nutritional benefit of *Acacia albida* to crops grown beneath the canopy is consistent with the 'islands of fertility' concept described by Garcia-Moya & McKell (1970) for shrubs and trees in semi-arid lands. Woody perennials extract nutrients from deeper layers of the soil profile and deposit them at the surface in litter (Fireman & Haywood, 1952; Rickard, 1965; Charley, 1972). These plants also provide cover for animals and trap aeolian debris. Soil water retention may be as much as 43% higher under the canopy of *Acacia albida* (Charreau & Vidal, 1965). A more favourable moisture and temperature environment will promote microbial decomposition and nutrient release. Since *Acacia* is a legume, symbiotic nitrogen fixation may contribute to the nutrient pool enhancement.

The characteristic reverse deciduous cycle of *Acacia albida* is a key physiological property that allows satisfactory production of crops under a full stand of the species. The leaves are shed at the onset of the rainy season, allowing sunlight access to the crops and reducing competition for water in marginal croplands.

The wood of the *Acacia albida* tree is hard and favoured locally for the construction of mortars and pestles as well as other light carpentry. Localised uses also include charcoal production and dugout canoe construction. The bark can contain up to 28% tannin and is used for treating hides (United Nations Development Programme and Food and Agriculture Organization, 1968).

The above-mentioned multiple use qualities of *Acacia albida* indicate that the species would be of interest to (1) the agronomist for increasing crop production without the use of expensive fertilisers; (2) the livestock producer for fodder during the dry season, as well as shade; (3) the watershed manager for improvement in soil water-holding capacity and decrease in erosion; (4) the forester for timber uses; and (5) the farmer as an improvement in his living standards without a change in cultural traditions. It is for these considerations that *Acacia albida* can be a focal point of a coordinated agro-sylvo-pastoral land management programme.

Many authorities on the problem of desertification recommend planting the species as an appropriate land management component in the Sahel (Guilloteau, 1953; Dancette, 1968; Giffard, 1971; Delwaulle, 1973; Catinot, 1974; Weber, 1977). There have been several attempts to organise land management programmes using *Acacia albida*, in Niger, Senegal, Nigeria and Chad. The Chad project is an interesting case study of the possibilities and problems of such a programme.

PROJECT DESCRIPTION

In June 1976, Cooperative for American Relief Everywhere (CARE), with funding from the United States Agency for International Development (USAID), set out to try an ecological approach to increase productivity and improve resource management in Chad by the planting and protection of *Acacia albida* trees on marginal farmlands. It was hoped that this popular and visible planting programme would serve as a tool that could bridge the gap of communications amongst the various development agencies and the villages, so that an integrated resource management programme of a larger and broader nature might develop.

The three-year project proposed the planting of 100 seedlings of *Acacia albida* per hectare on 3500 hectares of marginal farmland that was presently under cultivation. One hundred seedlings per hectare is five times the number of mature trees recommended by Giffard (1964) as sufficient to provide continuous cropping without the need of intermittent fallow periods. Due to the expected mortality of seedlings, this high planting intensity was considered necessary to ensure the survival of the desired numbers of trees and their proper distribution.

Cultivated fields were targeted for planting, rather than abandoned fallow fields, for two reasons: (1) in order to work with and employ the local farmers, following Eckholm's (1976) reasoning that the local inhabitants must willingly participate and recognise their self-benefit before a conservation project will succeed; (2) survival rates are much higher in cultivated fields than fallow land because of the extra protection the farmer provides against fire, grazing pressure, and grass competition (CARE, 1978).

The project area consisted of marginal farmlands just north and south of the 400 mm rainfall belt, which includes the arid fringes of the desert between latitudes 10° and 13° North, with annual rainfall ranging from less than 200 mm in the north to 700 mm in the south. This area was selected in order to demonstrate project technology in the most critically affected zone of the desertification phenomenon.

The land was inhabited by various tribes of sedentary farmers and pastoralists including the Sare, Moundan, Fulani, Arabs, Toubouri, Massa, Baguirmi, and Kotoko. Of these only the Sare, Moundan, Toubouri, and Massa had an inherent understanding of the benefits of *Acacia albida* and a tradition of protection and respect for the tree; other tribes have recently settled the area, coming from regions where the tree does not occur. Cultivated crops include millet, sorghum, cotton, and peanuts; livestock in the area include cattle, sheep, goats, and camels.

The programme design specified an initial questionnaire to obtain some semblance of understanding of local needs, perceptions and resource constraints. The survey sampled all locations of the project in order to canvass the various tribes and detect cultural differences. Time and language constraints rendered this endeavour practically worthless.

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The western oriented project managers (Americans) spoke in French, through a translation to Arabic, to the villagers whose mother tongue was any of a number of local dialects. The translators (French to Arabic) were Chadian Forest Service agents of the ruling class tribe (Sare) which was not trusted by the other groups.

Time was a limiting factor because the project was required to produce tangible evidence of progress before the first rainy season or else lose funding credibility. Therefore, out of necessity, and hopefully fairness to all tribal members, the programme was standardised. One policy for project operation was applied to all participants, at the expense of adjusting to the various cultural differences.

Project implementation

Nine nursery and extension centres were established in various locations ranging from 150 km north to 250 km south of N'Djamena (Fig. 2). Local villagers were hired and trained to run the nursery operations (Fig. 3). All efforts were made to establish nursery techniques for seedling propagation commensurate with locally obtained materials and indigenous technology.

Approximately 2500 farmers and their families participated in the revegetation effort (Fig. 4). The targeted 3500 ha were all planted by the third growing season. An organised campaign was necessary to ensure that all seedlings were in the ground within a two-week period at the onset of the rainy season. This planting-out component of the programme proved to be clearcut in terms of social and environmental complications, especially in comparison with the truly difficult task of protecting the seedlings in the field after establishment.

In the first year of operation 54 000 seedlings were planted on 540 ha of cropland. Within the next 12 months there was a mortality rate of 73 %, resulting in survival of only 14 500 saplings. In the second planting season 285 500 seedlings were established with 58 % survival, mainly due to an improved protection programme, bringing the total number of saplings after two years to 178 000. One-year-old plants had a much higher capacity for survival. During the third season (1978) 292 000 seedlings were planted. It was projected that combined mortality for seedlings and older plants would be about 26 %, leaving 350 000 young plants by the fourth year from the 470 000 cumulative total population (Fig. 5).

Among the mortality factors, grazing pressures caused the highest

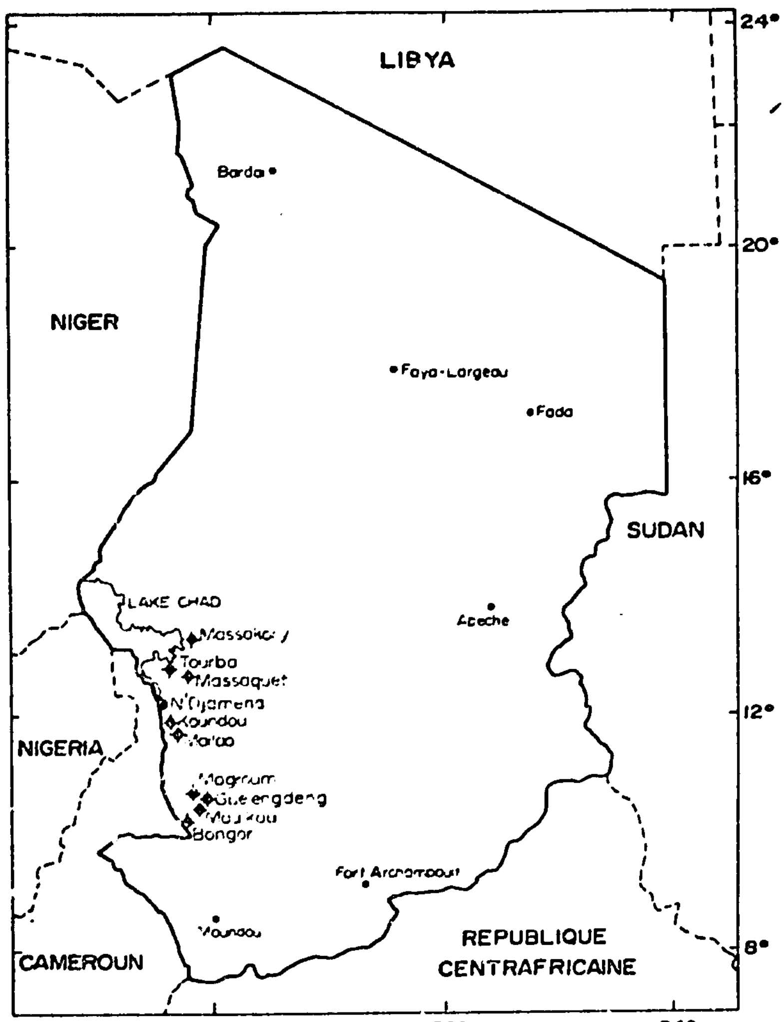

Fig. 2. Location of nine nurseries (◈) north and south of the capital of N'Djamena.

losses. *Acacia albida* is highly palatable to all herbivores, and being one of the few species with green foliage during the dry season it was readily taken if not protected. Perimeter fencing of the land was not possible or desired as this would have disrupted the traditional grazing patterns of the nomadic herder. Furthermore, imported fencing materials that would resist the rigours of the environmental conditions were highly prized by the local villagers and rapidly disappeared. Instead, the laborious task of

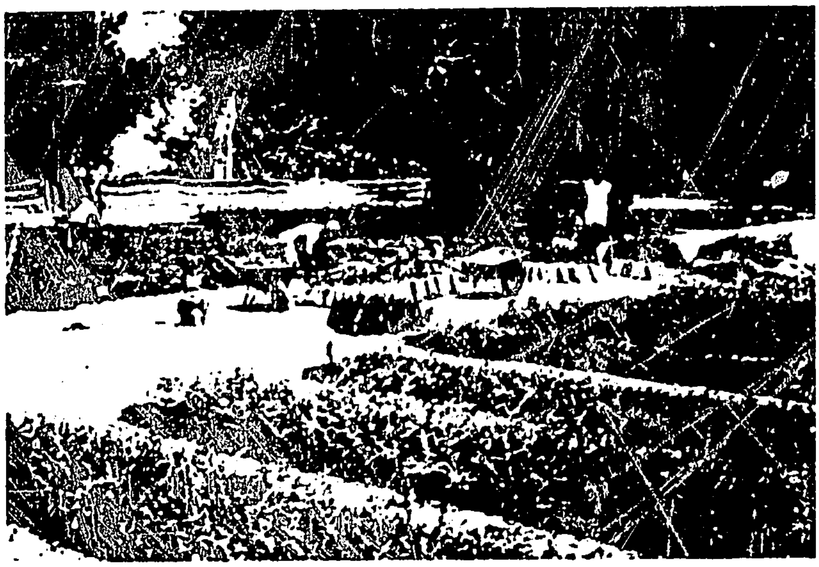

Fig. 3. Nursery near Bongor in the southern, more humid area of the project.

Fig. 4. Family members participating in the programme.

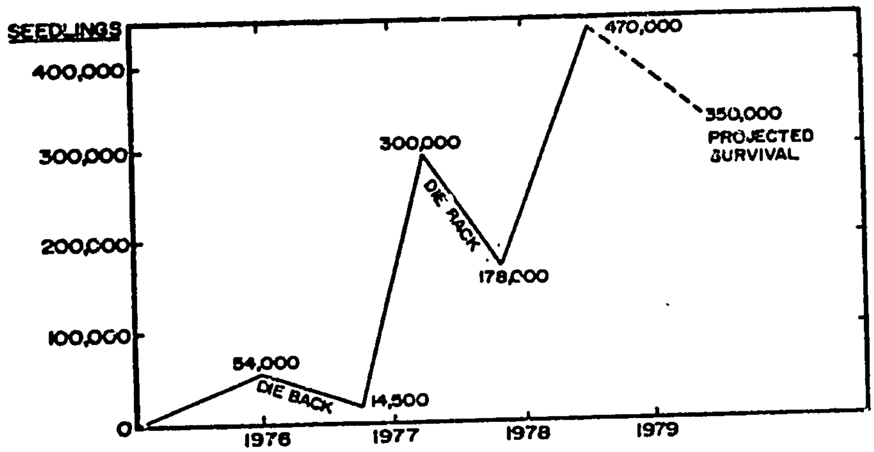

Fig. 5. Record of planting and mortality of *Acacia albida* seedlings.

fencing each individual tree with suitable local materials, such as thorny branches, was undertaken (Fig. 6).

Uncontrolled range fires also took a heavy toll of the young seedlings. Convincing the villagers and nomadic herders to refrain from their traditional burning habits was futile. Here again, the only solution proved to be a major task, that of clearing fire lines, 2 m in radius, around every seedling. This clearing of the native grasses also served to remove competition for soil moisture in favour of the *Acacia* seedling.

Where termite infestation occurred, insecticides were applied on a tree-by-tree basis. It was also necessary to protect the fencing material from the ravaging termites by a combination crankcase oil and insecticide treatment. Crankcase oil was more easily obtained and less expensive than commercial wood preservatives.

There were, of course, unfavourable environmental factors completely outside the control of project management. Periodic droughts could not be controlled. The rainy season normally lasts about two to three months in this part of Africa, leaving a pronounced dry period the rest of the year. For a seedling to take root before this long dry season, it had to be planted early during the rainy season, but only after the soil was moist to a depth of 40 cm (CARE, 1977). Correct planting time was critical to seedling survival, but unfortunately was highly dependent upon luck. If a two-week dry period occurred immediately after the seedling was planted, chance of survival greatly decreased. Another seedling mortality factor beyond control of the project management was elephant damage.

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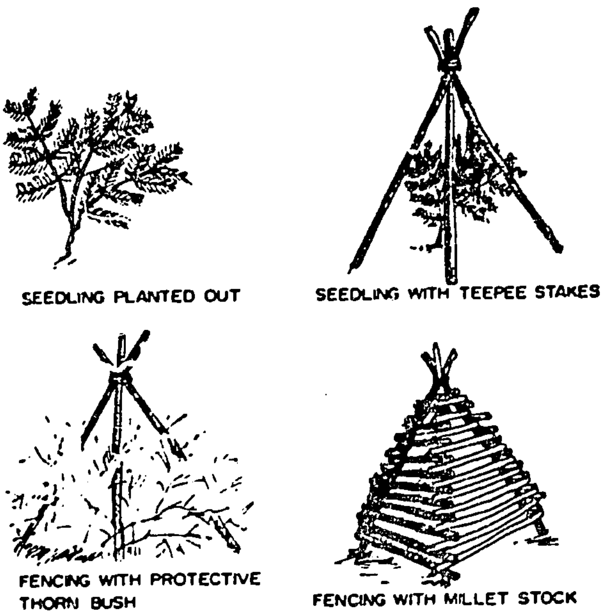

Fig. 6. Protection of individual young seedlings using local materials.

Elephants selected out *Acacia albida* saplings as preferred browse (CARE, 1977).

Technology transfer problems

In the face of environmental dispositions towards mortality, the predominant influence on seedling survival derived from the interest of the farmer who planted and protected the seedlings on his land, especially his understanding of the purposes of establishing the tree and the benefits it would bring.

In an effort to achieve an adequate level of understanding, an intensive training and sensitisation programme was initiated. Films were made, talks given, and demonstrations presented. All of the conventional western extension tactics were employed to promote the idea of *Acacia albida* as a key to proper land management. Interest was certainly generated, although not for the reasons one would have wanted. As one CARE employee pointed out, 'We are the only show in town'.

It was necessary to prop up the extension efforts with an incentive policy to attract the initial participation of local villagers into the revegetation scheme, and to encourage continuous protection of the planted fields. This incentive component involved the distribution of American-donated food commodities (called 'food for work'). Some contend that giving food creates a dependency, and an expectation by villagers that they must be compensated for their efforts to help themselves. This is a reasonable fear, but project experience demonstrated that satisfactory participation is simply not possible without such food, or some other incentive. (Actually, the Chadian Chief of the Forest Service suggested cash payments would be necessary.)

In most cases the village chief (Blahma) or religious head (Sultan) was the instrument of local project administration, which turned out to be a most successful extension arrangement. The ethnic diversity of the area presented insurmountable obstacles for complete coordination of activities. People of different tribes in this part of the Sahel (and probably elsewhere) simply do not work together.

The project was heavily burdened by the traditional problems of incompatability between government extension agents and rural villagers. Government Agents tended to assume a patronising attitude in their extension methods. They were well trained technically but poorly prepared to communicate ideas to the rural villagers or to motivate farmers to support the idea of the agro-sylvo-pastoral programme.

DISCUSSION

Most foreign assistance projects concerned with agricultural or pastoral development in Third World countries operate on assumptions, both technical and sociological. The technological transfer process generally assumes that the technology used in the developed country will work equally well in the client country. Due to critical deficiencies in research and lack of expertise of western technicians in the Sahelian situation, this assumption is often found to be faulty. A classical example of misapplication of technology is the use of sophisticated machinery in a land remote from spare parts and among people unaccustomed to engine maintenance. The advantage of the agro-sylvo-pastoral programme in Chad is that the 'technology' of *Acacia albida* is natural to the Sahel, time-tested, and well studied by research scientists.

Assumptions concerning the social implications of rural development programming in the Sahel are yet more complicated as they deal with intangible and elusive cultural nuances. It hardly can be expected that a technical expert will fully understand the cultural setting within which he is to operate. In fact, pretensions to understand often lead to the chronic problems of western ideas imposed upon unwilling villagers. This is not to imply that project personnel should ignore the cultural context, rather they should be sensitive to the needs of the villagers and include local-level input into the planning as well as the implementation phases.

The problems of change agents who are unfamiliar with client needs and perceptions, insensitive to different socio-economic status and the particulars and complexions of different ethnic groups, presume to know what is best for the client, and assume only temporary involvement in improvement projects, are examined in depth by Mbithi (1974) in a Kenyan context. These are universal issues in rural development, and the *Acacia albida* project was no exception. In the latter case an idea—an ecological concept with commercial agricultural value—was to be imposed on the villagers with the assumption that the local inhabitants understood or could be taught the principles of the programme. This proved to be the weakest point of the project. Farmer understanding was so critical to the success of the programme but yet was based on nothing more than western hope and expectations. For all practical purposes, there was no effective local level planning, and the project had to rely on free food incentives for motivation instead of adoption by the villagers of programme objectives.

From another point of view, transmitting a thorough understanding of the ecology of an *Acacia albida* plantation may have jeopardised the project. Under the traditional cropping system soil fertility is depleted after about five harvests and the farmer and his family then move on and clear a virgin or recovered field. But it takes *Acacia albida* about 15 years to reach maturity and produce the promised benefits. The cooperative farmers who carefully watched over the seedlings established on their cropland for the CARE programme would have to abandon their husbandry ten years before the fruits of their labour could be fully realised. The trees protected for those four or five years would be able to make it on their own and the objectives of the project would be reached eventually, possibly at the expense of the original partnership between donor and farmer if the latter did not return to the same field.

The project was a technical success in that it reached its goal of planting 3400 ha and involved over 2000 farmers, plus their families, in the three-year effort. It was also successful in providing a focus to coordinate the interests of various technical assistant groups working in the country.

On a sociological scale, the project could be rated a failure because of the requirement of a food incentive to assure participation. The 15-year delay before plantation benefits are realised cannot be overlooked while evaluating the impact of this project on a people living at a subsistence level. It has been observed that African languages often do not allow for a future tense (Mbiti, 1969): this could definitely handicap a project with long-term goals.

It would seem, therefore, that the change agent (in this case CARE) should be required to remain active in the project until benefits can be seen by the recipients, but this condition is generally constrained by the *modus operandi* of the funding agency. In 1976, USAID, for example, would only fund projects for periods of three years at a time. At the end of each three-year period continued funding is dependent upon proven success, such as increased animal production, increased agricultural output, increased rural jobs. This project, by nature of the biology of the development tool, required much more than three years to realise production gains or social changes. For this reason a programme with an ecological orientation such as this is less likely to receive continued financial support compared with irrigation, veterinary services, fertilisation and farm mechanisation improvements, or other highly visible projects with short-term objectives.

It is imperative that a project with the far-reaching goals of the *Acacia albida* establishment programme continue to be motivated by the extension agent until the clients see the results of their efforts and become willing participants.

Unfortunately, this project did not continue. The reasons, however, had nothing to do with the inherent problems of rural development programmes. The sudden and unexpected end of the project was due to the *coup d'état* in Chad in 1979, which underlines the ultimate prerequisite for a successful desertification control project—a stable governmental structure within which to work.

CONCLUSIONS

The desertification process is a complex web of environmental disturbances and its control is confounded by a labyrinth of social and ecological complications. 'Modernisation' has reached a stage in the Sahel such that a return to traditional ways would not be possible, even if desirable, as a means to check the 'desert creep'. It is in the interest of the developed world to work with the affected countries to find an ecologically sound and socially acceptable solution to the degradation problem. The ecological understanding necessary to apply conservative land management is available, but because of social and cultural differences the framework within which it may be properly applied has not yet been developed.

A suitable framework for development and conservation of the Sahelian ecosystem must involve a unified effort on the part of all sectors of agricultural and livestock production to ensure proper utilisation of the land's resources. Development efforts in the Sahel, however, do not have a history of such cooperation; coordination of efforts will only come with coordination of interests. The unique multi-use characteristics of *Acacia albida*, built into a rural development project, could be a device to focus related interests and forge cooperation between development efforts that have obvious ecological connections. This facilitation may ultimately be more helpful to the recipient country than the direct benefit of *Acacia albida* plantations to the agricultural and forage resources of the land.

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