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LIVE FENCING IN THE ASHANTI REGION OF GHANA

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ABBREVIATIONS

I.R.N.R.	-	Institute of Renewable Natural Resources.
U.S.T.	-	University of Science and Technology.
F.O.R.I.G.	-	Forestry Research Institute of Ghana.
I.C.R.A.F.	-	International Center for Research in Agroforestry.
J.S.S.	-	Junior Secondary School.

ABSTRACT

Many forms of live fences are established in the rural and urban areas within the Ashanti Region. The fences are established basically for the protection of the agricultural crops and/or properties but the aesthetic value of live fences is appreciated. The live fences serve as boundary markers of land units, control of erosion especially in hilly areas. They are extensively used for food (fruits, leaves and barks), medicines (bark, leaves and root), fodder and firewood. Very little attention has been paid to live fencing. Hence, literature on it is scarce in Ghana. To establish and manage live fences properly, it is necessary to study them. It is therefore the object of this study to investigate the traditional practices of live fencing in the Ashanti Region of Ghana.

The study was undertaken using questionnaires and personal interviews in 100 randomly selected towns and villages in the Ashanti Region. A stratified random sampling method was used and Kumasi was chosen as the reference point. The Ashanti Region was divided into 20 units along first class, second class, third class and feeder roads. Ten routes were then randomly sampled. One district was selected after reconnaisance trips along the selected routes. Data was collected in and around the communities in each of the selected districts. Field experiments on methods of propagation of eight of the identified species were also conducted at the I.R.N.R., U.S.T. Research Farm.

The study revealed that nine (42.86%) live fence species were indigenous and twelve (57.14%) were exotic. More exotic species than indigenous species were found in the urban areas whilst the reverse was true for the rural areas. Sixteen species (76.19%) were identified as having multipurpose uses. Seeds (42.86%), stake cutting (47.62%) and stem cutting (28.57%) were the major propagules for the live fence species. Pollarding (57.14%) and lopping (42.86%) management practices were performed on the tree species whilst trimming (33.33%) and pruning (19.05%) were done on the shrub species up to a maximum of three times in a year. Live fences for security were cut high (> 1.0m). The shrub species used for live fencing were generally cut low (0.7m) depending on their morphology, age of species or the management strategies imposed to provide the goods and services required. Live fences for aesthetic value or facade were properly managed and cut at more or less uniform heights (1.5m). The unmanaged live fences grow taller (ranging between 1.8 and 8.4m). The tree species could be managed to form a hedge. The planting distances vary and generally tree species used for live fencing were spaced wider (1.9m) than the shrub species (0.7m). The live fence species identified were susceptible to fire (42.86%), insects (33.33%) and plant parasites (14.29%). However, 42.86% of the species were found to be resistant to these agents of destruction.

In the field experimentations, seed germination was excellent for *Pithecelobium dulce* (100%) and fair for *Cassia*

siamea (50%) but poor for *Ricinus communis* (20%). Stem cuttings sprouting were excellent for *Gliricidia sepium* (100%) and *Pithecelobium dulce* (85.7%) and poor for *Euphorbia cortinifolia* (28.6%). *Ricinus communis* stem cuttings did not sprout. The *Breynia nivosa* was the only species with some sprouting success in root cuttings (25%). The *Jatropha curcas* stem cuttings was superior to *Spondias mombin* (averaging 82.2% and 1.7% respectively). The basal sections of *J. curcas* showed rapid regeneration (89.3%) but again, the basal section of *S. mombin* (2.6%) was poor in regeneration. The terminal sections of *J. curcas* (81.3%) and *S. mombin* (1.3%) were respectively lower than the *J. curcas* and the *S. mombin*. Regeneration of *S. mombin* stem cuttings were generally poor in the short period of the experiment. Trees, woody shrubs and succulent shrubs could be used to establish effective live fences and managed well to achieve the desired goals.

Information should be gathered on live fences particularly legume species to cover the different ecological zones in Ghana. Further studies should be done on sprouting of trees, woody shrubs and succulent shrubs to be able to make firm recommendation. It is however encouraging in that stem cuttings and seeds gave reasonable results. Comparative costs and benefits analysis on live fences and other forms of fencing should be evaluated.

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1. INTRODUCTION

1. INTRODUCTION

Living fences made of woody perennials or semi-lignous perennials (rarely big trees) constitute one of the oldest and very common techniques of protection of farm crops and properties in rural areas (Depommier 1985). The history of living fences in Ghana is closely associated with group settlements and community development.

The existence of living fence could be largely seen as amenity planting around homesteads.In such situations, various tree and shrub species are kept as fence hedges of posts to delineate building plots in the cities. In the villages, the living fence species provide medicinal products especially around traditional religious houses or shrines and as a means to check erosion of the predominant mud houses. The aesthetic value of the hedges cannot be overemphasized. They are left to flower and/or lopped or pollarded to more or less uniform heights. Such plantings have various types of grass lawns in their enclosures with interspersed horticultural plants.

Living fencing could also be used for boundary demarcation. Generally, boundary demarcation becomes very important where home or backyard gardens are in intense use. Normally, household waste water is directed into the gardens and as such, the well netted live fences at close spacing control the erodibility of the soil. The fence plants serve as a barrier to run-off water and slow down erosion. Hence, top-soil transport is effectively checked by the plant roots that bind the soil particles. Infiltration is improved and the volume of run-off water is greatly reduced. Many of the plant

species used as fences limit free movement of animals and/or man. In places where homegardens are well managed, live fencing species may be pruned to feed livestock confined in pens. In traditional farming systems where tree crops such as cocoa and coffee are cultivated, live fence plants with longer lifespans are planted to demarcate farm units, between individuals of the same family, between families and between communities. Such boundary plants must be resistant to fire, fungi, termites and must have the ability to sprout easily either from the stem or roots.

A number of plant species used for fencing contribute to more productive aspects such as fruits, fuelwood, etc. However, they may not be easily accepted as they take time to establish and may be unreliable due to breaks in continuity or open spaces developed at the tree/shrub bases as they mature or when they die.

Many other fencing materials are used in Ghana. In the rural areas, wooden posts are erected far apart. These are joined with split bamboo stems and sometimes made more effective in a short term by weaving palm fronds in between the bamboo layers. In the urban areas, lumber from the local timber mills are used for fencing. Dead fence posts are joined by barbed wire or lumber rails. More often, these fencing techniques do not last as the dead wood materials are succeptible to insects and fungi attacks. Usually, they do not last for more than two years. Webster and Wilson (1980) reported that the "slug fence" (Wooden fence commonly used in

Australia) is effective in holding cattle but smaller animals may crawl under it. In some situations, concrete pillars or metal posts are erected and wire mesh passed around them as fence. These types of fencing require greater capital cost. Even though they may be good and have longer life, they are very uneconomical and unacceptable to farmers producing at subsistence levels. Living fences may be less expensive to establish and the compensating benefits may offset the initial costs. The flexibility in selecting plant species for live fences, the duration, maintenance, effectiveness let also the additional products and services (erosion control, medicinal, fodder, fruits, fuelwood, aesthetics, etc.) as compared to the other from of fencing which need periodic changes at short interval and have highly technical approaches with greater investment costs, make the choice of fencing material shift towards the use of living plants species. There is a dearth of information on living fences in Ghana. It was therefore the object of this study to:

i. identify the plant species already used in live fencing in the Ashanti Region;
ii. assess the roles and functions and the effectiveness of traditional live fencing in the Ashanti Region.
iii. evaluate the management practices on live fences in relation to their effectiveness as obtains in the Ashanti Region; and
iv. investigate the methods of propagation of some of the fence plant species.

2. LITERATURE REVIEW

2.1 Trees and Shrubs for Fencing in the Tropics

2.1.1 The Arid zone

In the CARE-CHAD, *Acacia albida* Expansion Project, Diguera (1977) reported that neem (*Azadirachta indica*) is a principal tree mostly grown for windbreaks in the Sahel Region. *Dalbergia sissoo, Cassia siamea* are also planted in forestry reserves as shelterbelts. He further reported that *Commiphora africana* is one of the few woody species used by sahelian farmers in traditional fencing. *Balanites aegyptiaca* and *Ziziphus spp.* have the potential as live fencing plants but are little used traditionally. *Prosopis juliflora* (known as mesquite in North America and Mexico) and *Parkinsonia spp.* in the Sahel appear to be hardy species used as live fences.

Weber and Dulansey (1978), conducted a study on *Parkinsonia acculeata* for live fencing in Chad because of its rapid growth and ease of pruning. However, it does not have much value other than its use as a physical barrier.

2.1.2 Semi-Arid Zone

Leslie (1991), noted that the two most common genera used as hedges in Somalia are *Euphorbia* and *Commiphora*. Hedges of these not only exclude animals but also provide shelter. *Euphorbia tirucalli* and *E. grandicornis* are planted to form live fences and *Opuntia spp.* are commonly used as live fence on dunes. He further reported on *Solanum spp.* and *Erythrina spp.* as live fences retained around huts as shelter and to exclude livestock.

The use of *Parkinsonia acculeata, Leucaena leucocephala*

and *Caesalpinia pulcherrima* hedges to exclude livestock, provide limited shelter for crops and act as boundary markers between fields in Somalia was reported by Leslie (1991). He again reported that species such as *Casuarina equisetifolia, Conocarpus lancifolius, Azadirachta indica* and *Eucalyptus camaldulensis* are often planted along roadsides to serve as shelterbelts.

2.1.3 Rain Forest Zone

Moreno (1985), reported on living fence posts of *Gliricidia sepium* in Costa Rica. The investigation was conducted on a five year old *G. sepium* fence lines. He stated that branches of the fence posts were pruned and used as planting material for new living fence posts, and dead posts for corrals and fences. Baggio and Heuveldop (1984), conducted a study into the performance of *Calliandra calothyrsus* (Meissm) in Costa Rica and concluded that it had the potential for use in living fencing.

Beer (1987), also discussed the use of some potential fodder trees which were planted as living fence posts in Costa Rica and Nicaragua. He identified *G. sepium, Spondias purpurea, Erythrina poepigiana, E. berteroana* and *E. fusca* plant species. Crane (1945), commenting on the history of living fences in Cuba reported that, it is closely associated with the development of the cattle rearing industry from the middle of the sixteenth century. Land owners began staking out their legal claims and erecting fences around them. The tree species used for living fencing included *Bambusa*

vulgaris, Yucca aloifolia, Pereskia grandifolia, Euphorbia lutea, Bursera simaruba, Spondias lutea, Cochlospermum vitifolia, G. sepium, Jatropha curcas, Spondias mombin, Bursera graveolens, Euphorbia nivalis, Anacardium occidentale and *Moringa pterygosperma.*

Depommier (1985), identified the plant species commonly used for fencing as *Tephrosia* and *Flemingia spp., G. sepium, Markhamia lutea, Vernonia amygdaline, Ficus spp., Morus spp., Cassia spp., L. leucocephala* and *Psidium guajava.* Mintz (1962), studied living fences in the Fond-des-Negres Region of Haiti. He reported that *Bromelia pinguin* is one of the commonest plants forming a living fence. It is a spiny plant and grows in thick clumps to a height of about two feet. However, this plant harbours snakes, mongooses, rats and other small animals and most people in the region do not like it as a hedge close to the house.

Mintz (1962), further reported on *E. lutea* as another popular plant for living fence. It is a cactus-like succulent plant that grows to a height of about five feet. When fully grown, it forms an inpenetrable thicket and does not bunch at its base and can be growth in orderly lines. *Polyscias spp.* is also used as living fence in Haiti. It grows to maturity in less than six months. If left alone, it will grow to a height of ten or twelve feet. It can also be planted in very tight rows. It does not clump, and it is not prickly and harsh-looking. *Codiaeum variegatum* is yet another species used for living fences.

Mintz (1962), again identified *J. curcas* to be commonly planted around houses and around fields adjoining the yard. It is a less satisfactory living fence in general, less a barrier than a marker. However, *Pedilanthus tithymaloides* is a yard plant and may be planted either to form a hedge or in clumps (Mintz 1962).

A hedge is a fence of bushes and may serve as a boundary screen and a noise breaker. A well-cut hedge improves the beauty of a garden and of properties facade (Abbiw 1990). He identified hedge plants which include *Acacia farnesiana, Acalypha wilkesiana, Bauhimia rufescens, B. tomentosa, Bixa orellana, Breynia nivosa, Bridelia sternocarpa, Caesalpinia pulcherrima, Ficus leprieuri, Jatropha curcas, Oxytenanthena abyssinica, Thevetia peruviana, Ziziphus abyssinica, Z. mauritiana* and *Dracaena arborea*.

Mint (1962), also encounered two commercial plants; *Agave rigida* var. sisalana (Sisal) and *Anatherum zizanioides* which are living fence species. However, the present world market prices do not encourage the extension of their cultivation. Sisal is more commonly grown in rows inside a living fence of some other plants. Its leaves attain greater length. It can be cut commercially with fair frequency.

2.2 Roles and Functions of Live Fences

The main recognised role of fencing is usually the protection and/or delimitation of space with regards to livestock and also man. In most tropical areas, this is complemented by productive and soil protection roles. The

multiple uses of living fences, especially in sloping areas subject to strong water and wind erosion, make them a priority tool in soil conservation and rehabilitation (Depommier 1985).

Mintz (1962), reported that bamboos on rare occasions are used to form a boundary in Haiti. It however, has many local uses. It is mostly used for crafts, fencing, the manufacture of musical instruments, rain gutters and chicken cages. Abbiw (1990), reported that *Euphorbia leteriflora* is planted as a 'charm' by farmers to protect their crops.

2.2.1 Erosion Control

The efficiency of living fences depend on the way they are built. Depommier (1985), suggested that for erosion control, the fencing species must be planted on the contour lines of the slope and should be reinforced with other soil conservation techniques (e.g grass strips for stabilization if possible). In order to achieve the high density necessary to attain the best results, trees are planted very close together on one or two lines. The type of species to be selected must have the attribute to protect and rehabilitate soils through its rooting system, nitrogen fixing capability and must have high biomass production.

Depommier (1985), reported that well managed living fence appear very efficient to fight erosion and meet the needs of the local population. They function effectively to break run-off speed, filter the water carrying soil because of the woody perennials rooting system. They are able to protect the soil from excessive solar radiation (through its shading

effect) and reduce wind erosion. The surface soil layers are enriched with litter nutrients. After a certain period, the slope is reduced through development of natural terraces (behind the living fence if planted on contour lines).

The presence of live fencing species will improve the infiltration rate and finally provide a great diversity of products. *Bromelia pinguin*, as stated by Mintz (1962), holds the earth well and it is often planted where considerable passage of men and beasts has packed the paths down below he surface of adjoining land.

2.2.2 Barrier

Reporting on the CARE-CHAD *A. albida* Expansion Project, Diguera (1977), stated that during the wet season, paths and animal trails bordering grain fields are often fenced with thorns. The barrier is designed to screen or deflect foraging animals rather than to prevent them from entering completely. In most cases, the animals are herded and the barrier complements the shephered's vigilance. Mintz (1962), indicated that even though *B. pinguin* is a short plant, it is useful for bordering houses which open on major paths, since it keeps out all passing animals and man.

2.2.3 Protection

Moreno (1985), reported on *G. sepium* in Costa Rica indicating that a system of perimeter and internal fences of *G. sepium* protects plants and crops for small local processing and packaging plants against high temperatures, sun and strong winds. The fence also impedes the advance of insects and

other pests as well, and it provides protection against external contaminants to the medicinal plant species.

Crane (1945), reported that barbed plants (straight growing trees with few branches to which wire strands could be attached provide protection to tree and food crop plantations against livestock and thieves in Cuba. Madany (1991), indicated that live fences of *Parkinsonia acculeata* were planted around demonstration plots in Southern Somalia. The use of this technique was later extended to the protection of agricultural plots of bananas, tobacco, squash, the staple crops-maize and sesame, against livestock and erosion set up on the communities' own initiative.

Holt (1989), demonstrated that the local bush species including *Commiphora spp.* and *Balanites aegyptiaca* are used to establish living fence hedges around cultivated fields in Mogadishu and Somalia. This promises to reduce the destruction to range vegetation caused by farmers continually cutting branches of bushes to maintain dead thorn branch fences around their farms.

Shaw (1989), reporting on the design and use of living snow fences in North America concluded that rows of trees and shrubs were planted. This fencing technique keeps snow drifts off roads, enhances wildlife habitat, provides winter protection for livestock, increases environmental diversity and offers long-term economic benefits. Baggio and Heuveldop (1982), reported on *G. sepium* as live fence for the protection of food crops from wind damage.

A brief review of a mechanical system to protect young tree seedlings, woodlots, fencing around individual trees was undertaken by Ngulube (1988) in Malawi. Fencing was reported to be effective against goat damage.

2.2.4 Other Products and Services

Establishing living fences provide other direct and indirect benefits. Diguera (1977), reported the neem to be a principal tree for village wood plantations. It provides firewood, forage and other products like tannins and construction wood, when planted as fence species. He further reported that *Acacia spp.* are good in the exploitation of marginal lands.

Mintz (1962), reported on the testimony of peasant farmers in Haiti that if a crop is put into the land on which sisal had been growing, it does well particularly in he second and third harvests. The sisal roots rot and break up in the first year after they die, enriching the soil for future crops. He again reported that the fruits of *Balanites aegyptiaca* and *Ziziphus* fence species are often sold in the market as food.

Baggio and Heuveldop (1984), investigated on the use of *Calliandra calothyrsus* live fence for forage. They reported that 7-10 tons of dry material per hectare per year is estimated to be produced on the live fence, and that it grows well with elephant grass (*Pennisetum purpureum*). Because of its attractive flowers, the live fence of *C. calothyrsus* is frequently used as ornamental plant and as forage for honey

bees.

Out of more than 20 plant species used for fencing reported by Crane (1945), only two produce a potentially commercial product. *Moringa pterygosperma* seeds produce medicinal oil and cashew nut (*Anacardium occidentale*) produce tannin and resin which are incorporated in glue as an insect repellant used in book binding. Vertiver - a grass species used for fencing is not eaten by animals except rats and peasants find that it makes good roof thatching and its roots render essential oils in Haiti (Mintz 1962).

Budowski (1987), reported that the use of living fence posts to attach rows of barbed wire is widespread in tropical America. Live fences are also used for the production of fuelwood, food, fodder and act as windbreaks. They protect wildlife and branches from the fences are used to establish more fences and to fill in the old fences. He concluded that some 92 live fences species have so far been identified in Costa Rica alone.

Liyanage et al (1988), reported that *G. sepium* stakes planted 25cm from pepper plants grown under coconuts were successfully used as live support for over 10 years. The *G. sepium* is planted as a living fence along the boundary of of a one hectare block of coconut plantation.

2.3 Live Fence Management

2.3.1 Plant Propagation

Plant propagation is mainly by seeds, cuttings and graftings (Hartmann and Kester 1989). They indicated that in

propagating and growing young nursery plants, the facilities and procedures are best arranged so as to optimise the response of plants to the five fundamental factors influencing their growth and development: light, water, gasses, temperature and mineral nutrients.

Water content is a very important factor in controlling seed germination. Below 40-60% of water in seed (Fresh weight basis), germination does not occur. Absorption of water depends on the availability of water in the surrounding medium (Shull 1916 and 1920). Higher temperatures normally increase water uptake. Respiring seeds at higher temperatures may therefore increase water uptake (Koller, 1972). The optimum temperature for germination in non-dormant seed of most plants is between 25-30°C.

Good exchange of gases between the germination medium and the embryo is essential for rapid and uniform germination. Studies by Pearse (1943 and 1946) with grapes showed that when stock plants were grown under phosphorus, potassium, magnesium or calcium deficiency, root formation in cuttings was poorer. However, with reduced nitrogen in stock plants, root formation by cuttings was increased.

The propagating material for hardwood cuttings should be taken from healthy, moderately vigorous stock plants growing in full sunlight (Donovan 1976). In a study by Thimann and Delisle (1939) of root cuttings of certain coniferous and deciduous species known to root only with extreme difficulty, it was concluded that the most important single factor

affecting root initiation was the age of the tree from which the cuttings were taken. Best results with root pieces (root cuttings) were taken from young stock plants (Donovan 1976).

2.3.2 Propagation of Live Fence Species

Moreno (1985), reported on *G. sepium* grown by stem or thin branch cuttings. The propagules were cut 50cm long and planted in furrows. Diguera (1977), reported that *C. africana* is planted from cuttings soon after the first few rains. *C. africana* is susceptible to rot if the ground is inundated, but its establishment is not problematic on well-drained soil. The optimal size for a cutting is one meter long and six centimeters diameter. The cutting is allowed to scab over for one week in the shade before being planted out.

Depommier (1985), indicated that *Ficus, Dracaena, Markhamia lutea* and *Vernovia amygdaline* are best propagated by cuttings but *Tephrosia* and *Flemingia spp.* by direct sowing of seed. Baggio and Heuveldop (1984), concluded that *C. calothyrsus* is reproduced for planting by direct seeding, seedlings or cuttings. Salazar (1988), reported that *G. sepium* is principally used for establishing live fences in Costa Rica. A brief account is reported on the propagation of this species by seeds and seedlings. Vegetative propagation is done by stakes and this method is principally used for establishing live fences in Costa Rica.

2.3.3 Spacing/Arrangement

Diguera (1977), recorded a spacing of 30cm of *B. aegyptiaca* and *Ziziphus* line living fence establishment and

indicated that it is relatively easier as they can be directly seeded. Moreno (1985), working on *G. sepium* live fence recommended one meter spacing to ensure at least 70% survival rate of stakes whilst direct seeds attained 90-100% survival. Depommier (1985), concluded that *Ficus, Dracaena, Markhamia* and *Vernonia spp.* planted every 30-40cm in trenches of which the bottom was broken up, enriched with dead litter and watered ensured species survival. Baggio and Heuveldop (1984), said *C. calothyrsus* seedlings were planted in lines at 25, 50, 100 or 200cm spacing within the lines. The fence produced greater biomass at the closer spacings.

2.3.4 Pruning\Pollarding

Depommier (1985), reported that regular cutting of *Tephrosia* or *Cajanus cajan* one or two times a year at one meter high reinforced the fence vitality and avoided debranching at its foot. Beer (1987), worked on the pruning regimes on traditional living fence posts in Costa Rica and Nicaragua. The pruning methods were to reduce shading of adjacent crops and to produce new posts for fence line planting. He concluded that pollarding in November of one year old *E. berteroana* posts (two months prior to the dry season) gave a 300% increase in dry season forage reserves than those pruned in March. Posts which were not previously pruned produced less forage but no difference in annual production of woody material resulted.

Beliard (1983), reported that in a 5-year-old fence posts of *G. sepium* established on a cattle farm, six-month

pruning interval gave a greater dry weight yield than three-month pruning interval.

3. MATERIALS AND METHODS

3.1 The Survey Area

3.1.1 Location

The Ashanti Region is the fourth largest of the 10 regions of Ghana (Figure 1). It belongs to the West African Tropical Humid Zone. It lies between latitudes 6° 00'N and longitudes 1° 45'W and 2° 39'W (Figure 2). The forest vegetation type is moist-semi-deciduous with Northwest and Northeast subtypes belonging to the *Celtis - Triplochiton* Association (Hall and Swaine, 1981).

3.1.2 Climate

The are is characterized by a bi-modal rainfall with a total of 1,200 - 1,800mm/year, which peaks in May-June and September-October. Temperature variation in the forest zone is rather slight. The mean monthly maximum temperature is in February or March and ranges from 31°-33°C and the mean monthly minimum (19°-21°C) occurs in December-January in the northern part and in August in the South. The seasonal difference of daily mean temperature is between 3°-4.5°C. Mean temperature on the summits of highest hills (600m above sea level) may be 3°-5°C lower than those of the surrounding plains. Elevation is generally between 150-600m above sea level.

3.1.1 Soils

The soil type is dominated by forest ochrosols. The soil pH is between 5 and 6 and the base saturation is generally higher (Hall & Swaine, 1981). The relief is of high sandstone of Voltaian rock. The highest summits are found along the Kwahu-Mampong scarp.

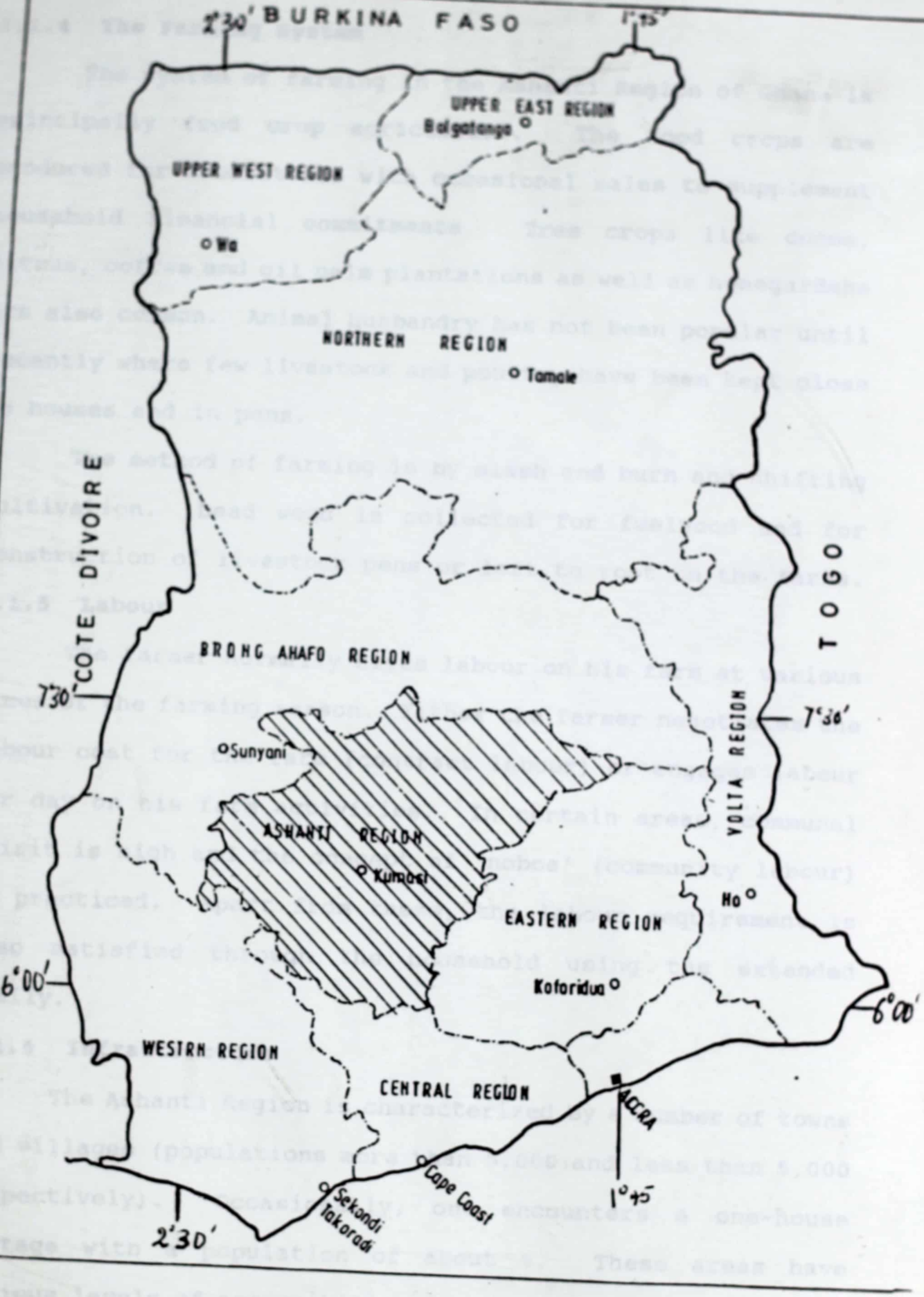

Fig. 1: Map of the Administrative Regions of Ghana, Ashanti Region represented by the shaded area.

3.1.4 The Farming System

The system of farming in the Ashanti Region of Ghana is principally food crop agriculture. The food crops are produced for subsistence with occasional sales to supplement household financial commitments. Tree crops like cocoa, citrus, coffee and oil palm plantations as well as homegardens are also common. Animal husbandry has not been popular until recently where few livestock and poultry have been kept close to houses and in pens.

The method of farming is by slash and burn and shifting cultivation. Dead wood is collected for fuelwood and for construction of livestock pens or left to root on the farms.

3.1.5 Labour

The farmer normally hires labour on his farm at various times of the farming season. Either the farmer negotiates the labour cost for the farm (contract labour) or engages labour per day on his farm activities. In certain areas, communal spirit is high and the concept of 'noboa' (community labour) is practiced. Apart from these, the labour requirement is also satisfied through the household using the extended family.

3.1.6 Infrastructure

The Ashanti Region is characterized by a number of towns and villages (populations more than 5,000 and less than 5,000 respectively). Occasionally, one encounters a one-house cottage with a population of about 6. These areas have various levels of accessibility depending on the presence of

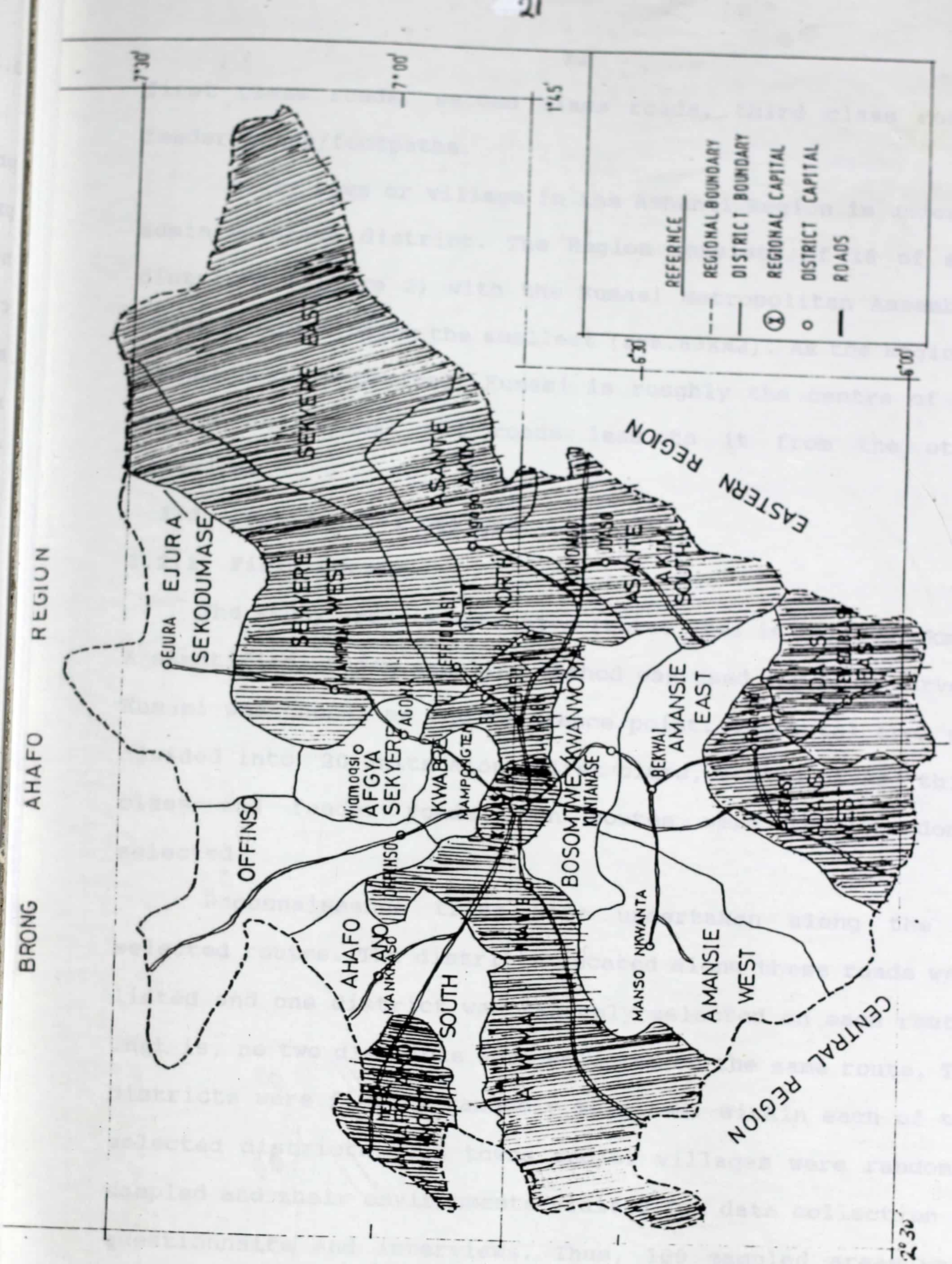

Fig. 2: Map of the 18 Administrative Districts of the Ashanti Region. The shaded areas represent the surveyed districts of this study.

first class roads, second class roads, third class roads, feeder roads/footpaths.

Every town or village in the Ashanti Region is under an administrative district. The Region consists of 18 of such districts (Figure 2) with the Kumasi Metropolitan Assembly, (KMA) district being the smallest (208.63km2). As the Regional Administrative capital, Kumasi is roughly the centre of the Region and almost all roads lead to it from the other districts.

3.2 Experimental Designs

3.2.1 Field Survey

The study area is extensive (total area is 24,390.00km^2). A stratified random sampling method was used for this survey. Kumasi was chosen as the reference point. The total area was divided into 20 units along first class, second class, third class and feeder roads. Ten routes were then randomly selected.

Reconnaissance trips were undertaken along the 10 selected routes. The districts located along these roads were listed and one district was randomly selected on each route. That is, no two districts were selected on the same route. Ten districts were finally randomly selected. Within each of the selected districts, ten towns and/or villages were randomly sampled and their environments visited for data collection by questionnaire and interviews. Thus, 100 sampled areas were covered for this study.

3.2.2 Propagation of Live Fence Species

The site for the study was the I.R.N.R. research farm (U.S.T., Kumasi). The experiments were carried out on eight identified live fencing plant species from the survey. the eight species subjectively chosen were: *P. dulce, c. siamea, G. sepium, E. cortinifolia, P. tithymaloides, Codiaeum spp., B. nivosa* and *R. communis*. These species were chosen because planting materials were readily available. The planting materials - seeds and cuttings (root and stems) were planted in single rows.

For each species, where seeds were available, they were planted in addition to their cuttings. The complete randomized design was used in the propagation experimentation. The proximal end of the stem cuttings were placed in the soil leaving at least one bud above the soil surface whilst with the root pieces, the distal end was placed in the soil. The root cuttings were inserted in the soil vertically so that the top was above the soil level as suggested by Donovan (1976). Twenty cuttings were planted for each species in a row or line and 100 seeds were sowed in each row and observed for a period of one month. The length of a row was 3m.

In another field experiment, two species (*J. curcas* and *S. mombin*) were propagated by stem cuttings. The stems of each species were divided into three sections: basal, middle and terminal. A factorial experiment involving the two species (*J. curcas* and *S. mombin*) and the three cutting sections (basal, middle and terminal) was carried out. A complete randomized block design was used. The cuttings were

established at 20.0 x 20.0cm spacing with five rows and each row measured one meter long. It was replicated three times in blocks. The duration of the experiment was one month.

3.3 Data Collection

Field data of the survey was collected by means of questionnaires and interviews. In the rural areas, the local vernacular names of the live fence species used were taken. In the urban areas, common names of the species were also recorded. All the species encountered in the survey were photographed. But only representatives of the species were produced in the text. Field measurements of heights and planting distances were done by using a graduated measuring pole and linen tape. These measurements were taken from the soil surface.

The history, uses of the live fencing species and the problems associated with them were also recorded. The ages of the live fences were categorized into two groups. That is, less than five years was described as "young" and over five years as "old". The experimental data on propagation were collected on the regenerations of each species and analysis of variance was performed. The effectiveness of the live fences were discerned from the photographs and the questionnaires.

3.4 Plant Species Identification

Local names and photographs of the live fence species were used in the identification procedure. Identification of the fence species was done with the help of Agricultural Extension Officers, horticulturists, foresters. Consulting the literature became necessary when there was difficulty with

proper identification or for confirmation.

3.5 Data Processing

The percentage representation of the live fence species under each characteristic was calculated over the total number of species identified in the study area. The fence species found in the urban and rural areas were also calculated as a percentage of the total species identified in the region. The occurrence of each species in the survey was calculated as a percentage frequency and presented as a histogram.

4. RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Live Fence Identification

The results of the identification of the live fences based on the scientific name, plant characteristics and the family name is presented in Table 1. Thirteen of the plants were trees, (61.91%), seven were woody shrubs (33.33%) and 4.76% were a succulent shrub. The species belong to thirteen different families and the *Euphorbiaceae* dominated (31.8%). There were three legume species: *Papilionaceae, Caesalpinaceae* and *Mimosaceae*.

In Table 2, 57.14% of the live fence species was recorded as exotic and 42.86% indigenous. the live fence species were present in both the rural and urban areas. In Figure 3, the percentage frequency of the live fence species are represented as a histogram. *Jatropha curcas*, an exotic species, was the most predominantly used for live fencing (13.3%) followed by *Draceaena arborea* (10.0%) an indigenous species, *Pithecelobium dulce* (8.7%) and *Thevetia peruviana* (6.7%) (exotic). *Ficus leprieuri* (6.0%) and *Bombax buonopozense* (5.3%) (indigenous) were also found to be widely used. *G. sepium*, a legume and a popular MPT in agroforestry systems is used for live fencing (7.3%) in the study area.

Table 1: The Characteristics of Identified Live Fence Species and their Families

Species Name	Tree	Woody Shrub	Succulent Shrub	Family
Dracaena arborea	*			Agavanaceae
Jatropha curcas	*			Euphorbiaceae
Ficus leprieuri	*			Moraceae
Bombax buonopozenses	*			Bombaceae
Markhamia lutea	*			Bignoniaceae
Cedrela odorata	*			Meliaceae
Spathodea campanulata	*			Bignoniaceae
Lannea welwitschii	*			Anacardiaceae
Spondias mombin	*			"
Acalypha torta		*		Euphorbiaceae
Ricinus communis		*		"
Pedilanthus tithymaloides			*	"
Gliricidia sepium	*			Papilionaceae
Cassia siamea	*			Caesalpinaceae
Thevetia peruviana	*			Apocynaceae
Caesalpinia pulcherrima	*			Caesalpinaceae
Barleria cristata		*		Acanthaceae
Codiaeum variegatum		*		Euphorbiaceae
Breynia nivosa		*		"
Euphorbia cortinifolia		*		"
Pithecelobium dulce	*			Mimosaceae
Percentages	61.91	33.33	4.76	

Ref. (Hawthorne, 1990 and Irvine, 1961).

Table 2: The origin of the Live Fence Species in the Ashanti Region of Ghana.

Species Name	Exotic	Indigenous
Dracaena arborea		*
Jatropha curcas	*	
Ficus leprieuri		*
Bombax buonopozenense		*
Markhamia lutea		*
Cedrela odorata	*	
Spathodea campanulata		*
Lannea welwitschii		*
Spondias mombin		*
Acalypha torta	*	
Ricinus communis		*
Pedilanthus tithymaloides		*
Gliricidia sepium	*	
Cassia siamea	*	
Thevetia peruviana	*	
Caesalpinia pulcherrima	*	
Barleria cristata	*	
Codiaeum variegatum	*	
Breynia nivosa	*	
Euphorbia cortinifolia	*	
Pithecelobium dulce	*	
Percentages of Origin	57.41	42.86

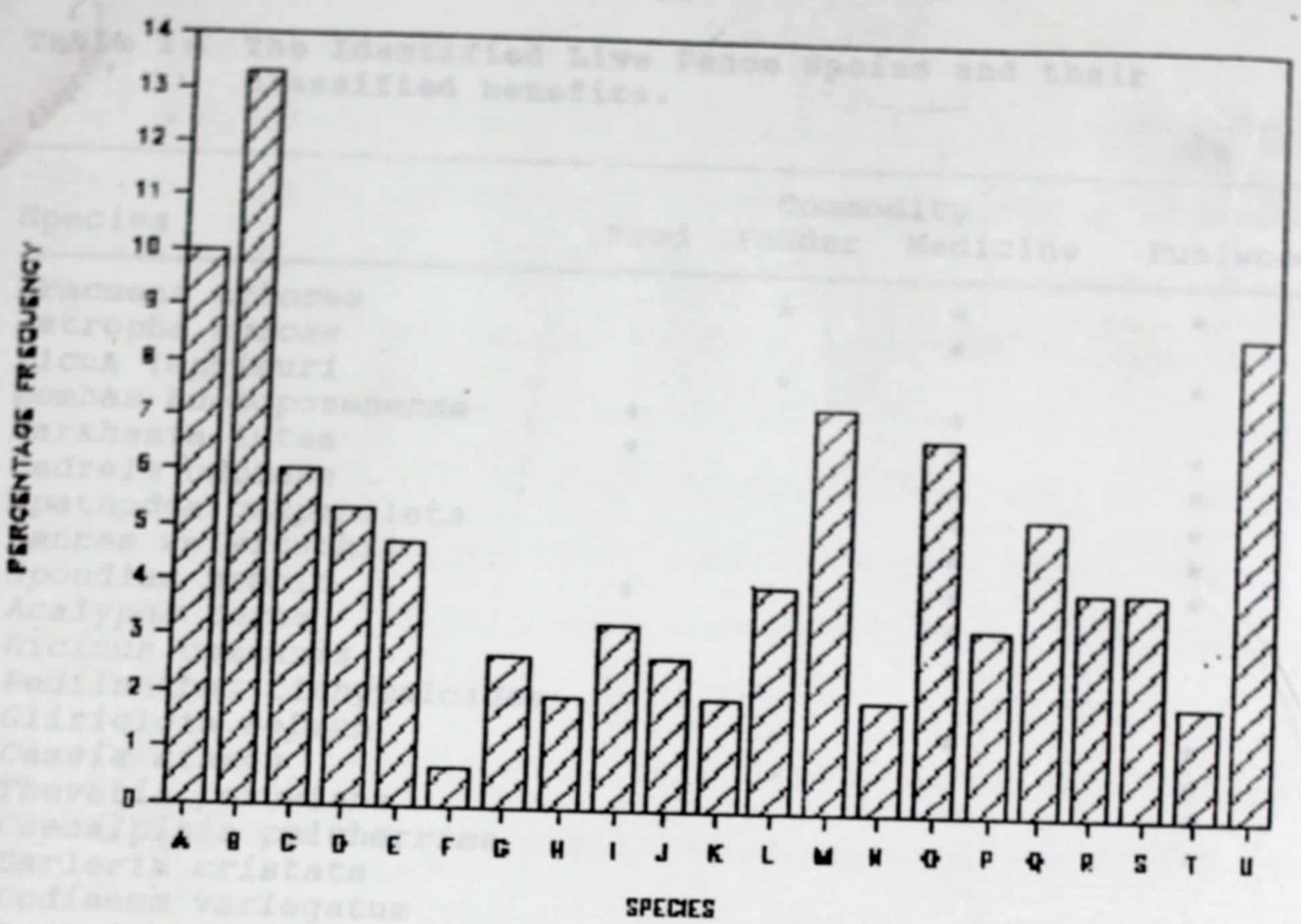

Fig. 3: The Relative Abundance of Live Fence species in the Ashanti Region (1992).

A Dracaena arborea
B Jatropha curcas
C Ficus leprieuri
D Bombax buonopozense
E Markhamea lutea
F Cedrela odorata
G Spathodea campanulata
H Lannea welwitschii
I Spondias mombin
J Acalypha torta
K Ricinus communis
L Pedilanthus tithymaloides
M Gliricidia sepium
N Cassia siamea
O Thevetia peruviana
P Caesalpinia pulcherrima
Q Barleria pulcherrima
R Codiaeum variegatum
S Breynia nivosa
T Euphorbia cortinifolia
U Pithecelobium dulce

Table 3: The Identified Live Fence Spcies and their classified benefits.

Species	Commodity			
	Food	Fodder	Medicine	Fuelwood
Dracaena arborea		*	*	*
Jatropha curcas			*	
Ficus leprieuri		*		*
Bombax buonopozenense	*		*	
Markhamia lutea	*		*	*
Cedrela odorata			*	*
Spathodea campanulata			*	*
Lannea welwitschii			*	*
Spondias mombin	*		*	*
Acalypha torta			*	
Ricinus communis			*	
Pedilanthus tithymaloides				
Gliricidia sepium		*	*	*
Cassia siamea		*		*
Thevetia peruviana				*
Caesalpinia pulcherrima				*
Barleria cristata				
Codiaeum variegatum				*
Breynia nivosa				
Euphorbia cortinifolia				
Pithecelobium dulce		*		*
Percentages of Commodity	14.29	28.57	57.14	61.90

MPTS Percentage 76.19

The species with other benefits apart for their current use as live fences is described as multipurpose tree or shrub.

[MPT(s)].

4.1.2 Roles and Functions

The primary role of a live fence is to form a physical barrier against trespassers and to protect or prevent destruction of agricultural products. Additional functions and benefits may be derived. In Table 3, some major products of the identified live fences are recorded. Food products formed 14.29%, fodder 28.57%, medicine 57.14% and fuelwood 61.90% out of the 21 plant species identified. *Acalypha torta*, *Breynia nivosa*, *Euphorbia cortinifolia* and *Pedilanthus tithymaloides* are used for fencing only.

The tree species in Table 1, are used for fuelwood (Table 3). The indigenous species (*B. buonopozense*, *M. lutea* and *S. mombin*) are the only ones used for food. Medicinal products are derived from both the exotic and the indigenous trees. The shrubs including the succulent *Pedilanthus tithymaloides* are of less use directly except for fencing. Thus, the identified fencing species that are multipurpose account for 76.19% of the species.

Table 4: The kinds of plant materials used for the establishment of the live fences in the Ashanti Region of Ghana.

Species	Seed	Stake	Stem	Natural Regeneration
Dracaena arborea		*		
Jatropha curcas	*	*		*
Ficus leprieuri		*		
Bombax buonopozenense		*		
Markhamia lutea		*		
Cedrela odorata	*	*		
Spathodea campanulata		*		*
Lannea welwitschii		*		
Spondias mombin	*			
Acalypha torta			*	
Ricinus communis	*			
Pedilanthus tithymaloides			*	
Gliricidia sepium		*		
Cassia siamea	*			
Thevetia peruviana	*			
Caesalpinia pulcherrima	*			
Barleria cristata	*			
Codiaeum variegatum			*	*
Breynia nivosa			*	
Euphorbia cortinifolia	*		*	*
Pithecelobium dulce	*		*	
Percentages	42.86	47.62	28.57	19.05

4.1.3 Management of the live fences

The propagules of the live fence species in the Ashanti Region comprise of seeds, stake and stem cuttings, seedlings and naturally regenerated seedlings. In Table 4, a greater number of exotic species are propagated by seeds (42.86%) except *G. sepium* which is also established by stake cutting. Stem cutting is also used for exotic species. Cuttings from some species easily take roots and are also naturally propagated by root suckers.

Stem cuttings is used for propagating most of the indigenous live fencing species. *Dracaena arborea* is

perpetuated by root regeneration. The seeds of the indigenous species are scarce, and store poorly. The longer time taken by seeds to germinate and establish as good live fence makes staking more attractive.

Seedling transplanting is not popular with live fencing except for *P. dulce* which is mostly grown as hedges in the cities and towns. Seedlings are produced for sale by Parks and Gardens Department in some urban areas.

Natural regeneration refers to situations where seedlings germinate under established hedges. In Table 4, *D. arborea* is shown to have high regeneration by roots and stems. *Barleria spp.* seedlings were found growing very close to the mother plants. *Breynia nivosa* also regenerates through root suckers. Such propagules are transplanted as and when found and needed.

The establishment of fences is based on digging trenches and holes. Seeds are broadcasted in the trenches and covered. Seeds of *J. curcas, C. siamea, Thevetia peruviana* and *P. dulce* are propagated this way. Stem cuttings of *Pedilanthus spp.* and *Breynia nivosa* (4cm long) are also planted in furrows. Posts or poles from stems and branches about 1.3m long are cut from the live fencing tree species. These stakes are driven into holes and secured firmly.

Spacing is usually irregular for all the live fences. The broadcast propagules sometimes form multiple lines whilst the fence posts or poles form single lines.

Table 5: Traditional Management Practices on the Live Fences in the Ashanti Region.

Species	X'tics	Pollarding	Trimming	Lopping	Prunning
Dracaena arborea	Tree				
Jatropha curcas	Tree	*		*	
Ficus leprieuri	Tree	*		*	
Bombax buonopozense	Tree	*		*	
Markhamia lutea	Tree	*			
Cedrela odorata	Tree			*	
Spathodea campanulata	Tree	*			
Lannea welwitschii	Tree			*	
Spondias mombin	Shrub		*		*
Acalypha torta	Shrub				*
Ricinus communis	Shrub	*	*		*
Pedilanthus tithymaloides	Tree	*		*	
Gliricidia sepium	Tree				
Cassia siamea	Tree			*	
Thevetia peruviana	Tree	*			
Caesalpinia pulcherrima	Shrub	*	*		
Barleria cristata	Shrub		*		
Codiaeum variegatum	Shrub		*		
Breynia nivosa	Shrub	*	*	*	
Euphorbia cortinifolia	Tree	*	*	*	*
Pithecelobium dulce					
Percentages		57.14	33.33	42.86	19.05

A good fence is established when watered during the dry season when rainfall distribution is poor. Most fences are established in the wet season. Weeding is done about three times in a year around the live fences. The fence line is thinned out (the broadcast propagules) and dead ones are replaced where big gaps are found. The thinning material is used to fill in the gaps.

The husbandary of the established live fence species are presented in Table 5. The tree species are pollarded (57.14%) and lopped (42.86%) at the beginning and during the rainy seasons (May - June and September - October) to reduce shading during the cropping periods (wet seasons). The shrubs species are also trimmed (33.33%) and pruned (19.05%) during the same periods. However, *D. arborea, S. campanulata, R. communis, T. peruviana, Codiaeum spp.* and *B. nivosa* do not receive routine management practices. *T. peruviana, Codiaeum spp.* and *B. nivosa* are trimmed and/or pruned when used in the cities as aesthetic hedges.

Table 6a: The Average Height (m) and Spacing (m) of the Tree Species used for Live Fencing in the Ashanti Region.

Species	Measurements (m)			
	Height	S.D	Spacing	S.D
Dracaena arborea	3.0	2.0	2.0	1.5
Jatropha curcas	5.0	3.0	2.0	1.6
Ficus leprieuri	2.5	0.5	1.5	0.5
Bombax buonopozenense	3.8	1.2	1.5	0.5
Markhamia lutea	3.0	1.5	1.0	0.5
Cedrela odorata	3.1	1.8	2.2	1.5
Spathodea campanulata	3.0	1.5	2.5	1.3
Lannea welwitschii	4.5	1.5	2.1	1.0
Spondias mombin	4.0	1.0	3.0	1.0
Gliricidia sepium	6.3	2.0	3.0	1.0
Cassia siamea	2.2	1.1	0.5	0.2
Thevetia peruviana	8.4	7.0	5.0	4.8
Caesalpinia pulcherrima	4.2	2.1	0.3	0.1
Pithecelobium dulce	1.8	1.2	0.5	0.1
Percentages	3.9	1.8	1.9	1.2
Coefficient of Variation	46.2%		63.2%	
Range	1.8-8.4		0.3-4.8	

Table 6b: The Average Height (m) and Spacing (m) of the Shrub Species used for Live fencing in the Ashanti Region.

Species	Measurements (m)			
	Height	S.D	Spacing	S.D
Acalypha torta	1.5	0.5	1.0	0.5
Ricinus communis	3.2	1.1	1.0	0.5
Pedilanthus tithymaloides	1.5	0.8	0.1	0.06
Barleria cristata	1.8	1.0	0.1	0.05
Codiaeum variegatum	1.5	0.5	2.0	1.3
Breynia nivosa	1.5	0.5	0.2	0.1
Euphorbia cortinifolia	2.0	1.0	0.4	0.2
Percentages	1.9	0.6	0.7	0.6
Coefficient of Variation	31.6%		85.7%	
Range	1.5-3.2		0.1-2.0	

In Table 6a and 6b, the heights of the livintg fencing and their planting distances are shown to be different. There is a high variability in the heights and spacing of the live fences (coefficients of variation are high particularly that for the spacing). However, the tree species are cut higher (average 3.9m) than the shrubs (average 1.9m). The planting distances of the living fences show a similar pattern. Thus, the tree species are spaced wider (average 0.7m). The wider ranges for the heights and the spacings show that the management strategies of the farmers are different.

Table 7a: The Stem/Branch morphology and the planting arrangement of the tree species used for live fencing in the Ashanti Region.

Species	Height at Branching	Morphology Stem/Branch Characteristic	Planting Arrangement
Dracaena arborea	-	Smooth	Single Line
Jatropha curcas	Medium	"	"
Ficus leprieuri	High	"	"
Bombax buonopozenense	"	Spiny/thorny	"
Markhamia lutea	"	Smooth	"
Cedrela odorata	"	"	"
Spathodea campanulata	"	"	"
Lannea welwitschii	"	"	"
Spondias mombin	"	"	"
Gliricidia sepium	Medium	"	"
Cassia siamea	Very low	"	"
Thevetia peruviana	Low	"	"
Caesalpinia pulcherrima	Medium	Spiny/thorny	"
Pithecelobium dulce	Very	"	"

Table 7b: The Stem/Branch Morphology and planting arrangement of the shrub species used for live fencing in the Ashanti Region.

Species	Height at Branching	Morphology Stem/Branch Characteristic	Planting Arrangement
Acalypha torta	Very low	Smooth	Single Line
Ricinus communis	High	"	"
Pedilanthus tithymaloides	Very low	"	Multiple "
Barleria cristata	"	Spiny/thorny	Single line
Codiaeum variegatum	"	Smooth	"
Breynia nivosa	"	"	"
Euphorbia cortinifolia	Low	"	Single line

Percentages:
Branching Heights

Very Low Branching (0-0.2m) = 33.33%
Low Branching (0.2m-1.0m) = 9.52%
Medium Branching (1.0m-1.4m)= 14.29% High Branching= (>1.4m)
No Branching = 4.76%

Characteristics		Planting Arrangements	
Smooth means no appendages	= 76.19%	Single Line	= 90.48%
Succulent means non-woody	= 4.76%	Multiple Line	= 9.52%
Spiny/thorny species	= 19.05%		

The live fence species are associated with some degree of branching except *D. arborea* (no branching and accounted for 4.76%). The tree species (Table 7a), exotics and indigenous (Table 2) branch at medium (1.0 - 1.4m) to high (> 1.4m) heights (14.29% and 38.10% respectively). The shrubs (Table 7b) have very low (0-20cm) to low (20cm - 1.0m) branching heights (33.33% and 9.52% respectively).

The Table 7a and 7b, 76.19% of the live fence species identified had no spines/thorns/prickles and only one was a succulent shrub (4.76%). Two of the four thorny species (*B. buonopozense, B. cristata, C. pulcherrima* and *P. dulce*) were leguminous (Table 1). The live fences were often established in single rows and represented 90.48% of the total species and 9.52% of the species were established in multiple lines or rows (*B. nivosa* and *P. thithymaloides*). *B. nivosa* naturally regenerate by root suckers and the *P. tithymaloides* also by the stem if it touches the soil. These characteristics make them double rows if even grown initially in single rows.

Table 8: The Common agents of Destruction of the Live Fences other than Livestock

Species	Fire	Insect	Plant Parasite	None
Dracaena arborea				*
Jatropha curcas				*
Ficus leprieuri	*	*		
Bombax buonopozenense	*			
Markhamia lutea	*			
Cedrela odorata	*			
Spathodea campanulata				
Lannea welwitschii				*
Spondias mombin		*		
Acalypha torta				*
Ricinus communis				*
Pedilanthus tithymaloides				*
Gliricidia sepium		*		
Cassia siamea		*	*	
Thevetia peruviana	*	*	*	
Caesalpinia pulcherrima	*	*		
Barleria cristata	*	*	*	
Codiaeum variegatum				*
Breynia nivosa				*
Euphorbia cortinifolia				*
Pithecelobium dulce	*	*		
Percentages	42.86	33.33	14.29	42.86

The most common agents of damage to the living fencing species are fire (42.85%) and insects (33.33%) (Table 8). Only 14.28% of the live fence plant species were attacked by plant parasites. The number of species identified to be resistant to these agents was high and 42.86% were found to be free.

4.1.4 Propagation Methods

Table 9: Germination and/or Regeneration Percentage of some Identified Live Fence Species in the Ashanti Region. 1992.

Species	Planting Material		
	Seeds (n=100)	Root Cuttings (n = 20)	Stem Cuttings (n = 20)
Pithecelobium dulce	100	0	85.7
Cassia siamea	50.0	0	85.0
Gliricidia sepium	-	0	100
Euphorbia cortinifolia	-	0	28.6
Pedilanthus tithymaloides	-	0	87.5
Codiaeum variegatum	-	0	57.1
Breynia nivosa	-	25.0	57.1
Ricinus communis	20.0	0	0

Results of the initial propagation studies of the eight identified live fence species is recorded in Table 9. Seeds of *P. dulce* and *C. siamea* were readily available and germination was 100% and 50% respectively. The seed germination of *R. communis* was low (20%). The seeds of the other species in Table 9 were not available. Root cuttings of *B. nivosa* showed 25% regeneration. Root cuttings of *R. communis, P. dulce, C. siamea, G. sepium, E. Cortiniforlia, P. tithymaloides* and *C. variegatum* however failed to regenerate. The stem cuttings of *R. communis* also failed to regenerate. However, stem cuttings of *P. dulce* (85.7%), *C. siamea* (80%), *G. sepium* (100%), *P. tithymaloides* (87.5%), *C. variegatum* (57.1%) and *B. nivosa* (57.1%) showed good regeneration. The *E. cortinifolia* stem cuttings regeneration was poor (28.6%).

Table 10: The Percentage Sprouting (n=75) of Cutting Sections of *Jatropha curcas* and *Spondias mombin* after one month Planting in October, 1992.

Species	Stem Cuttings		
	Basal Section	Middle Section	Terminal Section
Jatropha curcus	89.3	76.0	78.7
Spondias mombin	2.6	1.3	1.3

From Table 10, *J. curcas* generally sprouted well from all the stem cutting sections; Basal 89.3%, Middle 76.0% and Terminal 81.3%. Conversely, stem cuttings of *S. mombin* failed and very low sprouting (2.6% for the basal section and 1.3% each for the middle and terminal sections) was recorded.

Table 11: Analysis of Variance (ANOVA) Table of the generation of *J. curcas* and *S. mombin* Stem Cuttings Grown for one month. 1992. n=75.

Source of Variation	df	ss	ms	F_o [1]
Blocks	2	4.00	2.000	0.7326
Treatment	5	1837.20	367.440	134.5934*
Species (1)		1820.06	1820.060	666.6886*
Cutting Sections (2)		10.33	5.165	1.8919
Spp cutting interactions (2)		6.81	3.405	1.2473
Error	10	27.30	2.730	
Total	17			

*Significant at (P <0.01). Offset figures in brackets are partitioning of the df's and sum of squares for treatments, and are therefore not included in the Total at the bottom of the table.

The ANOVA (Table 11) showed that there was significant

difference betweeen the two species in their regeneration from cuttings and also the portions of the stem used as planting material produced significant differences.

Plate 1: Markhamia lutea, Dracaena arborea and Jatropha curcas (right to left) live fence around a home garden at Woraso near Kumawu. 1992.

Plate 2a: Dracaena arborea live fence marking the boundary of building plot at Apeadu. 1992.

Plate 2b: Dracaena arborea live fence posts around a prayer ground at Apeadu. 1992.

Plate 3a: Jatropha curcas live fence at Woraso near Kumawu. 1992.

Plate 3b: Jatropha curcas live fence posts in Mampong protecting a homegarden. 1992.

Plate 3c: Jatropha curcas live fence posts in marking a building plot at Effiduase. 1992.

Plate 4: Euphorbia cortinifolia live fence around a homegarden at Woraso. 1992.

Plate 5: Young Ricinus communis live fence protecting a vegetable farm at Woraso. 1992.

Plate 6a: Spondias mombin live fence post and bamboo rails protecting a Parish farm at Donyina. 1992.

Plate 6b: Gliricidia sepium live fence posts and bamboo rails protecting a Parish farm at Donyina. 1992.

Plate 7a: Thevetia peruviana live fence hedge bordering a religious shrine at Penteng. 1992.

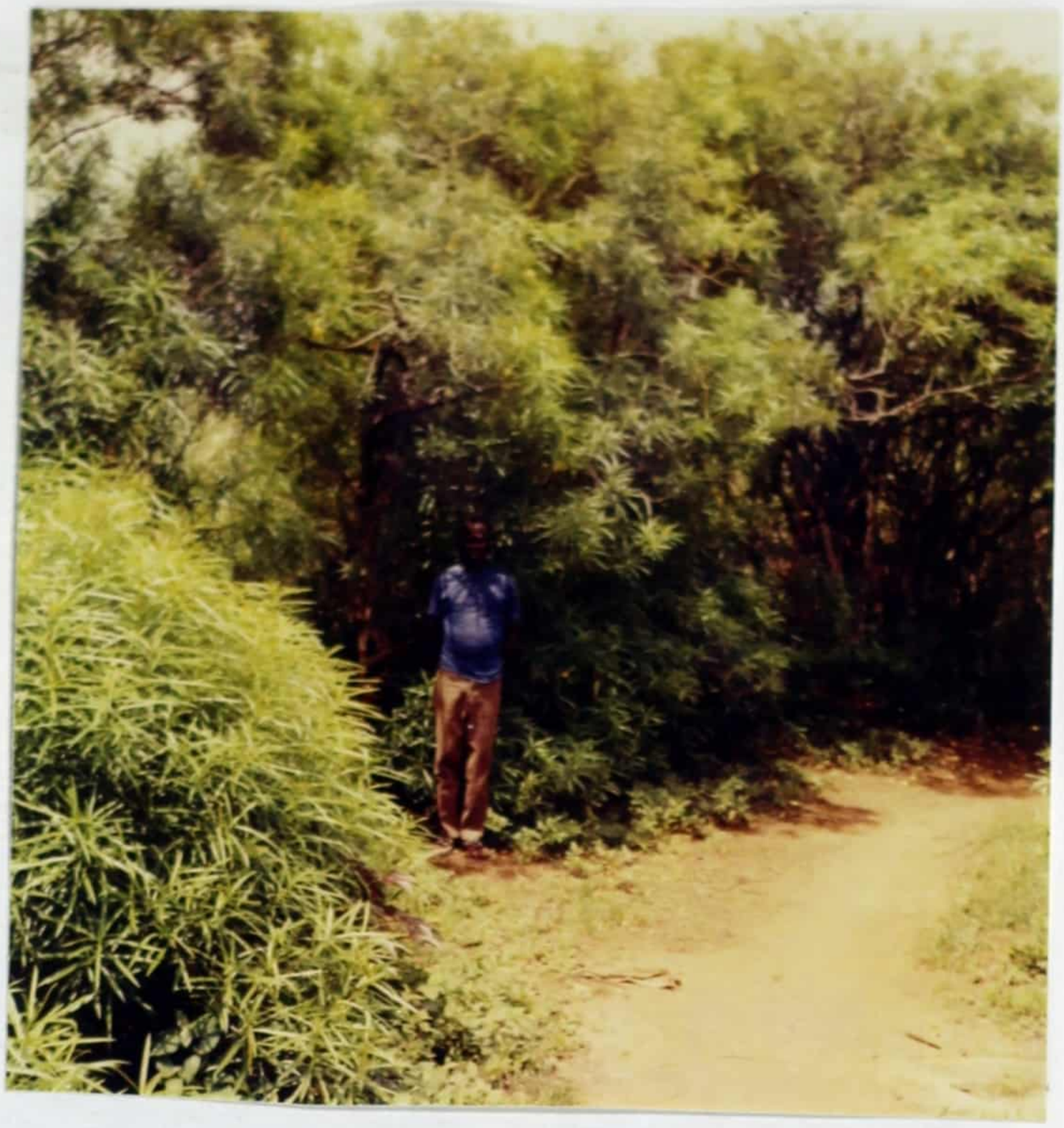

Plate 7b: Thevetia peruviana Live fence as a piggery barrier and a boundary marker at Woraso. 1992.

Plate 8: A wooden fence for pigs supplemented by Thevetia peruviana hedge at Nwowadan. 1992.

Plate 9: Wooden, M. lutea and B. buonopozense live fence posts around a bathhouse at Nnama village. 1992 1992.

Plate 10: Spathodea campanulata, Cedrela odorata live fence posts protecting a vegegable garden at Appah. 1992.

Plate 11a: Ficus leprieuri live fence post at Kyekyewere. 1992

ate 11b: Ficus leprieuri live fence posts with rails of midribs of oil palm frond around a homegarden at Kyerekyewere. 1992.

Plate 11c: Coppicing Fence posts of Ficus leprieuri joined with rails of bamboo battens to protect a backyard garden at Krofa. 1992.

Plate 12a: Pedilanthus tithymaloides. A succulent shrub live fence around a raphia fenced village bathplace at Appah. 1992.

Plate 12b: A Pedilanthus tithymaloides live hedge established from succulent stem cuttings at New Edubiase. 1992.

Plate 12c: A two months old Pedilanthus tithymaloides live hedge planted close to the wall of a house at Yonso. 1992.

Plate 13: Caesalpinia pulcherrima live fence on a J.S.S. School compound at Abesewa. 1992.

Plate 14a: A shruby and thorny live hedge, Barleria spp. enclosing a homegarden in Kumasi. 1992.

Plate 14b: Barleria spp. protecting a Parish prayer arboretum against intruders and harmful animals at Juaso. 1992.

Plate 15a: Shruby and spiny Barleria cristata live hedge bordering a walking pavement in Juaben. 1992.

Plate 15b: Poorly managed and maintained Barleria cristata in front of a house at Nkawie. 1992.

Plate 16: Acalypha torta live hedge used for landscaping a building site at Opoku Ware Secondary School, Kumasi. 1992.

Plate 17a: A well-managed Thevetia peruviana live hedge along a road at Kononge. 1992.

Plate 17b: Thevetia peruviana live hedge as a boundary marker, and a barrier at Opoku Ware Secondary School, Kumasi. 1992.

Plate 18: Breynia nivosa live hedge bordering one of the roads on the Agogo Hospital compound. 1992.

Plate 19: Lannea welwitschii live fence post supporting Raphia battens at the FORIG Guest House, Akotaa. 1992.

Plate 20a: Pithecelobium dulce live hedge that has been severely grazed by livestock on the U.S.T. Campus, Kumasi. 1992.

Plate 20b: Well-Managed Pithecelobium dulce for aesthetic on St. Andrews School compound in Mampong. 1992.

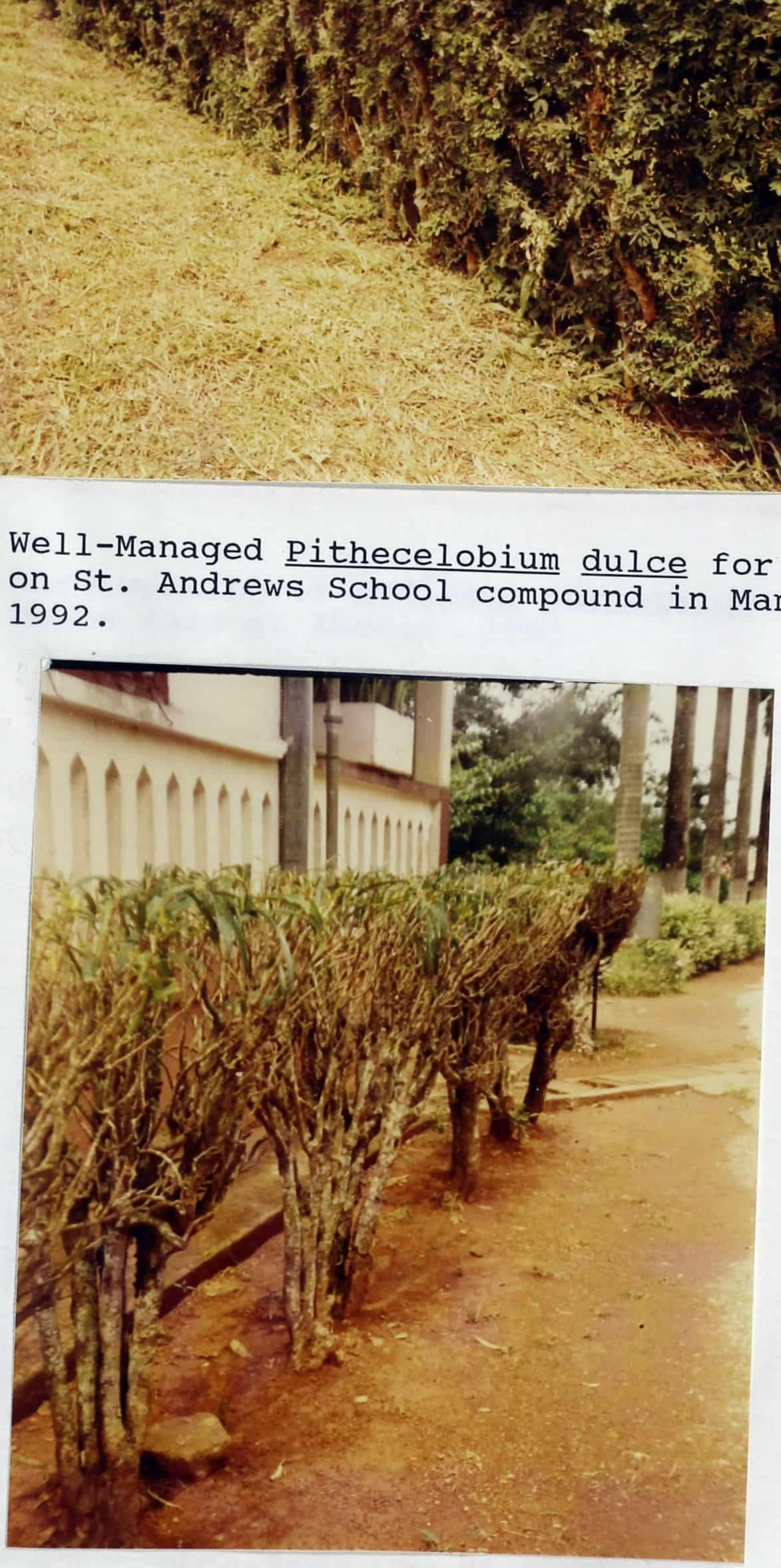

Plate 20a: A 20 year-old Codiaeum variegatum living fence for decoration at the Agogo hospital. 1992.

Plate 21b: Wide spacing of Codiaeum variegatum plants on a cocoa farm at Akotaa. 1992.

Plate 21c: A boundary marker of Codiaeum variegatum between owner cocoa farms at Akotaa. 1992.

Plate 21d: Cassia siamea hedge demarcating the boundary of the Handicap School compound at Kwadaso, Kumasi. 1992.

Plate 21e: Thevetia peruviana and Cassia siamea hedge as a boundary marker on the Handicap School compound at Kwadaso, Kumasi. 1992.

Plate 22d: A wooden piggery corral at Nwowadan. 1992.

Plate 23: A wooden fence enclosing a plantain homegarden at Tepa. 1992.

Plate 24: Conventional concrete fence posts with wire railing at the U.S.T., Kumasi. 1992.

Plate 25: A wire net fence with veneer wood core as support posts protecting a backyard garden at Ayigya, Kumasi. 1992.

shows that *D. arborea* posts take up rails without a problem and hold the bamboo battens. The fence is effective in construction and isolates mediatators from attractive agents in the environment. However, the bamboo requires replacement once a year. Large gaps are created when they become old and collapse. In such a situation (as seen in the plate) absolute isolation is not realized.

Plates 3a, 3b and 3c are *Jatropha curcas* live fences. The growth of *J. curcas* is good but maximum crop protection is not offered by it alone (plates 3a and 3b). Bamboo layers or rails are constructed in between the live fence posts to avoid invasion of crops by livestock. In plate 3c, *J. curcas* living fence posts is supplemented by lumber posts and rails. The lumber layers are raised up to 0.6 meters. The combination of these fencing materials makes the fence effective in preventing animals from crossing over the fence line is also the boundary of the building plot and protection is given to the food crops grown in the forecourt of the house. Branches of the *J. curcas* are cut and used as live stakes for yam in the garden.

Plate 4 depicts *E. cortiniforlia* as an effective live fence species, however, a large gap is found as a result of failure to replace dead plants. To make it livestock proof, a large plank is used to close up the gap created at the base of the living trees.

The *Ricinus communis* live fence grows well and could be used effectively for live fencing. However, it may not grow very close together as may be required. It could however be

4.2 Discussions

The establishment of live fences has been a traditional practice in Ashanti Region. The "Operation Feed Yourself" (OFY) agricultural campaign in 1972 contributed to sporadic fencing either for demarcation of land units - boundary planting, to confine livestock in corrals or to protect homegarden crops from animal destruction.

Throughout the survey, the selection of species for the living fences was found to be based on the availability, familiarity of the species and just adopting what is in use. However, all such selected live fence plants species are able to regenerate, germinate or coppice easily and have long life spans. Usually single line (except for *Pedilanthus spp*) planting is adopted for fencing and gaps are closed up with other available materials.

The effectiveness of the live fences to accomplish desired goals could be discerned from the photographs taken. In plate 1, the live fence species of *M. lutea, D. arborea* and *J. curcas* were not closely planted but the protective role as a fence is achieved. Plantain and cassava crops are protected against livestock destruction. The branches and branchlets of the plant species involved and the *D. arborea* leaves interlock to close up what otherwise would have been gaps.

In plate 2a, the long and large leaves of D. arborea compensate for the unbranched tree. The fence is effective as a human barrier but not to stubborn livestock and crawling animals. As the tree ages, the older leaves drop to expose large gaps especially when planted at wide spacing. Plate 2b

supplemented by other railing materials e.g bamboo, raphia or palm fronds as shown in Plate 5.

The live fence posts of *S. mombin* and *G. sepium* coppice well (Plates 6a and 6b). They support bamboo railings and weaves. The bamboo however requires yearly replacement for an effective fencing against crop destruction by livestock and against human trespassers.

In Plate 7a, *T. peruviana* live hedge delimits the sacred grounds of a religious priest. It serves as a human barrier to unauthorized trespassers. However in plate 7b, the live fence of *T. peruviana* marks the boundary for piggery husbandry (left). It also provides shade to the pigs and prevents them from escaping from the confined area.

Pigs in villages are usually kept in pens (plate 8). the corral of the wooden fence and the *T. peruviana* live fence provides the necessary protection. *T. peruviana* provides shade to the pigs, checks erosion of the soil preventing the creation of escape routes for the pigs possibly under the wooden fence. In plate 9, the fence posts of both living (*M. lutea* and *B. buonopozense*) and dead wooden materials provide support for coconut and oil palm fronds fencing around the bath house. The living posts effectively prevent erosion and flooding around the bath place. The coconut and oil palm fronds require replacement every two months and the wooden posts are replaced every year.

Vegetable gardens near homesteads need to be protected against trespassers. Plate 10 shows a vegetable homegarden that is fenced with *Cedrela odorata* and *Spathodea campanulata*

live posts as support for midribs of oil palm fronds. The fence is made effective by tying the rails of the midribs of oil palm fronds with fibre ropes from tree barks. The regeneration or coppicing of *C. odorata* and *S. campanulata* fence posts is good and the rails are changed annually as they break or decay. This offers adequate prevention for livestock entry into the garden.

Ficus leprieuri live fence post is used for fencing backyard gardens in most villages in the Ashanti Region. The rails of midribs (oil and raphia palm fronds) are constructed by tying them onto the fence posts. Oil palm fronds may be used in between the rails to ensure maximum protection of crops from livestock grazing (Plate 11a). The rails are tied up close together to prevent livestock passage (Plate 11b). The coppices from the *F. leprieuri* live fencing posts are pruned during the dry season to feed livestock. In plate 11c, the *F. leprieuri* posts had recently been lopped to feed livestock and they are coppicing well. The posts are joined with bamboo rails and secured with nails. Livestock and man cannot pass through (without destroying the fence) as the rails are nailed closely together. The cut branches are used for firewood.

A village "bathhouse" is located in the centre of a compound (plate 12a). The *Pedilanthus tithymaloides* fence species is grown around the bath to serve as a drying hedge. It also reduces flooding and erosion of the surrounding. It ensures adequate partitioning and thus screens off passers-by. The *P. tithymaloides* hedge in plate 12a was established from

stem cuttings on a ridge. The objective was to hold the surrounding soil together and prevent erosion. In addition, it serves as a barrier, a boundary marker and prevents erosion. To achieve these services, it was necessary to establish multiple lines or rows.

C. pulcherrima live fence is common on school compounds. It checks erosion, livestock avoid passing through such fences due to the presence of thorns or prickles on the stems and branches. It screens off students view beyond the school compound. However, it is easily neglected as shown in plate 13. The plate species is commonly used in biology classes and nature study. The aesthetic value of this live fence plant species is exhibited by the different colours of its flowers. The Pride of Barbados (as it is often called) living fence is known to repel snakes and other harmful animals.

The *Barleria spp.* (plate 14a) protects a homegarden even though it has weak stems. The stems are erect with long slender branches. It is effective due to the presence of thorns and sometimes, snakes, livestock and man find it difficult to trespass however short the fence may be. *Barleria spp.* (plate 14b) is often established as a hedge fence to protect prayer grounds of Parish Centres. It is maintained by trimming at a height of 1.2m. this effectively blocks the view of people passing by. The species suppresses the growth of weeds, controls erosion and marks the boundary of the prayer grounds.

A well-maintained *Barleria cristata* live hedge (Plate 15a) is established along the walkway to a church entrance at

Juaben. It checks erosion of the sloppy terrain and provides good aesthetics by its shape and flowers to the church surrounding. In contrast, plate 15b is a poorly-maintained and poorly managed *B. cristata* hedge at Nkawie. This was supposed to have contributed to the aesthetic value to the surrounding of a bungalow. Poor management leaves the fence very unattractive.

Plant species are used in landscaping especially at building sites. Plate 16 shows an ornamental plant, *Acalypha torta* being used as such. The aesthetic value is appreciated however, the spacing was not close enough to serve as a barrier to effectively prevent people walking across the hedge row. It also reduces erosion of the top soil.

Thevetia peruviana live hedge is well maintained (plate 17a) and contribute to the beauty of the environment. it is pruned regularly (during the wet season) to maintain constant and uniform height (1.0m). It checks erosion of the roadsides. Plate 17b shows a recent cut or loppped *T. peruviana* hedge. When properly managed, it is used as a barrier, a boundary marker and the cut stems used for firewood.

A beautiful and well-knitted *B. nivosa* live hedge is established along a road at Agogo Hospital. It checks erosion, prevents walking through the live hedge (fence) and adds beauty to the hospital environment. It is interesting to note that the fence is 20 years old (Plate 18).

Lannea welwitschii live posts have the ability to coppice well. This is observed in plate 19. The raphia rails

are tied up with a fibre rope to the living fence posts to provide security at the FORIG guest house at Akotaa. Similarly, *Pithecelobium dulce* live hedge is used, but as a result of overgrazing by stray livestock on the U.S.T. Campus, Kumasi, a low live fence of *P. dulce* (height 1.0m) (Plate 20a) has been severely devastated. The supposed hedge has lost its value and importance completely. Poor management of fences could lead to disastrous results. On the contrary, in plate 20b, a well managed *P. dulce* live hedge contributes to the beautiful St. Andrew's School compound at Mampong.

A variety of *Codiaeum variegatum* live fence hedge was established 20 years ago (plate 21a) on Agogog Hospital compound. It has been a well-maintained hedge, and erosion could have been very bad if the hedge had not been there. This is evident at the bases of the hedge plants. Even though, some of the roots have been exposed, the soil is able to support the hedge and vice versa. Its aesthetic contribution is however still significant. Another variety of *C. variegatum* species is used to mark a boundary on a cocoa farm (plates 21b and 21c). The planting distance is irregular ranging between 1.5 - 2.0m. This effectively marks the boundaries between two neighbouring cocoa farms. It grows well under the canopy of the larger trees and has been used well over 25 years without any occurence of land disputes.

Cassia siamea live hedge marks the boundary of the Handicap School compound and effectively leaves the major road at the front of the school well separated. It is mixed with *T. peruviana* and managed well to delimit free movement of the

handicapped children from the school. It reduces the noise made by vehicles moving on the road.

Lumber, a fencing material is used to contain pigs (plate 22). It requires regular replacement as the pigs rub or scratch their bodies against the fencing rails. The fences sometimes break and the pigs escape from the confinement. Lumber fence posts and midribs of raphia palm fronds are also used (plate 23). the railings are secured by nails onto the fence posts. The life span of such a fence is about five years if durable lumber like Odum (*Melicia excelsa*) posts are used. It is most effective against livestock entry if the rails are changed after the fifth year. Stealing crops from such fenced gardens is also prevented. However, the price of durable lumber keeps rising and most people cannot afford it.

Concrete pillars are erected and barbed wires are passed through them to form a horizontally tiered wire fence (plate 24). This is effective against larger animals (e.g cattle, horses etc.) but not smaller livestock. Such a fence has longer life but the establishment cost is high. Farmers would not adopt this fencing technique around homegardens as they cannot afford it.

Veneer wood core or lumber is used as fence post and wire net is passed around them (plate 25). The wire netting is secured by nails onto the wooden posts. This is effective for crop protection against all trespassers including man. The wooden posts however, decay faster and require regular replacement (once every two years). The wire net is also very expensive. This fencing is mostly adopted in cities around

small gardens where the destruction by poultry on free range is great.

The irregularity of the cutting heights of the live fencing species in use may be due to the different management practices imposed on the species. It may also be based on their use(s) or the age of the fence. In plates 3b, 3c, 7b, 9, 10 and 11c, the tree species used for live fencing are cut high to provide the required security. However, in plates 1, 2a, 4, 5, 8, 17a, 17b, 20b, 21d, 21e, the trees are cut low.

The height of the shrub species in plates 12a, 12b, 12c, 14a, 14b, 15a, 16, 18 and 21a are relatively lower. The morphology of the shrubs may not have permitted cutting at greater heights or the management strategies employed on them may have restricted their heights. However, the ages of the live fences may have accounted for the lower heights in general. For example, in plates 1, 2a, 3a, 11b, 12c, 14a and 19, the young plant species are shorter.

The live fences for facades (plates 18, 20b and 21a) are cut to more or less uniform heights and they add beauty to the environment. The heights of unmanaged live fences especially for barrier, security or protection are generally taller (Plates 6b, 7a, 7b, 8, 13, 19, 21b and 21d). It was observed that the trees; *P. dulce, T. peruviana, C. pulcherrima* and *C. siamea* (exotics) if well managed, could be maintained as hedges by early and frequent cutting whilst the indigenous species, *B. buonopozense, M. lutea, F. leprieuri, D. arborea, S. mombin* and *S. companulata* are difficult to be maintained as such. This may be due to their slower growth and their bigger

stem sizes when established.

The planting techniques of the live fences may depend on the morphology of the species. The wider spacing of the tree species (averaging 1.9m) may have depended on the anticipated sizes when old (plates 3c, 9, 10, 11c, 17b, 19 and 20a). They may not be effective as fences against trespassers due to the wide gaps created as the species mature or branch at above 1.0m from the ground. Hence, dead wooden rails are secured by tying with a rope, nailing or weaving with oil palm fronds or bamboo onto the live fence posts to serve the intended use(s) of the fences (plates 2b, 3a, 3c, 4, 5, 6a, 6b, 10, 11a, 11b, 11c and 19).

The lower branching system of the shrub species and/or their stem/branch sizes whether old may have allowed closer planting distances (0.7m). Thus, they are most sutiable for erosion control, well netted to prevent trespasses. they may however be at a disadvantage if greater heights are required to ensure effective fencing (plates 12b, 12c, 14a, 14b, 15a, 16, 18, 20b and 21a).

Thorny species may be established quite close together and be rendered effective as passing through may be difficult for man and/or livestock. Plant species that can naturally regenerate either by root suckers or stem cuttings required no special planting technique during propagation. Such plant species may be well knitted even if they are widely spaced (plates 12a, 12b, 12c, 14a, 14b, 15a and 18).

Hartmann and Loreti (1965), reported that seasons of the year can have in some instances dramatic influence on root

cuttings. This may explain why many of the root cuttings regeneration was not successful. The experiments were carried out in the minor season close to the dry season (October) where seeds of the species were scarce (Table 8). The low regeneration recorded for *R. communis* seeds may be attributed to the season of propagation, the nature of the seeds, or the water contents of the seeds and soil were too low to have encouraged germination as suggested by Shull (1916 and 1920). The cut stems of *R. communis* showed large and spongy pith. It may have dried out easily in the dry period affecting the viability.

In Table 8, it may be suggested that propagation of *J. curcus* may be successful with stem cuttings. Enough food reserves may be concentrated in the regions of the stem to ensure regeneration and the species is drought hardy. It may also tolerate high temperatures. Koller (1972), commented that plant propagules are sensitive to high temperatures. The low survival of *S. mombin* cuttings could be due to the age of the stem and the season of planting. The propagules may have had difficulty in taking roots early and may require more than one month for sprouting successfully. However, the recorded regeneration percentages even though low, suggest that vegetative propagation may be good in the wet season or growth hormones may be applied to stimulate early root formation and development.

4.3 Conclusions

Farmers are using a number of plant species for live fencing for various purposes such as protection, barrier,

erosion control, food, fodder, fuelwood, medicine, aesthetics and as boundary markers. In many cases, live fence posts are established and made effective (where physical barrier is the objective) by supplementing with wood (lumber), or rails of dead materials like fronds of oil palm or coconut or their midribs, bamboo, etc. This is because of the gaps that are left in the live fence lines or rows due to poor establishment techniques or management or by the premature death of established plants.

The proper management of the live fences could also be very important. However, information for proper management practices is limited. The choice of species is principally based on what is available and/or what species are seen to be used by others. Stakes of various lengths are used for live fence posts and planted at irregular spacing. Tree species for live fences are left taller and spaced wider than the shrub species. Where seeds are available, they are sown directly by broadcast in trenches or in furrows. Pruning, pollarding, trimming or lopping is done at the beginning of the rainy seasons and/or during the rainy seasons or as and when desired. When to start cutting, how often to cut in a year and how high to cut the live fence is left to the owner not necessarily based on the aim for which the live fence was established.

The analysis in table 11 suggests that species regenerated independently from their basal sections planting materials. Therefore, live fences of *S. mombin* and *J. curcas* may be established from their vegetative parts. The basal

regions of the stem cuttings are more suitable for rapid regeneration. From the text, live fences could be classified into two main categories i.e., live fence hedges and live fence posts.

Live fencing establishment must therefore be encouraged as cost may be reduced, the useful life of the fence may be increased and the added trade-off benefits may be superior to other forms of fencing in the Ashanti Region of Ghana.

4.4. Further Research Needs

1. More information should be collected on live fences in Ghana to cover the other ecological zones.
2. Experiments should be conducted on identified live species: i.e., propagules, propagation techniques and the fence management practices that would satisfy the intended uses effectively.
3. Attention should be paid on more legumes and the MPTS for live fencing.
4. Costs and benefits analyses should be performed on live fences and compared to other forms of fencing.

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APPENDIX

QUESTIONNAIRE

TRADITIONAL LIVE FENCES IN ASHANTI REGION

Route: .....

Town:.....

District: ..... Distance from Kumasi (Km):

.....

(A) Information on the spp.

1. Species name (Vernacular): ..... Exotic ( )

2. Species name (Scientific): ..... Indigenous ( )

(B) Phenological behaviour

Month	J	F	M	A	M	J	J	A	S	O	N	D
1. Growth Cycle												
2. Flowering												
3. Fruiting												
4. Leaf shedding												

5. Comments: .....

(C) History

1. Year of establishment: 19.... 2. Planting materials

3. Age of Fence (yrs)..... (a) Natural Regeneration ( )

4. Nursery Practices & Planting (b) Direct sowing( )

1. Germination to field (c) Cuttings ( )

Planting (months) ..... (d) Stake cutting( )

2. Planting distance ..... (e) Root cutting ( )

(spacing) (f) Leaves ( )

3. Planting arrangement ..... (g) Others .....

Reason for choice.....

(D) Tree

1. Coppicing ( )
2. Pollarding ( )
3. Trimming ( )
4. Lopping ( )
5. Pruning ( )
6. Time (months/yr) .....
7. Height of Pruning .....
8. Why this Mgt. .....

.....

.....

(E) Uses

1. Edible leaves ( )
2. Edible fruits pods ( )
3. Fodder ( )
4. Medicinal ( )
5. Barrier:

   Security ( ) Livestock ( )
6. Poles ( )
7. Others (specify) .....

.....

(F) Problems

Susceptible to:

1. Browsing ( )
2. Rodents damage ( )
3. Termites ( )
4. Wind ( )
5. Fire (seeding only ( )
6. Fire (general) ( )
7. Epiphytes/Parasites( )

Insect Damage

8. Insect Species .....

.....

9. Fungal Damage ( )

(G) Observational Records

1. What is the usefuliness/effectiveness of fence?

   .....

2. Why this spp. but not others? .....

   .....

3. What are the other good substitutes (in order of preference)

1. ..... 3. .....

2. ..... 4. .....

Why? .....

5. Morphological Characteristics

1.	Spiny/thorny ( )	5.	Multi-branches ( )
2.	Single-stemmed ( )	6.	Stem form .....
3.	Multi-stemmed ( )	7.	Buttressed stem ( )
4.	Low crow base ( )	8.	Crown form .....