PN-AAR-317
ISN-30118

EXCERPTS

from

Evaluation of and Recommendations for Research on Fast-Growing Tree Species for Wood Energy Production in the Dendro-Thermal, Charcoal Production and Gassification for Irrigation Projects.

Technical Report by Michael D. Benge, Bureau for Science and Technology, Office of Forestry and Natural Resources, A.I.D., Washington, D.C., an outcome of a consultancy from Nov. 27 thru Dec. 4, 1982, on Request of USAID/Manila.

February 1, 1983

CONTENTS (Cont.)

APPENDICIES	No.
Proposed Asian Research Network - A.I.D.	.... G
Nitrogen-Fixing Trae Species	.... H
Planters	 I
Advantages & Disadvantages of Root Trainers, etc.	.... J
Mycorrhizae May Save Fertilizer Dollars	.... K
Hillside Ditching	 L
Living Firebreaks	.... M
Rat Control	.... N
Tree Pruners	.... O
Zig Zig Air Seed Seperators	.... P
Vegetative Propagation of Leucaena	.... Q
Fuelwood Production Based on Soil Taxonomy	.... R

CONTENTS

Page No.

Section 1 -- Technical Appraisal of the Dendro-thermal, Charcoal Production and Gassification for Irrigation Projects

A. Introduction
B. Objectives 1
C. Technical Assistance
D. Research 2
E. Management
F. Recommendations 3

Section 2 -- Research Recommendations

A. Introduction 5
B. Research Design 6
   1. Base-line data 7
   2. Soil amelioration 8
   3. Species, Provenance and Variatial Trials ... 10
      Leucaena ... 11
   4. Tree Improvement and Seed Orchard Establishment... 12
   5. Plantation Establishment and Management
      a. Nursery and Establishment Practices ... 14
      b. Site Preparation and Weed Control
      c. Coppice Management ... 16
      d. Soil Engineering and Water Management
      e. Spacing Trials ... 17
      f. Agroforestry (intercropping)
      g. Ground Covers ... 18
      h. Fire Control
      i. Rat, Ant and Termite Control ... 19

BIBLOGRAPHY ... 21

APPENDICIES No.

Leucaena Seed Improvement .... A
Seed Improvement .... B
Vegetative Propagation (to include tissue culture) C
Biodata -- Research Design and Layout Person .... E
Biodata -- Agronomist .... F
Job Description -- Plant Geneticist and Tree Improvement Specialist .... G

1. Base-line data

It is imperative that base-line data be generated for all sites so research results can be adapted to site conditions. Such base-line data should include rainfall, altitude, temperature and soil tests.

Soil profiles and analyses should be made on all sites. The profiles should average no less than 1 profile per hectare with samples collected down to the C horizon (parent material, approximately 90 to 120 cm). The profiles should be taken at depths of surface to 20 cm; 20 cm to 50 cm; and 50 cm to 120 cm. The profiles should average 1 per hectare where there isn't any apparent change in the topography or surface soil type. Where changes are noted the number of profiles

per hectare should be adjusted to identify the changes. Soil analysis should include pH, for both macro and micro nutrients and moisture-holding capacity (ref. no. 2 below and Section 2-B.3.c.).*

2. Soil amelioration

Regardless of the genetic potential of the plant materials, optimum yields will not be obtained unless adequate levels of soil nutrients are available. Continued harvest of trees will mine nutrients from the soil. Most of the sites have nutrient poor soils, not capable of sustaining yields in perpetuity. If these sites are marginal for agricultural production, they are also marginal for sustained tree production. A great share of the abandoned cogan lands were once farmed by Kaingeros. They were abandoned because crop yields could not be sustained. Approximately 70 kg. of phosphorus (p), 330 kg. of potassium (k), and 57 kg. of sulfur (s) are removed from the soil when 12 cubic meters of dry biomass is harvested from one hectare of land (10). Other nutrients important for maximum tree growth are removed also. Most of these nutrients can be returned to the soil in the Dendro-thermal project if the ashes from the furnaces are pelletized (for ease of handling and shipment) and returned and applied to the tree plantations.

Soil analysis is very important if maximum wood production is to be obtained from Leucaena and other fast growing trees. Phosphorus is an essential nutrient for plant growth.

Most tropical soils are low in phosphorus. Phosphorus is important for root development and research has shown a direct relationship between phosphorus availability and nitrogen fixation. The application of small amounts of Boron (on boron-deficient soils) has proven to dramatically increase the growth rate of some trees. The micro nutrient molybdenum is necessary to activate Rhizobium and nitrogen production in nitrogen-fixing trees.

* Based on recommendations of Dr. Mark Hutton, expert Leucaena agronomist and soil scientist and has over 20 years experience with adapting Leucaena to adverse soild conditions. Formerly at Commonwealth Scientific and Industrial Research Organization of Australia, Dr. Hutton has recently completed five years research on the adaptation of Leucaena to acid soils at CIAT in Cali, Colombia. He will continue his work at IMBRAPA in Brazil.

Low levels of calcium in the surface soil material (20 cm to 1 m) can be a major limiting factor in root development and deep root penetration which will result in poor performance of Leucaena on acid sites. Adequate amounts of nutrients are important not only for the maximum growth of Leucaena, but are equally important for the growth of all trees.

Foliar analysis is an excellent and easy field method for determining nutrient deficiency in a tree or plant. By analyzing the nutrients in the leaves one can determine if the tree is taking up adequate amounts of specific nutrients. However, it is important to choose leaves that are relatively new and fully expanded and not older leaves. The plant will rob older leaves of nutrients and shift them to the newer leaves.

Foliar analysis is valuable only if information is available on which nutrients are essential for the maximum growth of a specific species of trees (such as Ca for Leucaena). However, it will not tell you if you have adequate amounts of these nutrients to sustain yield production. Also, some nutrients may be available in the sub-soil but not in the upper strata. If the roots do not reach the nutrients available at a lower level, the growth of the tree can be retarded. Such is often the case with Leucaena and Ca in acid soils (3). Also, foliar analysis may not give an accurate indication of micronutrients, such as Mg, Fe and Mo. Molybdenum (Mo) deficiency will show up as a nitrogen deficiency, indicated by yellow leaves.

Is soil amelioration economically feasible? Can one afford to fertilize trees under Philippine conditions? Perhaps the question should be asked, "Can one afford not to fertilize?" In the case of some necessary nutrients (such as Mo), soil amelioration is very inexpensive. Only by experimenting and by comparing fertilized plots of trees to unfertilized plots and by costing out inputs vs returns can this question be answered.

Many tree species require the same levels of nutrients. There are some exceptions such as in the case of Mo which acts as a catalyst to maximize nitrogen production of Rhizobia in nitrogen-fixing trees. The Rhizobia can produce adequate levels of nitrogen to satisfy the trees' requirements. Nitrogen is an essential nutrient. However, nitrogen-fixing trees do not need another source of nitrogen. Much of the research information concerning nutrient requirements can be transferred from one species to another. However, nutrient availability will differ from site to site and some tree species will give a greater response to a specific nutrient than others.

Soil taxonomy is being used as a tool by some researchers to determine soil similarities between sites to predict performance of tree species (Tab R). This can be a useful tool, however, soil nutrient levels will vary between sites (even with similar soils) thus growth rates of trees will still vary.

The importance of fertilization on impoverished tropical soils has been demonstrated by research in Colombia, where NPK contributed substantially to sustained improvement in the rate of growth and general vigor of Eucalyptus grandis. Plots receiving boron as well as NPK produced 7 times greater yields of straight poles than plots receiving no boron (18). Applications of 50 gm. of NPK (10-30-10) and 5 gm. of boron to Eucalyptus grandis and Pinus oocarpa seedlings at transplanting time significantly increased initial growth and helped the young trees get ahead of the weeds and grass. By this means, the number of post-planting cleanings necessary to establish a plantation was reduced. The difference of magnitude was such with E. grandis that the researcher concluded this species should not be planted without the combination of NPK and boron. The plantation of E. grandis on the research site without any fertilizer was a complete failure. Other results recorded in the experiment were that without boron there were three times as many forked trees as in the plots where 5 gm. boron was applied, and the incidence of terminal dieback was reduced with the boron application (19).

The greatest growth variability within a species will be effected by establishment practices, plantation management (such as coppicing), and seed quality.

3. Species, Provenance and Variatial Trials

Species trials are necessary to determine which types of tree will perform best on specific sites. Management practices (such as the ability of a tree to produce a high yield coppice crop) will be another determining factor in species choice. Species trials research must incorporate soil information so that trial results are valid. Therefore, baseline soil data and analysis is necessary before conducting species trials.

Ideally, one should conduct provenance (sub-species) trials of tree species. The Oxford Model is one of the most frequently used designs for provenance trials. However due to the genetic diversity of most tropical forests and widespread deforestation in many areas, it will be difficult to follow the Oxford model, which is based on the collection of seeds from 100 trees in one contiguous area. For many of the fast-growing tree species, it may be difficult or impossible to find 100 trees in one location, or be confident that the seed source will still exist

when the trials are completed (due to the rapid rate of deforestation).

However initial species and provenance trials can be launched by using seed collected from superior mother trees that have shown desirable characteristics. A standardized species trial design should be adopted, so that research results can be compared with results obtained from other sites and with results obtained by other researchers elsewhere in the Philippines and Asia. USAID and other organizations are now attempting to facilitate a research network in Southeast Asia. Standardized research design and methodologies must be a basis for this networking if the exchange of research data is to be of value.

A number of fast-growing trees (some are nitrogen-fixers), give a high cubic meter yield on a short rotation and are excellent sources of wood/charcoal energy. Leucaena leucocephala is well known; but it should not be considered as a panacea. It will not give sufficient yields on some sites (especially the more acidic ones) to meet the wood/energy requirements of the various projects. Other fast-growing species, such as Albizia, Gliricidia, Pithecolobium and Casuarina, may do as well or better than Leucaena on certain sites or on some portions of the same site. This can only be determined through species trials that incorporate soil conditions into the research design.

On some sites preliminary observations may indicate that one species outperforms another. However, research could prove that the species that yielded poorly on the unameliorated plots will outyield the other species with moderate soil amelioration at an affordable cost.

Whenever possible, nitrogen-fixing trees should be planted, for nitrogen is an essential plant and tree nutrient (Appendix H). Most tropical soils lack adequate amounts of nitrogen, which is essential for maximum production and sustained yield of short-term tree crops.

Leucaena

Research has proven that Leucaena is not the "Miracle Tree", as it has so often been touted, but like any other agricultural crop (such as corn), it requires specific agronomic inputs to maximize production and sustain yields (2)(3)(4). These inputs include:

a. Pure seed of known pedigree with the genetic capability for maximum wood production.

b. Well-drained soils with a pH above 6.

c. Adequate levels of macro and micronutrients available in both the upper and sub-soil strata, (such as P, Ca, Mo, Mg, K, S, Zn, Cu, and Fe).

d. Adequate nursery (or field) and establishment practices and plantation management (1)(3).

Each of the above can be considered a sub-system, the whole of which comprises the system within which Leucaena thrives. Maximum wood production and yield will not be obtained if a subsystem is not functioning properly.

On some sites, Leucaena may grow well at the lower portion of the hills, on deeper soils with less slope or on secondary forest areas with a higher organic matter content. Leucaena may not grow well on steeper slopes, which have poorer and shallower soils, while other species will (9).

Leucaena should be planted only on those sites where it grows well for maximum wood production. However on some sites, it may not be economically feasible or cost-effective to plant Leucaena. On these sites other species may produce higher yields.

It is possible to grow Leucaena on more acid soils, with a pH of 5.5 to 6 (even as low as pH5). However these soils often lack the necessary levels of nutrients and will require soil amelioration with fertilizers such as superphosphate and dolomite (1)(3). These inputs may be impractical or prohibitive in some areas of the Philippines.

This does not mean that Leucaena should not be tried on the sites that need soil amelioration. Some Leucaena varieties may perform surprisingly well. But in order to obtain yields projected to meet requirements and demands of the Dendro-thermal, Charcoal Production and Gassifiers for Irrigation Project, sufficient quantities of other tree species that show promise on these sites should be planted first.

4. Tree Improvement and Seed Orchard Establishment

Adequate quantities of quality seed of a known pedigree are necessary and must be the basis for any sound tree/crop improvement program. Additionally, base-line data for each site must be gathered (soil profiles, pH and nutrient analysis) and incorporated in species trials design or valid and useful research data will not result.

It is recommended that the three projects jointly employ a plant geneticist (plant or tree) who would be in charge of a tree improvement program, and would work under the overall research director (ref. Section 2 Research Recommendations, A. Introduction).

Genetic improvement can give gains of 10 to 30 percent in yield in the first few generations, and generations can be as short as 2 to 3 years for some tropical trees (20). A tree seed improvement program can produce immediate results within the first year by simply using quality seeds or other plant material from select trees that have shown desirable characteristics, such as fast growth and straight trunks. This is not only seed (and plant material) from Leucaena, but from all tree species. This means that project implementation and planting schedules will not have to be delayed.

It is imperative that sufficient quantities of quality seeds of all fast growing species, that are appropriate for planting in the Philippines and have the genetic capability of fast growth and high yield, be developed. Sufficient quantities of this seed must be readily available on the local level for the yield demands of the Dendro-thermal, Charcoal Production and Gassification for Irrigation project to be met.

An intensive effort should be launched to enlarge and improve the germ-plasm base of fast growing and nitrogen-fixing trees for future plantings in the Philippines. This collection should not only be made in the Philippines but it should be on regional and on an international basis as well. This effort should include the collection, testing, evaluation, selection, improvement and reproduction of the most promising germ-plasm.

Fuelwood research has been identified as one of four major research priorities of A.I.D at a recent A.I.D. conference to identify fuelwood research needs. The improvement of the germ-plasm base for fuelwood species was a high priority.

A great number of the fast growing and nitrogen-producing trees out-cross, therefore they express genetic inheritance from both parents. Thus all trees grown from seeds from one outstanding mother tree may not express similar characteristics. Some tree species, such as Leucaena leucocephala are largely self-pollenating (Leucaena is estimated at 95%) and are easy to breed and while others are more difficult and take a longer time to set seed. Seeds from trees that are out-crossers will have only 50% of the genetic charactistics of the mother tree, therefore several years may be required to produce seeds with genetic uniformity.

5. Plantation Establishment and Management

a. Nursery and Establishment Practices

(1) Direct seeding, bare-rooting, containerization, and vegetative propagation are four methods used for tree establishment.

(a) Direct seeding may be an effective means of plantation establishment for some tree species, such as Leucaena. It is cost-effective and the roots are not damaged when transplanted (which can affect tree growth at a later stage). Ground preparation becomes most important in direct seeding.

One method that has proved effective in some places in the Philippines is to plow a double furrow with a buffalo-drawn plow and direct seed into the furrow, as one does with corn. It is most important to break up the top soil to enhance root establishment and reduce weed/grass competition.

Post hole or auger hole planting combines advantages of nursery propagation and direct seeding. A post hole digger or an auger is used to make a hole in the ground 5 or 6 inches deep. The soil is mixed with organic matter and appropriate nutrients are added. In the case of nitrogen-fixing trees, molybdenum is added to the mixture, phosphorus is added to those soils deficient in the nutrient (almost all soils), calcium is added for trees like Leucaena for establishment on acidic soils, and nitrogen is added for non-nitrogen-fixing trees. The soil is placed back in the hole and a scarified seed inoculated with the appropriate strain of Rhizobium (if necessary) is placed in the hole at the onset of the rainy season. A modified corn planter can make direct seeding easy. A corn planter can easily be fabricated in the Philippines (reference Appendix I).

This method is very advantageous, for root development is enhanced by the added phosphorus (and calcium in the case of Leucaena on acidic soils). Research has shown that tree establishment and growth can be enhanced by the

hole size and other site preparation (15)(17). This method will also enhance initial growth of seedlings, giving them a faster start, thus an edge over competing weeds.

(b) The bare-root method of planting trees has been used for some species of trees. Seedlings are very light and large numbers can be carried by one person to the planting site. However, the roots dry out easily, the root hairs and some roots may die, and the seedling will suffer from transplant shock, making it a slow starter and a poor competitor with weeds and grass.

(c) Root trainers have many advantages over plastic bags and bare-rooting, such as reduced weight (compared with plastic bags), little or no root damage, a higher rate of survival, and seedlings start faster and compete better (a more detailed comparison is given in Appendix J).

(d) Vegetative propagation (detailed in Appendix C).

(2) The presence of the appropriate strains of Rhizobium and Mycorrhizae will enhance tree growth and reduce nutrient and fertilizer requirements to sustain high volume wood yield.

(a) Rhizobium have the ability to fix nitrogen and are usually associated with legumes as well as with <u>some</u> non-legumenous trees (such as Casaurina). It is important that nitrogen-fixing trees are inoculated with the appropriate strains of Rhizobium which will make it unnecessary to fertilize with nitrogen. Most tropical soils are deficient in nitrogen, and trees will not grow well without it. Inoculation with Rhizobium can be done either in the nursery or in the field and it is a cheap insurance to inoculate in order to protect the investment in tree planting.

(b) <u>Mycorrhizae</u>

The research program should include research on <u>Mycorrhizae</u>. Mycorrhizal fungi facilitate the uptake of phosphorus and have the ability to transform unavailable forms of phosphorus

into forms available for plant uptake. Most tropical soils are phosphorus-poor, and adequate levels of phosphorus are necessary for maximum tree growth. Mycorrhizal fungi facilitate the uptake of other nutrients as well (Appendix K).

In the absence of Mycorrhizae, tree growth is limited. It has been hypothesized that appropriate strains of Mycorrhizae usually associated with trees are absent from cogan lands (Imperata cylindrica) that have been without trees for a prolonged period of time. The presence of appropriate strains of Mycorrhizae will help sustain yields without fertilizer. Also, Mycorrhizae will facilitate the more efficient use of fertilizer applied to trees, thus reducing fertilizer costs.

b. Site Preparation and Weed Control

Site preparation and weed control are important elements in plantation establishment, seedling survival and growth rate of trees. On lands dominated by Imperatar cylindrica, it is important to burn off the grass and break up the grassroot mass to allow good root establishment of the seedlings, to reduce competition for space, water, nutrients and light and to increase water infiltration and soil aeration (11)(12)(13). Research has proven that the elimination of the sod of grasses and the loosening of the soil favors the establishment and growth of trees.

Inadequate weeding causes trees planted on grasslands (15) to quickly show signs of ill health and poor growth (14). Where the herbicide (Roundup) was used to control grass in a three year old tree plantation, there was a significant growth improvement the following year (16). Trees planted on grasslands previously dominated by tenacious grasses but eliminated by intensive site preparation had 574% more volume after three years than trees planted in the same area with minimum site preparation (17). This research shows that site preparation is important and cost effective.

c. Coppice Management

The yield of some trees, such as Eucalyptus, decreases after the second or third coppice generation (18). When Eucalyptus is cut during the dry season, coppice regeneration results in up to 25% stump mortality (14).

12

It has been reported that some species of Agoho (Casuarina) coppice poorly and the coppicing ability of many other excellent fuelwood species, such as Acacia mangium, is unknown. Therefore, long-term research data is necessary to provide reliable data to choose species which will produce yields to meet projected wood demands for the various projects.

Initial observations in the Philippines indicate that Agoho (Casuarina) grows better on some sites than Leucaena and could provide adequate yeilds from the first harvest to meet projected needs at some Dendrothermal Plant sites. However, if Casuarina does not produce a good coppice yield, future harvests will not be sufficient.

Pat Dugan, Forestry Advisor, has observed that Casuarina regenerates better after cutting if a longer stump is left. This management practice is termed pollarding (lopping of branches in contrast to cutting the trunk closer to the ground, leaving a much shorter stump), which may provide an adequate volume of coppice yield but may be an uneconomical method of harvesting on steep slopes because of the size of the log. One the other hand with soil amelioration, other trees such as Leucaena may give equal or higher yields than Casaurina and produce a log that is more economical to harvest and haul. However, research to prove or disprove this will require a 6 to 8 year continuing and well disciplined research program. This is not indicated in the present TA package.

d. Soil Engineering and Water Management

Although most targeted plantation sites receive adequate rainfall, the rainfall pattern is uneven, the soil is compacted and water infiltration into the soil is poor. Therefore, maximum yields will not be sustained as sheet erosion will occur, resulting in soil and nutrient loss. Tree yields on many sites can be increased by increasing water infiltration through simple soil engineering techniques such as contoured hillside ditching (see Appendix L). Erosion problems will be reduced and the contoured ditches can be formed into catchments, which could provide water for fish ponds or food crops.

e. Spacing Trials

Optimum spacing of trees for maximum fuelwood yield has already been determined for some species. Spacing

trials for species such as Leucaena are well on their way at the University of Hawaii. However, these trials are being conducted on deep soils on relatively level ground and the results may not be appropriate for steep hillsides with shallow soils, as will be found on some plantation sites in the Philippines. Additionally, the spacing may vary for the production of stems (logs) that will be economical to remove from the plantations by the proposed cable systems and trucked to the conversion plants.

Optimum spacing for Leucaena for wood production will probably not be the same as for Casaurina, Albizia, Gliricidia, Pithecolobium, etc. Spacing trials data for some of these species may be available through organizations such as the UN/FAO or the International Development Research Center (IDRC, Canada). However, spacing will have to be adjusted for Philippine site conditions and for end user. Spacing may be different if different stem size is required for each of the end user, dendro-thermal power plants, charcoal conversion units and the gassification units. It also will be influenced by the harvesting systems designed for the various sites.

f. Agroforestry (intercropping)

Farmers who are growing the trees for the various projects will also be growing food crops for subsistence. These food crops could be grown between the trees in the plantations (sometimes referred as the taungya system) which may benefit the trees because the farmers would keep the weeds and grasses out of the plantations.

However, food crops would compete with trees for essential plant nutrients, such as phosphorus. This could be avoided by providing the farmers with subsidized fertilizer for application to their food crops. The trees would also benefit from this fertilizer, increasing the growth of trees on nutrient-poor soils. The food crops would serve as a cover crop and reduce erosion. Research would have to be conducted to see if the benefits in increased tree growth are cost-effective and culturally feasible. Food crops could only be grown for one year at which time the trees would shade out food crops.

g. Ground Covers

It is recommended that a research effort be launched to develop and determine appropriate shade-tolerant ground

covers for interplanting under various kinds of trees used in the wood energy plantations.

Trees, unless planted in engineeringly sound systems with adequate ground cover, do too little to prevent soil erosion. A good canopy will reduce raindrop impact and organic litter will help reduce sheet erosion. However, the fine leaves of Leucaena and many other trees are poor interceptors of raindrops. Some trees like Leucaena will fold their leaves periodically (always at night and generally during storms), further reducing the leaf area for interception of raindrops. Also, the fine leaf litter decomposes rapidly, resulting in inadequate mulch to reduce sheet erosion.

Some legumes, such as Desmodium ovalifolium and Aeschynomene indica (local) and some grasses, such as Stenotaphrum secundatum (St. Augustine grass) are shade-tolerant and may work well as ground covers in wood energy plantations.

h. Fire Control

Fires can cause extensive damage to newly established tree plantations. Firebreaks cleared by hand or machinery are expensive to maintain; therefore other alternatives should be tried. Prior to plantation establishment, the grass on the plantation site and surrounding area should be burnt off.

Leucaena (both common and giant types) and Calliandra densely planted in rows spaced 1 to 1 1/2 meters apart will serve as effective live firebreaks. (Four rows may be required.) The rows should be prepared by plowing (buffalo or cow) and the seed dibbled into the edge of the furrow. The paired rows will form a canopy and shade out the grass providing a living firebreak (see Appendix M).

i. Rat, Ant and Termite Control

Rat, ant and termite damage to seeds and newly planted seedlings (especially Leucaena) has been reported in newly reforested areas. The most heavy damage seems to be plantings in Imperata (cogan) lands. This damage can be prevented or greatly reduced by certain preventive measures.

Rat populations are directly proportional to available cover (in which they hide and reproduce) and food

supply. Cogan grass is excellent ground cover for rats and should be burnt prior to plantation establishment to reduce rat populations. Rats relish tree seeds and newly sprouted seedlings, which are often the only green plants in the area. Rat populations can be controlled by placing out bait traps as one does for rice, corn or other field crops (ref. Appendix M).

The chemicals thiram and aldrin applied to tree seeds have been found to be effective against rodents, and endrin has been used to repel both insects and rodents (7)(8). The fungicide thiram is applied as a seed coating to repel birds (8).

Endrin has been used to protect seeds against ants and dieldrin and aldrin have been effective against ants and termites. Dusts containing 5% chlordane, 2 1/2% aldrin, 2 1/2% heptachlor or 1 1/2% diedrin has been effective against termites when applied around the base of trees. Chlordane is effective against termites in mounds. However, chlordane has a residual effect and the Environmental Protection Agency has banned its use in the United States without a special waiver.

Biblography

1. Leucaena Wood Production and Use: a guide to the production and use of wood from the versitile shrub and tree, Leucaena leucocephala. prepared by the Los Banos Manual Team in preparation for the Leucaena Workshop. Singapore. Nov. 22-26, 1982 and will be published by the Nitrogen Fixing Tree Association, Waimanalo, Hawaii (in press).

2. Benge, M.D.. The Miracle Tree: Reality or Myth?. paper presented at Leucaena Workshop. Singapore. Nov. 22-26, 1982. Leucaena Workshop (Singapore) Proceedings. International Development Research Center. Singapore (in press).

3. Hutton, E.M.. Selection and Breeding of Leucaena for Very Acid Soils. paper presented at Leucaena Workshop. Singapore. Ibid.

4. Halos, S.C.. Ipil-ipil-The Wonder Ceases. Canopy International. Sept. 1980.

5. Brewbaker, J. L.. The Problem of Seed Contamination and Adulteration. as cited by I.C. Pagsuberor his article: Expert Warns Against Leucaena Seed Mixture. Leucaena Forum International. PCARR Los Banos, Laguna, Philippines.

6. Perry, T.O. Maternal Effects on the Early Performance of Tree Progenies. Tree Physiology and Yield Improvement, Academic Press. 1976..

7. Dalmacio, M.V.. Chemical Protectants for Benguet Pine Seeds Against Rats. Unpublished Masters' thesis. College of Forestry. UPLB Los Banos, Philippines, 1974.

8. Sowing Forests from the Air. National Academy of Sciences. Washington, D.C., 1981.

9. The Leucaena planting established by Mabuhay Agro-forestry Corporation in Illegan, Mindanao is a classic example of Microsite growth differences.

10. Felker, P.. et. al.. Screening Prosopis (Mesquite) Species for Biofuel Production on Semi-arid Lands. Final Report to the U.S. Department of Energy for Period 1, April 1978 thru 30 March 1981.

11. Buckman, H.O. and Brady. 1960. The Nature and Property of Soils. McMillan Co., New York.

12. Kramer, P.J.. 1969. Plant and Soil Water Relationships. McGraw-Hill Book Company, New York.

13. Baver, L.D. et. at. 1972. Soil Physics. John Wiley and Sons, New York.

14. Fox, A.V.. Afforestation of Difficult Sites, Eroded Areas and Steep Slopes: With Special Emphasis on the Mambilla Plateau. published in Savanna Afforestation in Africa. FAO Forestry Paper No. 11. 1976.

15. Ladrach, W. E.. First Year Results of Mechanical and Chemical Site Preparation Tests for the Reforestation of Pastured Slopes. Investigacion Forestal. Research Report No. 78, Aug., 1982. Carton de Colombia, S.A.

16. Cannon, P.. Efecto del control del pasto yaragua por gramaxone en el crecimiento diametrico de Cupressus lusitanica. Informe de Investigacion Forestal 65. Carton de Colombia.

17. Cannon, P.G.. Site Preparation Trials on Andept Soils with Pine and Eucalyptus Species: Results After Three Years. Investigacion Forestal, Research Report No. 75. March, 1982. Carton de Colombia, S.A.

18. Cooling, E.N. & B.E. Jones. 1970. The importance of boron and NPK fertilizers on Eucalyptus in the Southern Province, Zambia. East Africa Agric. For. Jour. 36(2):185-194.

19. Ladrach, W.E. Tree Growth Response to the Application of Phosphorus, Nitrogen, And Boron at the Time of Planting in the Departments of Cauca and Valle. Investigacion Forestal. Research Report No. 59. July, 1980. Carton de Colombia, S.A.

20. Wood, P.J., J. Burley, and A. Grainger. Technologies and Technology Systems for Reforestation of Degraded Tropical Lands." OTA commissioned paper (unpublished) as cited in Sustaining Tropical Forest Resources: Reforestation of Degraded Lands. Background Paper No. 1, Office of Technology Assessment, U.S. Congress, Washington, D.C. (in press).

Leucaena Seed Improvement

Dr. James Brewbaker has warned of seed contamination and adulteration, which may adversely affect the production of Leucaena for wood (5). Although Leucaena is essentially self-pollenating, (there is an estimated 5% chance of outcrossing), there is a very high probability that the varieties of Leucaena seed being used for wood production in the Philippines are not genetically pure, given the considerations that: the different varieties of Leucaena recommended for wood production (K8, K28, K29, K67, K132 and K636) were collected from wild stands; the varieties planted in the germ-plasm bank in Hawaii are not maintained in isolation; Leucaena seed reproduction in the Philippines generally has not been done in isolated varietal pure stands; seed adulteration on occasion has been known to occur; and the usual procedure of seed collection has been to collect seeds from trees to which the collectors have easy access (short and weedy trees rather than the tallest).

One evidence suggesting genetic impurity is the uneven growth of trees, which is being observed in most Leucaena plantings in the Philippines and elsewhere. Growth variation can also occur even with genetically pure seeds with differences in site conditions (such as nutrient availability and soil depth), other environmental factors (such as competition) and establishment and management procedures.

1. Immediate Seed Resources

   a. Trees in existing Leucaena plantings that have shown desired characteristics (such as fast growth and large, straight trunks) should be identified and marked. Desired characteristics should be identifiable at 2 years of age.

   b. Outstanding trees should be cut off (preferably sawn) at 1 meter in height at the beginning of the rainy season and allowed to coppice. A large number of new branches will develop from the cut stump, forming a bushy growth. It has been reported that coppiced stumps will bear more seeds than a full tree and the seeds are more readily accessable. Coppicing does not alter the genetic make-up of the selected tree.

c. Whenever feasible, other undesirable Leucaena trees in the immediate vicinity should be marked and cut and prevented from flowering and setting of seed. This can be done by frequent cutting of the coppice, which can be used for livestock forage or as a green manure mulch. The cutting of these trees will prevent cross pollenation of desired seed trees with undesirable ones (seed adulteration).

d. During seed production, Leucaena is vulnerable to insect damage at both the flowering stage and when seed pods are developed. Larva of a small moth can destroy the florets of Leucaena, reducing seed set, and seed weevils will destroy the mature seed in the pods. Therefore to maximize seed production, it is recommended that the seed trees be sprayed with a systemic pesticide, such as Cygon -- O, O-dimethly S - (N Methyl Carbanoylmethyl) Phosophorodithioate.

e. Seeds should be collected when pods are fully mature (the entire pod should be light brown in color), but the pods should not be left too long on the trees. The pods can easily be harvested with a tree pruner (Appendix O). The pods can be threshed by placing them in a rice bag, and the seeds threshed from the pods by stamping on the bag or beating on the bag with a stick. Immature seeds and other trash can be removed by winnowing the seed as one would rice.

f. Seeds should be thoroughly sun dried before storage, and treated with a pesticide such as Sevin and a fungicide such as Captan. The seeds can be stored in plastic carboys (Jerry cans), which should be sealed and stored under dry (30% relative humidity) and cool (10°C) conditions (1). A "rule of thumb" for seed storage is: relative humidity plus temperature in degrees Fahrenheit should be less than 100 (for example 50% humidity +40°F=90 or 40% humidity + 50°F is o.k.).

g. Seeds should be scarified before planting to ensure even germination. The simple hot water treatment is recommended.

2. Future Seed Resources

Even though some seed sources allegedly can trace the origin of the Leucaena seed, due to seed contamination and adulteration it is recommended that seed orchards be established from seed of known pedigree. Therefore, new seed of the K8, K28, K29, K67, K132 and K636 varieties should be obtained from Dr. Brewbaker at the University of Hawaii and segregated seed orchards of the different varieties should be established and maintained.

Original planting spacings should be 1 m x 1 m or 1 m x 2 m thinned to 2 m x 3 m or 3 m x 3 m after 1 1/2 to 2 years. The plantation and surrounding area should be kept free of all other Leucaena (1).

The same procedures for seed orchard maintenance as mentioned in a. thru g. above should be followed for the establishment and maintenance of seed orchards of most trees.

21

Seed Improvement

Larger tree seed will initially produce stronger, more viable seedlings, which have a better chance to compete and survive because the endosperm of larger seeds contains more food for the growth of the embryo. This is termed the maternal effect and lasts a month or more after seed germination (6).

It is recommended that all Leucaena seed, and whenever possible all other tree seed, be cleaned and sized by separating them through hardware screens or dockage sives (round holes) and by the use of a Zig Zag Air Separator or a vibrating table separator. The specifications for the Zig Zag Air Separators and an example of a vibrating table can be found in Appendix P. A vibrating table can be purchased through any seed machinery supply company.

I recommend the Zig Zag Air Separator, for it can be constructed from materials found in the Philippines, and it is easily made and maintained and less expensive. Additionally, the Zig Zag Separator will separate seed covered with fungus and insect or otherwise damaged seeds that may not separate out on a vibrating table.

The screening will generally separate out the common varieties of Leucaena from the giant varieties, for the common seed is usually smaller. By both screening and separating, the immature and malformed, the broken and insect or otherwise damaged seed will be removed. Approxmiately 20% of the seed (by weight) will become discards. Recommended hole sizes for the hardware screens are 10/64, 12/64 and 14/64 (inches diameter). This will give you four seed size seperations.

If seeds are propagated in containers, this seed sorting process will virtually eliminate empty containers, thereby reducing nursery costs. If the seeds are directly sown, the average seedling will be stronger and more capable of competing with weeds and grass and have a higher rate of survival. The growth rate of all seedlings will be more even.

Appendix C

Vegetative Propagation (To include tissue culture)

Vegetative propagation is an excellent method of cloning trees that show superior and desired characteristics for the rapid establishment of seed orchards of self-pollenating "super trees."

Tissue culture is a biotechnology that is proving to be a valuable tool in tree improvement. Super trees (conifers) are being developed by private corporations, using tissue culture to clone superior trees that show fast growth, superior form, and wider tolerances. These cloned trees are used for the establishment of seed orchards. Much of this work is closely guarded corporate secrets.

I have received reports of single "super trees" evolving from the same lot of Leucaena seed on the same site (Haiti and Mauritius). All of the trees showed good growth, uniform and of phenotypic character; however, in both cases one tree was outstanding; it was taller than the others, grew more vigorously and developed more and larger leaves. I observed the same thing in the Philippines -- one tree that seemed to have substantially greater vigor, which had been planted at BFD in Quezon City (and since cut down). Are these specific hybrids, chance crosses, mutants, tetraploids or simply the result of ordinary genetic recombination? We don't know. They may be sterile or not breed true even if self pollinated. But these trees could be inexpensively cloned by cuttings or tissue culture and multiplied to create seed orchards or plantations of "really super trees." Think of the potential!

Tissue culture is an appropriate tool to short-cut the lengthy time it takes to reproduce seed from superior trees. In the case of Leucaena, a second generation crop of seed can usually be produced in one and a half years. Therefore, tissue culture may not be an appropriate technology to use, unless it is for the cloning of mutants or sterile hybrids. However, for many other fast growing trees it may take 6-8 years to produce a second generation of seed, and all of that seed will not perform the same as the mother tree. Some species of trees are poor seed producers (either producing small amounts of seed or the percentage of viable seeds is low). Therefore, tissue culture could be used to clone thousands of the superior trees for the first generation seed orchard. The second generation could be cloned by rooted cuttings in "clonal hedges."

Many of the tree species may be vegetatively reproduced (by cuttings, etc.), which would seem to be a more practical course to take than tissue culture. However, it may be possible to get only about 100-200 viable cuttings from one superior tree. The project would have to wait another year and a half before making a second generation reproduction from these trees, which would give about 40,000 cuttings (enough to plant 4 hectares, at a 1 m x 1 m spacing). By using tissue culture methods millions of clones can be produced from one superior tree. (One has to be careful not to plant large monoculture plantations from identical genetic material for such plantations could be highly susceptible to disease or insect infestation). If you chose to, a smaller number could be cultured for a plant material orchard and the next generation could be produced by rooted cuttings (This may be an economical method in countries where the private sector has developed tissue culture facilities).

Tissue culture does not need to be expensive. Leucaena is difficult to propagate with the older rooted cutting method, although a relatively successful method has been developed in Taiwan (Ref. Appendix O). Rooting of cuttings has been more successful when the cuttings are immediately submerged in water after severance from the mother tree to maintain the water columns so that transpiration can continue. Juvenile tissue is required for successful vegetative propagation of many tree species, such as Eucalyptus.

Regardless of the genetic potential of the seed/planting material, maximum yield will not be obtained unless adequate amounts of soil nutrients and other required environmental conditions are present.

APPENDIX H

ECONOMICALLY IMPORTANT NITROGEN FIXING TREE SPECIES

(J. L. Brewbaker and Brian K. Styles, eds.
Prepared for Bellagio Workshop; Document #2A)

Format:
SPECIES AND FAMILY
1. ORIGIN; HEIGHT,SHAPE
2. USES AND CHARACTERISTICS
3. ADAPTATION (INCL.MIN RAINFALL)
4. COMMENTS, Chromosome No.

ACACIA ALBIDA DEL. (MIMOSOIDEAE; LEGUMINOSAE)
1. Africa and Israel, to 20 m; leafless in rainy season
2. Forage (pods, foliage), shade
3. Dry tropics, Sahel (to 300 mm min)
4. Slow growth 2n=26

ACACIA AURICULIFORMIS A. CUNN. EX BENTH. (MIMOSOIDEAE; LEGUMINOSAE)
1. Australia, New Guinea; to 30m, spreading
2. Fuelwood, pulpwood; sp.gr..68; 15 m3/ha/yr
3. Wide adapt., acid soils; humid tropics (750 mm. min)
4. Not too tolerant of drought? fire? winds? 2n=26

ACACIA CONFUSA MERR. (MIMOSOIDEAE; LEGUMINOSAE)
1. Philippines, Taiwan; to 14 m, spreading
2. Firewood (high sp. gr.), ornamental
3. Wet subtropics (to 750 mm min), acid soils
4. Slow growth 2n=26

ACACIA FARNESIANA (L.) WILLD. (MIMOSOIDEAE; LEGUMINOSAE)
1. Tropical America; to 10 m, often shrubby
2. Fuelwood; forage, tanning; perfume from flowers; ornamental; black dye used tomake ink
3. Dry tropics; wide variety of soils
4. Very thorny; can be weedy 2n=52

ACACIA MANGIUM WILLD. (MIMOSOIDEAE; LEGUMINOSAE)
1. Australia and Papua New Guinea, Indonesia; to 30 m, erect, stately
2. Timber (.65 sp gr), Firewood?, to 30m3/ha/yr
3. Moist tropics (to 1000 mm min), acid soils?
4. Insects on leaves, genetic variability

ACACIA MEARNSII WILLD. (MIMOSOIDEAE; LEGUMINOSAE)
1. Australia; to 25 m, spreading
2. Fuelwood, charcoal, tannins; dense wood (.75sp.gr.), to 25 m3/ha/yr
3. Moist sub-tropics, mid elevations; to 800mm min?
4. Can become weedy 2n=26

- Gujarat on Gandi Nagar India
outgrows everything else
Gujarat State Forest Dept

ACACIA NILOTICA (L.) WILLD. EX DEL. (MIMOSOIDEAE; LEGUMINOSAE)
1. Africa and India; to 20m, usually less
2. Firewood, charcoal, fodder (pods, leaves), tannin and gum
3. Dry tropics (but thrives under irrigation)
4. Extremely thorny, variable 2n=52,104

ACACIA SALIGNA (LABILL.) H. WENDL. (MIMOSOIDEAE; LEGUMINOSAE)
1. W. Australia; shrub or small tree to 7 m
2. Fodder; fuel; sand-dune fixation; tannin; recolonization of mining areas; erosion control ornamental
3. Humid to subhumid tropics; 300-1000mm. rainfall; adapted to both sandy and swampy sites
4. Rapid growth outside native areas; tolerant to drought, salt, winds, and fire; may become weedy

ACACIA SENEGAL (L.) WILLD. (MIMOSOIDEAE; LEGUMINOSAE)
1. Africa, Pakistan, India; to 13 m,often shrubby
2. Firewood, charcoal; to 5m3/ha/yr, gum arabic, feed (pods, foliage)
3. Drytropics (to 200mm min), poor soil,hot
4. Extremely thorny, becomes weedy 2n=26

ACACIA TORTILIS (FORSK.) HAYNE (MIMOSOIDEAE; LEGUMINOSAE)
1. Africa, Sahel, Israel, Arabia; to 15 m, often shrubby;
2. Firewood, dense; fodder (pods, leaves)
3. Dry tropics (to 100 mm min), heat tolerant, alkaline soils
4. Thorny, lateral roots

ALBIZIA FALCATARIA (L.) FOSBERG (MIMOSOIDEAE; LEGUMINOSAE)
1. Indonesia, New Guinea; to 45 m
2. Pulpwood, soft sp. gr. .33, moldings, boxes, soil improvement
3. Moist tropics (to 1000 mm min), midlands?
4. Soft wood, poor fuel

ALBIZIA LEBBEK (L.) BENTH. (MIMOSOIDEAE; LEGUMINOSAE)
1. Tropical Asia and Africa; to 30 m
2. Fuelwood (high value, 5200 kcal/kg), foliage for feed, yields to 5 m3/ha/yr, furniture
3. Wide adapt., dryand moist tropics (to 600 mm min)
4. Slow growth 2n=26

ALNUS ACUMINATA O. KUNTZE (BETULACEAE)
1. C. America; to 25 m or more
2. Firewood; sp. gr. .5; timber,to 15m3/ha/yr; shoes
3. Cool tropic highlands to 3000m, moist (1250 mm min)
4. Not heat/drought tolerant

ALNUS GLUTINOSA (L.) GAERTN. (BETULACEAE)
1. Europe to W. Asia; Asia Minor to N. Africa; to 40 m
2. Energy production (fuel); soil stabilization, e.g. river banks, roadsides, mine wastes; shoes; sp.gr. .52
3. Widely adapted, temperate or subtropical, to 500m
4. Not drought 2n=28

26

ALNUS NEPALENSIS D. DON (BETULACEAE)
1. Himalayas; to 30 m
2. Firewood but sp.gr. .35; utility timber
3. Cool tropic highlands to 3000m, mesic (800 mm min?)
4. Some insects, soft wood 2n=28

CALLIANDRA CALOTHYRSUS MEISSN. (MIMOSOIDEAE; LEGUMINOSAE)
1. C. and S. America; to 10 m, shrubby
2. Firewood; forage (high tannin) and green manure; sp. gr. .65
3. Moist tropics (min. 1000mm), cooler (above 500m?); to 40 m3/ha/yr with annual harvest
4. Shrubby (=C. confusa Sprague & Riley) 2n=22

CASUARINA CUNNINGHAMIANA MIQ. (CASUARINACEAE)
1. Australia, to 35 m
2. Firewood, sp. gr. .7; shade tree; river bank stabilization
3. Cool tropics to warm temperate; 500 mm min.
4. Can be weedy (Florida) 2n=18

CASUARINA EQUISETIFOLIA L. (CASUARINACEAE)
1. Australia and Pacific Isl. to India; to 35 m
2. Firewood, charcoal; sp. gr. 1.0, "best in world"; windbreak; timber for postwood
3. Warm tropics, coastal areas; typhoon tolerant, very saline tolerant; very saline tolerant
4. Coppices poorly?

CASUARINA GLAUCA SIEB. EX SPRENG. (CASUARINACEAE)
1. Australia (N.S.Wales to Qld.); to 20 m
2. Firewood, charcoal, fencing, piles for seawater, windbreaks in coastal areas; sp.gr. .98
3. Warm temperate to subtropics, coastal areas; salt-tolerant; heavy clay soils
4. Produces root suckers and can be weedy (e.g. Florida)

CASUARINA JUNGHUNIANA MIQ. (CASUARINACEAE)
1. Indonesia; to 30 m
2. Firewood, charcoal, poles, piling; wood very fissile
3. Tropical lowlands and midlands, forming dense forests; wide pH tolerance, moderate drought tolerance
4. Little studied; male clone (or hybrid) widely used in Thailand

DALBERGIA SISSOO ROXB. (PAPILIONOIDEAE; LEGUMINOSAE)
1. Indian subcontinent; to 30 m
2. Lumber, fuelwood, sp gr. .68
3. Warm tropics, mesic or arid (to 500 mm min); yields fast for a Dalbergia, slow by other standards
4. Slow growth 2n=20

ERYTHRINA BERTOEROANA URBAN (PAPILIONOIDEAE; LEGUMINOSAE)

27

1. Tropical America; to 10 m; small crown
2. Live fence posts; soft wood which accepts wires and nails well; forage; windbreaks; easily cloned
3. Lowland and submontane moist tropics to 2000m; usually in wetter areas but needs good drainage
4. Fast growth; resistant to wind 2n=42

ERYTHRINA FUSCA LOUR. (PAPILIONOIDEAE; LEGUMINOSAE)
1. C. & S. America, to 30 m; broad crown
2. Shade for coffee and cacao; live fenceposts; soft wood
3. Lowland moist tropics to 1500m; often in swamps or on poorly drained clayey soils
4. Fast growth; effective green manure; easily cloned 2n=42

ERYTHRINA POEPPIGIANA (WALPERS) O.F. COOK (PAPILIONOIDEAE; LEGUMINOSAE)
1. S. America to Panama; to 40m
2. Shade for coffee, ornamental; soft wood; paper pulp; forage, mulch
3. Dry to mesic tropics, to highlands
4. Fast growth; coppices and clones easily 2N=42

GLIRICIDIA SEPIUM (JACQ.) WALP. (PAPILIONOIDEAE; LEGUMINOSAE)
1. S. and C. America; small tree to 10 m
2. FIrewood, timber, sp. gr. .75, fodder, shade, ornamental; easily propagated by cuttings, living fence, to 8 m3/ha/yr
3. Dry to humid tropics (1000 mm min), also saline areas
4. Toxic bark/seeds/roots; aphids on foliage 2n=20

INGA VERA (L.) BKITTON (PAPILIONOIDEAE; LEGUMINOSAE)
1. Caribbean, C. America; to 20 m
2. Shade for coffee, fuelwood (sp. gr. .75), timber, shade, honey relatively fast growth
3. Humid tropics (1000 mm min?), lowlands
4. Little studied

INTSIA BIJUGA (COLEBR.) O. KUNTZE (CAESALPIINIOIDEAE; LEGUMINOSAE)
1. Southeast Asia, E. Africa, India; to 40 m, buttressed
2. Handsome timber, decking, truck bodies ("ipil" in Philippines), highly resistant to rot; slow growth
3. Moist tropics, prob. 2000 mm min;
4. Genetic variability 2n=24

LEUCAENA DIVERSIFOLIA (SCHLECHT) BENTH. (MIMOSOIDEAE; LEGUMINOSAE)
1. C. America, to 18 m (with shrubby variants)
2. Fuelwood (est. .5 sp. gr.), shade, forage
3. Dry to mesic tropics, prob. 500 mm min, to midlands (1500 m)
4. Little studied, great genetic diversity 2n=52

LEUCAENA LEUCOCEPHALA (LAM.) DE WIT (MIMOSOIDEAE: LEGUMINOSAE)
1. C. America and Mexico, to 18 m (with shrubby variants)
2. Fuelwood, nurse tree, forage, small timber and pulpwood; sp. gr. .55, some food use (pods, seeds, leaves), energy plantations, yields to 50 m3/ha/yr
3. Dry to mesic tropics, 500 mm min, lowland
4. Widely studied 2n=104

MIMOSA SCABRELLA BENTH. (MIMOSOIDEAE; LEGUMINOSAE)
1. S.E. Brazil & Argentina; to 12 m, thornless
2. Fuelwood, pulpwood, ornamental; shade for coffee; rapid growth?
3. Mid-elevation cool tropics and subtropics (flourishes at 2400m, Guatemala)
4. Little studied

PARKIA ROXBURGHII G. DON (MIMOSOIDEAE; LEGUMIONSAE)
1. Indo-Malaysia, Philippines; now widely pantropical; to 40 m, umbrella crown
2. Timber, ornamental, seeds used in local medicine
3. Humid tropics to 1000mm?; 500-700 m elevation
4. Pest-tolerant; protected in Indonesia

PARKIA SPECIOSA MASSK. (MIMOSOIDEAE; LEGUMINOSAE)
1. Thailand, Malaysia; to 15 m, thin crown
2. Food (seeds from large pods)
3. Humid tropics, to 1500 m elevation
4. Seeds often insect infested; slow growth; hybridizes with P. roxburghii

PARKINSONIA ACULEATA L. (CAESALPINIOIDEAE; LEGUMINOSAE)
1. Americas; to 20 m, spreading
2. Fuelwood; fodder; ornamental; fences; local medicine
3. Widely adapted, to moist tropical and dry areas, also sandy and saline soils
4. Very thorny; weedy in Argentina 2n=28

PITHECELLOBIUM DULCE (ROXB.) BENTH. (MIMOSOIDEAE; LEGUMINOSAE)
1. C. to S. America, to 20 m, irregular and untidy spreading tree
2. Fuelwood (to 5500 kcal/kg), smoky; forage, construction postwood, shade (thorny hedges), food (pods), some tannin and oil (seeds)
3. Dry to mesic tropics, to cooler elevations (So. Florida)
4. Thorny (segregating), poor form 2n=26

PONGAMIA PINNATA (L.) PIERRE (PAPILIONOIDEAE; LEGUMINOSAE)
1. Indian subcontinent, Malaysia, China, Tropical Asia; to 8 m
2. Firewood, fodder (leaves), oil (seeds), pest control (leaves), shade tree, medicine
3. Mesic tropics (min. 600mm), saline tolerant; to full height in 5 yrs.
4. Aggressive spreading roots; also known as <u>Derris indica</u> (Lam.) Bennet

Not a fast growing Tree

PROSOPIS ALBA/CHILENSIS "Complex"
(Includes P. alba Griseb. and P. chilensis (Mol.) Stuntz; also P. flexuosa and P. nigra)
1. Argentina, Paraguay, Chile, S. Peru; to 15 m
2. Firewood, occasional use as timber; fodder (pods); to 12 m3/ha/yr
3. Cool dry subtropics (200 mm min); to 3000m in Peru
4. Thorny (segregating) 2n=28

PROSOPIS CINERARIA (L.) DRUCE (MIMOSACEAE; LEGUMINOSAE)
1. India, to 9 m, thorny, spreading
2. Firewood, excellent charcoal; fodder, some timber; green manure, yields to 3m3/ha/yr (under drought stress)
3. Dry hot tropics, to 100 mm min?
4. Thorny (segregating), weedy

PROSOPIS PALLIDA/JULIFLORA "Complex"
(Includes P. pallida (Humb & Bon ex Willd) and P. juliflora (Swartz) DC)
1. C. and No. S. America; to 15 m, aggressive
2. Firewood (.8 sp. gr.), exc. charcoal; fodder (pods), honey, wood, to 5 m3/ha/yr
3. Dry hot tropics, to 200 mm min; deep roots, some var. frost-tolerant
4. Thorny (segregating), often weedy (P. glandulosa and P. velutina are the mesquites of So. USA and elsewhere in tropics, often labelled juliflora in error) 2n=26,52,56

PROSOPIS TAMARUGO F. PHIL. (MIMOSOIDEAE; LEGUMINOSAE)
1. Chile, to 15 m,
2. Firewood, forage (pods, leaves), some use use (high sp. gr.)
3. Dry hot saline tropics, to 10 mm (uses fog drip?); remarkable saline tolerance
4. Slow growth, thorns?

PTEROCARPUS INDICUS WILLD. (MIMOSACEAE; LEGUMINOSAE)
1. S. E. Asia, Indo-China, Pacific IslandS; to 40 m, broad crown, lofty
2. Choice timber (narra), ornamental, furniture, flooring
3. Moist tropics; relatively fast growth
4. Needs deep soil; some diseases 2n=22

ROBINIA PSEUDOACACIA L. (PAPILIONOIDEAE; LEGUMINOSAE)
1. N.E. America, to 25 m
2. Fuelwood (dense), erosion control, nurse tree, posts, to 20m3/ha/yr; forage
3. Temperate
4. Restricted to highland tropics (little tested) and temperate regions 2n=20,22,24

SAMANEA SAMAN (JACQ.) MERRILL (MIMOSOIDEAE; LEGUMINOSAE)
1. C. & So. America, Mexico; to 40 m, wide spreading
2. Shade, timber and craftwood, food (pod), sp. gr .52, ornamental
3. Mesic to wet tropics (to 600 mm min)
4. Not good fuelwood, rapid growth 2n=26

SESBANIA GRANDIFLORA (L.) POIR. (PAPILIONOIDEAE; LEGUMINOSAE)
1. India to SE Asia; to 10m, slender
2. Pulpwood, forage (leaves, pods), food (flower, leaves, young pods), ornamental; sp. gr. .42; to 22 m3/ha/yr, large nodules
3. Moist tropics (1000mm min), onto poor soils
4. Genetic variability, soft wood, borer susceptibility 2n=14,24

NFTA 82-03

ECONOMICALLY IMPORTANT NITROGEN FIXING TREE SPECIES "B" LIST

(James L. Brewbaker and Brian K. Styles, Eds.
Prepared for Bellagio NFT Workshop, Sept. 1982)

The following species were considered important economically, but of less importance than the annotated "A" list. Many of these species (asterisked) are not known to fix nitrogen, which may account for their absence from the "A" list.

ACACIA ANEURA
ACACIA AULACOCARPA
ACACIA CAVEN
ACACIA HOLOSERICEA
ACACIA KARROO
ACACIA KOA
ACACIA MELANOXYLON
ACACIA PEUCE
ACACIA PENNATA
ACACIA SALICINA
ACACIA SEYAL
ACROCARPUS FRAXINIFOLIUS
ADENANTHERA PAVONINA
ALBIZIA PROCERA
ALNUS RUBRA
CAESALPINIA CORIARIA*
CASSIA FISTULA*
CASSIA GRANDIS*
CASSIA JAVANICA*
CASSIA SIAMEA*
CASUARINA CRISTATA
CASUARINA GRANDIS
CASUARINA OBESA
CASUARINA OLIGODON
CASUARINA SUMATRANA
CEDRELINGA CATENAEFORMIS*
CERATONIA SILIQUA*
CERCIDIUM FLORIDIUM*
COPAIFERA LANGSDORFII*
DALBERGIA LATIFOLIA
DIPHYSA ROBINIOIDES*
ENTEROLOBIUM CYCLOCARPUM
ERYTHRINA INDICA
ERYTHRINA ORIENTALIS
GEOFFROEA DECORTICANS*
INGA EDULIS
INGA PATERNA
KOOMPASSIA EXCELSA*
HAEMATOXYLON BRASILETTO
LYSILOMA BAHAMENSIS
MIMOSA TENUIFLORA
PELTOPHORUM PTEROCARPUM*
PERICOPSIS ELATA
PITHECELLOBIUM JIRINGA*
PROSOPIS GLANDULOSA complex
(P.glandulosa, P. velutina, P. torreyana)
PROSOPIS PUBESCENS
SCHIZOLOBIUM PARAHYBA
SINDORA JAVANICA*
TAMARINDUS INDICA*

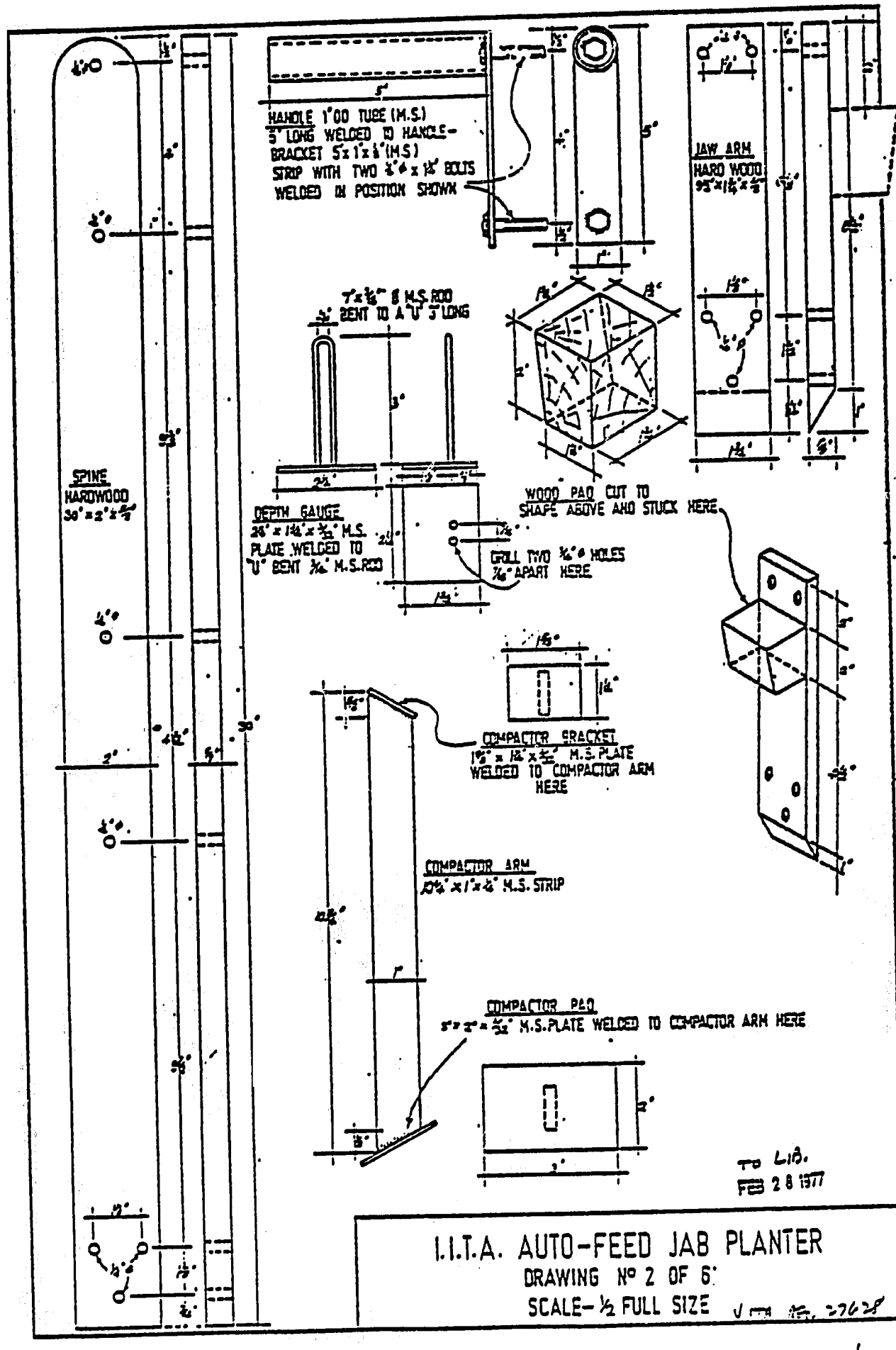
APPENDIX I

PLANTERS

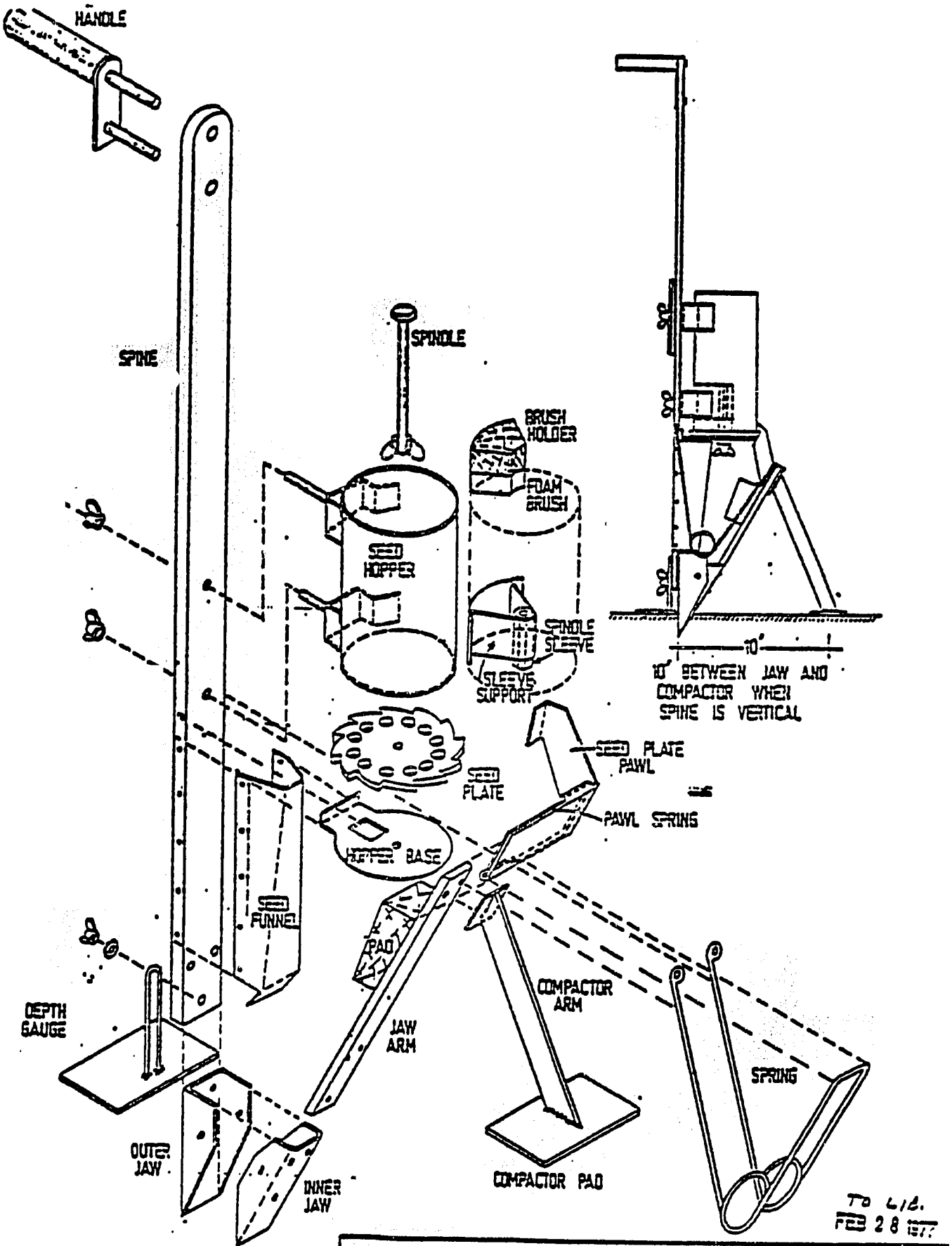
For planting maize, cowpeas, pigeonpea, desmodium triflorum (very similar to birdsfoot trefoil found in the U.S.) and certain species of trees directly into the ground two different styles of planters are needed. For farms less than 2½ hectares (95% of total land) a hand operated jab planter would be suitable. For farms of between 2.5 and 5 hectares, a walking machine like the Esmay planter would be best.

The jab planter should be designed so that the farmer can walk upright, jabbing the device into the earth with one hand. Automatic feed with the option of placing a pellet of fertilizer at the proper distance would be useful. Presently, the farmer uses only a machete to lift the soil and throw a seed under or a pointed stick to poke a hole in the ground into which seed is placed then covered with soil with a sweep of the foot. Above all, the cost must be low and fabrication must be possible in a simple metalforming or carpentry shop. Wood or sheet metal and springs are acceptable materials.

The walk-behind machine whould also have automatic feed of seed and fertilizer. Multiple row seeding is likewise an advantage. The Esmay seeder has worked well in tests but is a bit costly and complex for fabrication in some areas.

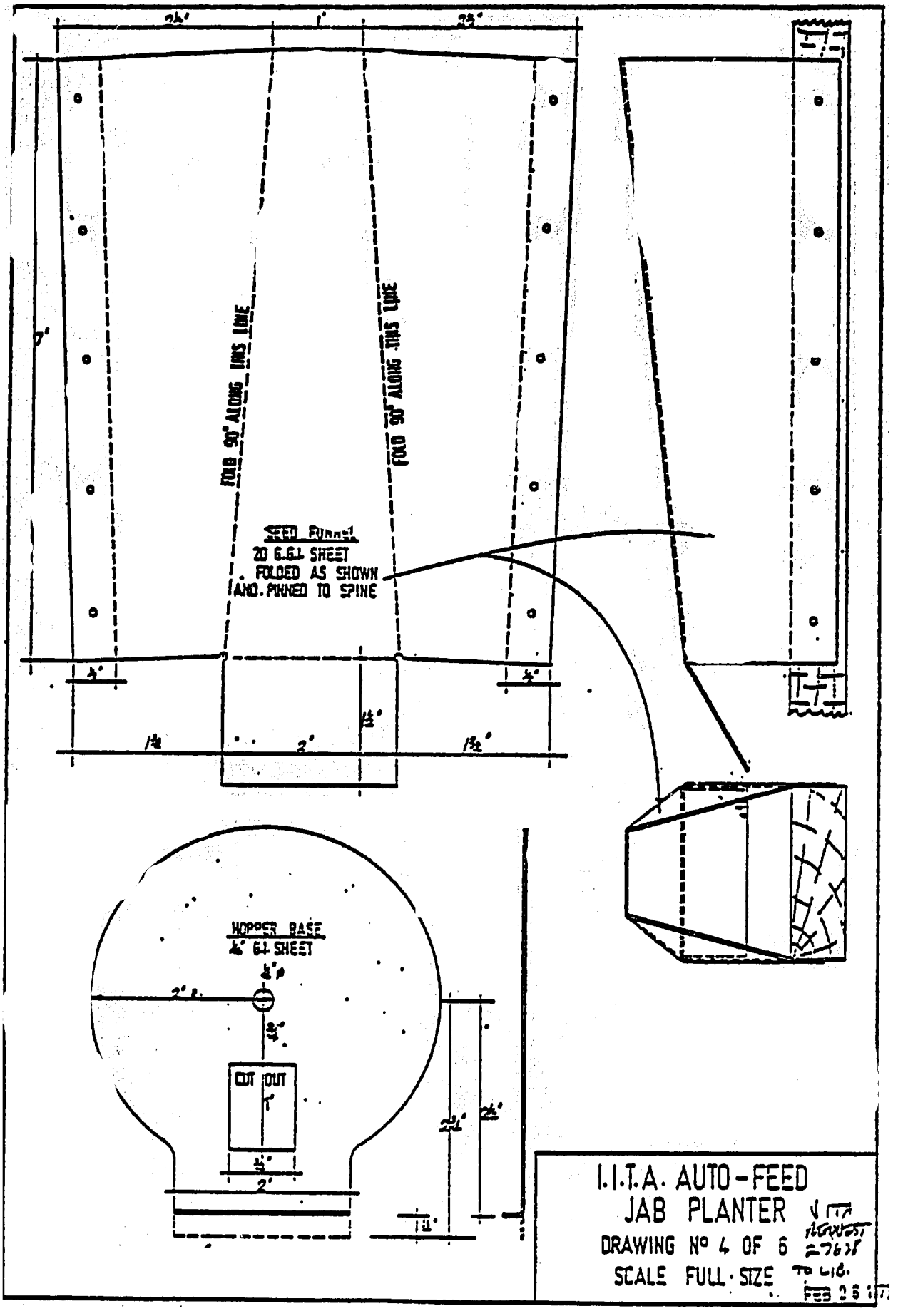

HANDLE 1" OD TUBE (M.S.)
5" LONG WELDED TO HANDLE-BRACKET 5"x1"x⅛" (M.S.)
STRIP WITH TWO ⅜"ϕ x 1½" BOLTS WELDED IN POSITION SHOWN
JAW ARM
HARD WOOD
7"x⅜" ϕ M.S. ROD
BENT TO A "U" 3" LONG
SPINE
HARDWOOD
DEPTH GAUGE
M.S. PLATE WELDED TO "U" BENT ⅜" M.S. ROD
DRILL TWO ⅜"ϕ HOLES ⅞" APART HERE
WOOD PAD CUT TO SHAPE ABOVE AND STUCK HERE
COMPACTOR BRACKET
M.S. PLATE WELDED TO COMPACTOR ARM HERE
COMPACTOR ARM
M.S. STRIP
COMPACTOR PAD
M.S. PLATE WELDED TO COMPACTOR ARM HERE
TO LIB.
FEB 28 1977
I.I.T.A. AUTO-FEED JAB PLANTER
DRAWING Nº 2 OF 6
SCALE-½ FULL SIZE

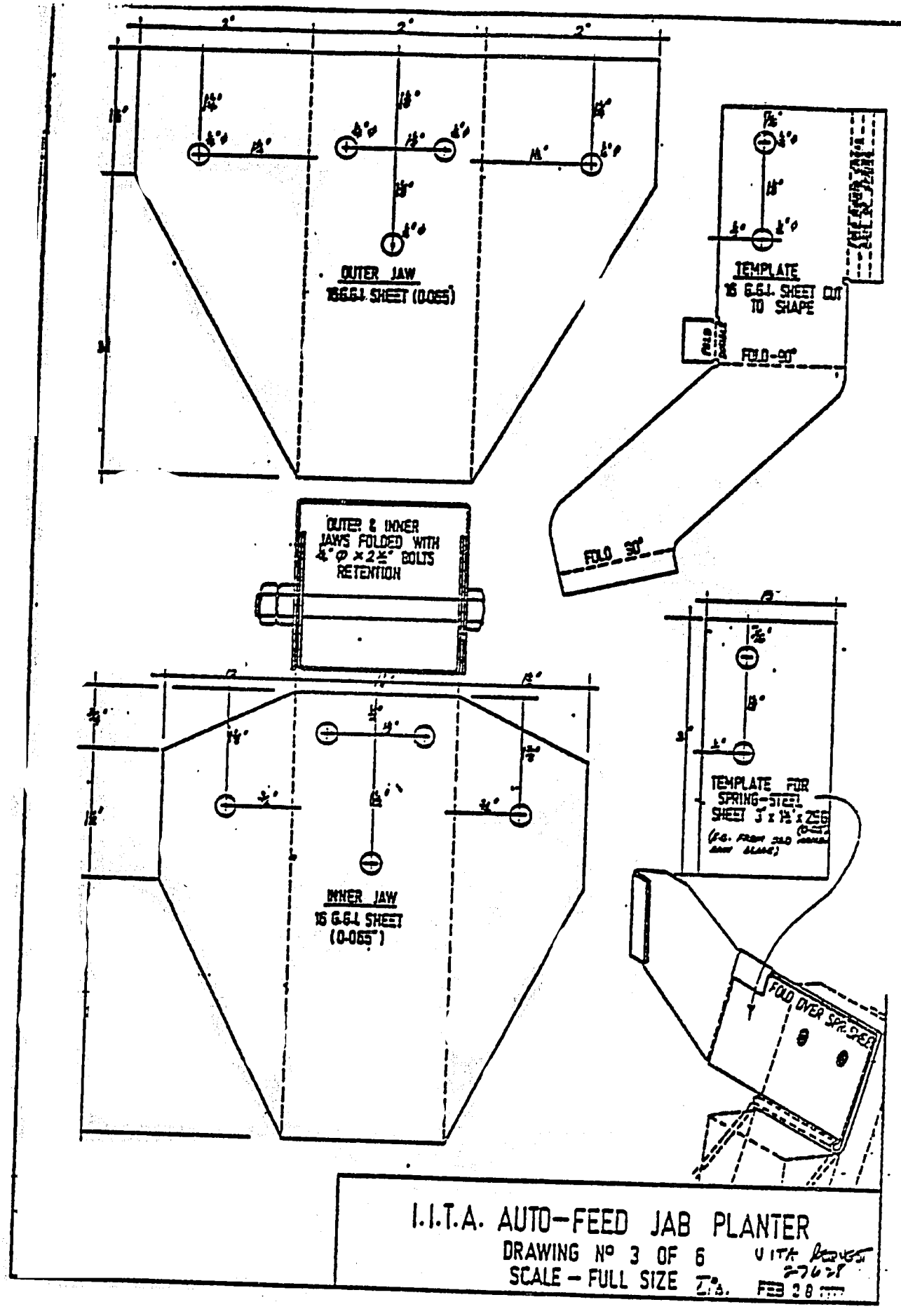
214



TO L/A.
FEB 28 1977

I.I.T.A. AUTO-FEED JAB PLANTER
SCHEMATIC ASSEMBLY DRAWING N° 1 OF 6
INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE
IBADAN NIGERIA

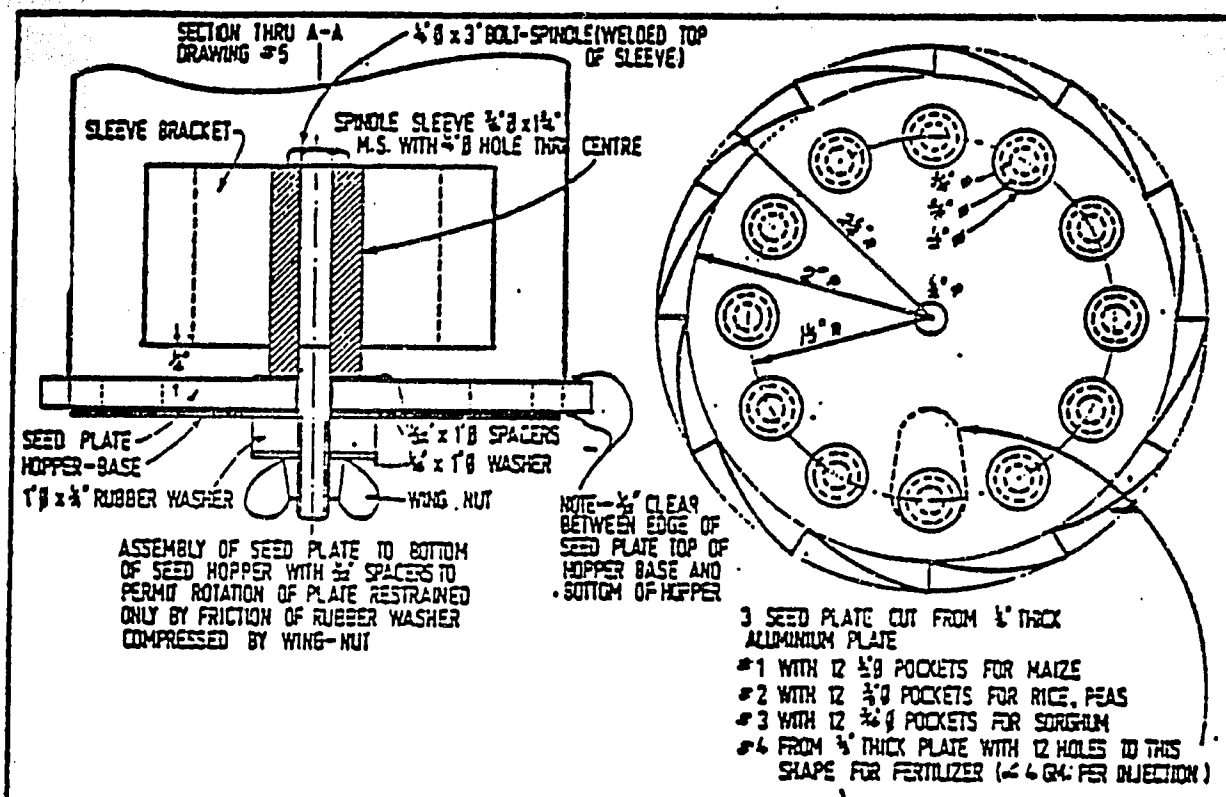

FOLD 90° ALONG THIS LINE
FOLD 90° ALONG THIS LINE
SEED FUNNEL
20 G.G.I. SHEET
FOLDED AS SHOWN
AND PINNED TO SPINE
HOPPER BASE
CUT OUT
I.I.T.A. AUTO-FEED
JAB PLANTER
DRAWING Nº 4 OF 6
SCALE FULL-SIZE



I.I.T.A. AUTO-FEED JAB PLANTER

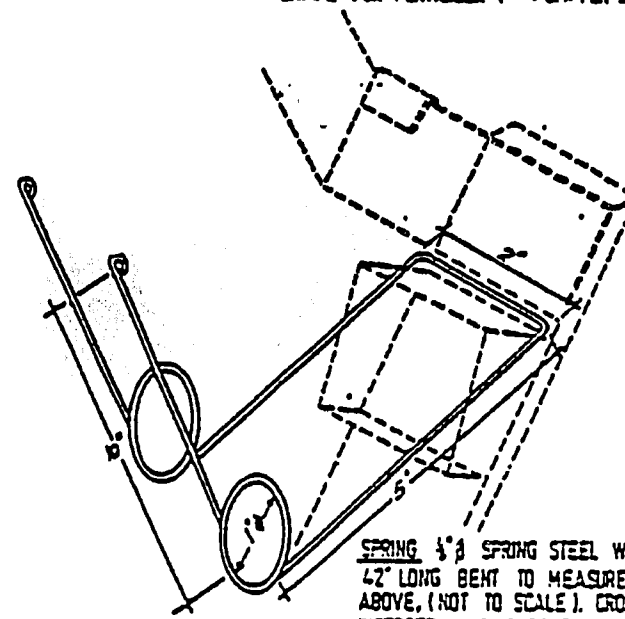
DRAWING Nº 3 OF 6

SCALE – FULL SIZE



3 SEED PLATE CUT FROM THICK ALUMINIUM PLATE
#1 WITH 12 POCKETS FOR MAIZE
#2 WITH 12 POCKETS FOR RICE, PEAS
#3 WITH 12 POCKETS FOR SORGHUM
#4 FROM THICK PLATE WITH 12 HOLES TO THIS SHAPE FOR FERTILIZER (≤ 4 GM. PER INJECTION)

MISCELLANEOUS HARDWARE	
x 3" BOLT-(SPINDLE)	1
x BOLT (JAWS)	1
x 1" BOLTS-(JAWS HANDLE ETC.)	11
x BOLT UPPER HOPPER	1
WING NUTS	3
THICK, 1"Ø- WASHERS	2
THICK, 1"Ø- WASHER	2
Ø SPRING WIRE	42"
1"Ø x THICK x TO RUBBER WASHER	1
x PANEL PINS	10
Ø x M.S. SLEEVE (Ø HOLE THRU CENTRE)	1
Ø x AL. PLATES (SEED)	3
Ø x AL. PLATE (FERTILISER)	1

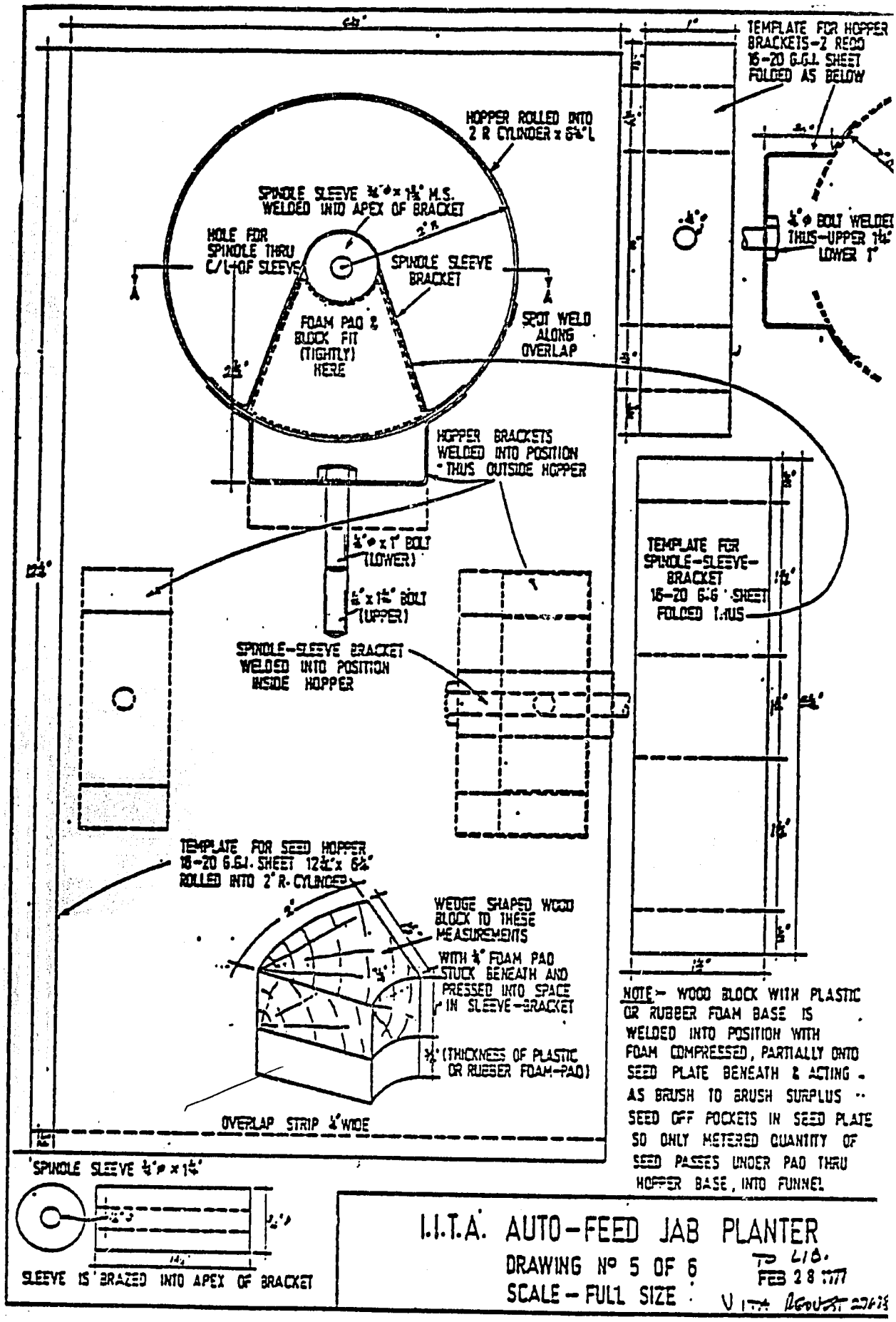


SPRING Ø SPRING STEEL WIRE 42" LONG BENT TO MEASUREMENTS ABOVE, (NOT TO SCALE). CROSS ARM (Z) INSERTED INTO SLEEVE ON JAW-ARM. FREE ENDS SCREWED INTO EITHER SIDE OF SPINE JUST ABOVE POINT OF ATTACHMENT OF SEED FUNNEL. SPRING IS TENSIONED TO HOLD JAWS CLOSED.

I.I.T.A. AUTO-FEED JAB PLANTER

DRAWING Nº 6 OF 6
SCALE- FULL SIZE
(EXCEPT WHERE STATED)

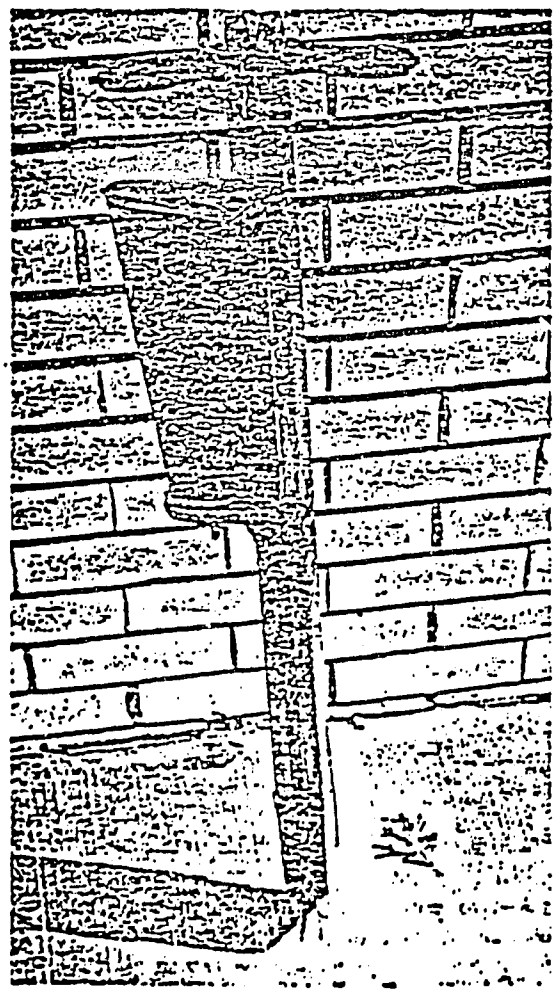
FEB 28 1977


TEMPLATE FOR HOPPER BRACKETS-2 REQD 16-20 G.G.I. SHEET FOLDED AS BELOW
HOPPER ROLLED INTO 2 R CYLINDER x 6¾" L
SPINDLE SLEEVE ¾"ø x 1½" M.S. WELDED INTO APEX OF BRACKET
HOLE FOR SPINDLE THRU C/L OF SLEEVE
SPINDLE SLEEVE BRACKET
FOAM PAD & BLOCK FIT (TIGHTLY) HERE
SPOT WELD ALONG OVERLAP
¼"ø BOLT WELDED THUS-UPPER 1½" LOWER 1"
HOPPER BRACKETS WELDED INTO POSITION THUS OUTSIDE HOPPER
¼"ø x 1" BOLT (LOWER)
¼" x 1½" BOLT (UPPER)
TEMPLATE FOR SPINDLE-SLEEVE-BRACKET 16-20 G.G. SHEET FOLDED THUS
SPINDLE-SLEEVE BRACKET WELDED INTO POSITION INSIDE HOPPER
TEMPLATE FOR SEED HOPPER 16-20 G.G.I. SHEET 12½" x 6¾" ROLLED INTO 2" R. CYLINDER
WEDGE SHAPED WOOD BLOCK TO THESE MEASUREMENTS
WITH ¼" FOAM PAD STUCK BENEATH AND PRESSED INTO SPACE IN SLEEVE-BRACKET
¼" (THICKNESS OF PLASTIC OR RUBBER FOAM-PAD)
OVERLAP STRIP ¼" WIDE
NOTE- WOOD BLOCK WITH PLASTIC OR RUBBER FOAM BASE IS WELDED INTO POSITION WITH FOAM COMPRESSED, PARTIALLY ONTO SEED PLATE BENEATH & ACTING AS BRUSH TO BRUSH SURPLUS SEED OFF POCKETS IN SEED PLATE SO ONLY METERED QUANTITY OF SEED PASSES UNDER PAD THRU HOPPER BASE, INTO FUNNEL
SPINDLE SLEEVE ¾"ø x 1½"
SLEEVE IS BRAZED INTO APEX OF BRACKET
I.I.T.A. AUTO-FEED JAB PLANTER
DRAWING Nº 5 OF 6
SCALE - FULL SIZE
FEB 28 1977

For the first row, we stretch a line between stakes and run the seeder along this line. The seeder has an adjustable row marker which marks the next row, so if we get the first row straight (easy when using a tight line), all the other rows in the planting will be straight too.

To make the furrows prior to hand sowing we use our Planet Junior garden plow, one of the high-wheel types that you find almost everywhere, which are made by numerous companies. I'm not sure about the other brands, but ours comes with three different-sized furrows. For large seed such as peas and potatoes, we use the moldboard plow attachment. After sowing the seed, the plow is run first down one side of the furrow, then back in the opposite direction down the other side, closing the furrow and covering the seed neatly and very quickly. It is certainly a whole lot faster than using a hand hoe. For small seeds such as carrots, we use the small cultivator tooth on the high-wheel plow and then cover the seed by hand during sowing.

HAND-OPERATED JAB PLANTERS



A hand-operated jab planter.

For at least a century, most of the corn in this country was planted with jab planters. Two variations on the same idea were built, but both of them are basically glorified dibble sticks. The lower steel blade of the planter was jabbed into the ground, and then, by moving the handles, three or four kernels of corn were dropped from the planting box through a planting tube into the ground opened up by the blades. When the point of the planter was pulled out of the ground, the dirt fell around the seed.

Even after these planters were more or less obsolete, farmers used them to replant hills of

Gene Logsdon demonstrating the use of the jab planter.

40

corn skipped by the horse-drawn planter.

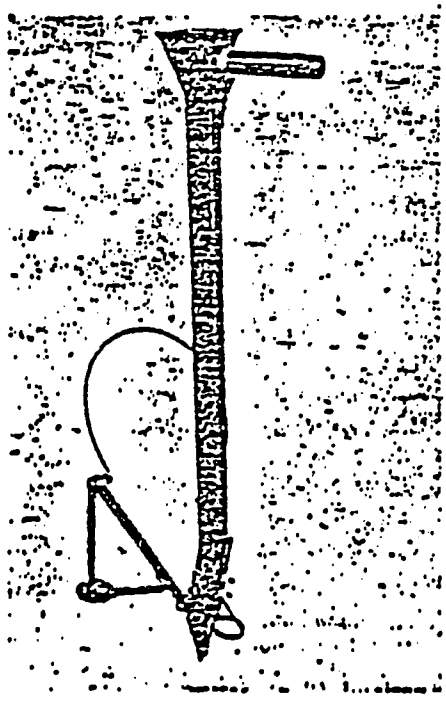
Today, a jab planter can come in handy for interplanting. For example, if you have a row of corn up and growing and want to plant pole beans beside the cornstalks, the hand planter is just what you need. You can walk along the row, plant the seeds where you will, and not disturb the soil around the already growing corn.

Fancy new models of the jab planter are still available and are used in research plot planting. They are available from manufacturers and suppliers of seed industry equipment. Old, used jab planters are often available at farm sales. You might pay $5 for one, or you might pay $35—you can never tell at an auction.

NORTH AMERICAN SOURCES OF HAND PLANTERS

Jab-Type Hand Planter

The Allan Machine Company has three models of jab planters which are hand fed, spring operated, have a metal barrel, and will adjust to different planting depths.



ALMACO Slim-Style Jab Planter model SHP-NBA
Allan Machine Co.

Model SHP-NBA

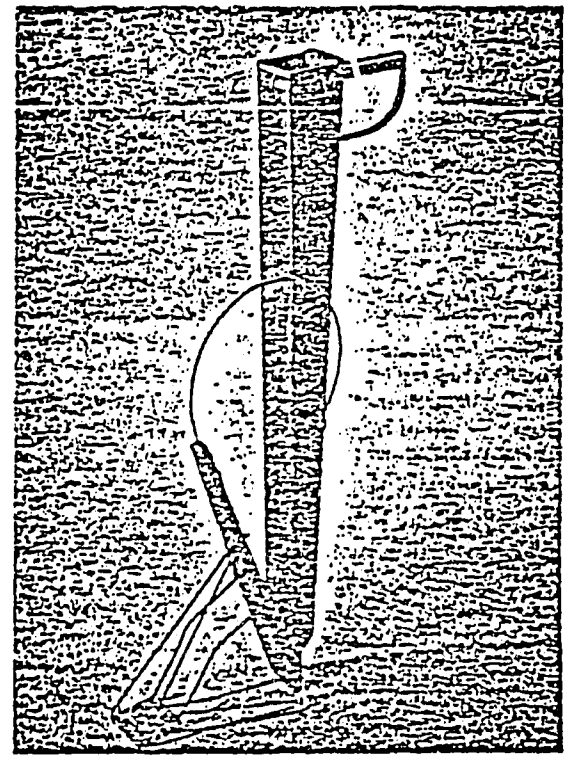
This is a slim-style unit and has a narrow, single barrel weighing 4½ pounds with a 1⅜-inch by ⅞-inch barrel opening.

Model HP-SBA

This is a single-barrel model which weighs 4 pounds and has a wooden back and a barrel opening of 2½ inches by 3 inches at the top.

Model HP-DBA

The third model has a double- or divided-barrel style and comes with a wood back.



ALMACO Single-Barrel Jab Planter model HP-SBA
Allan Machine Co.

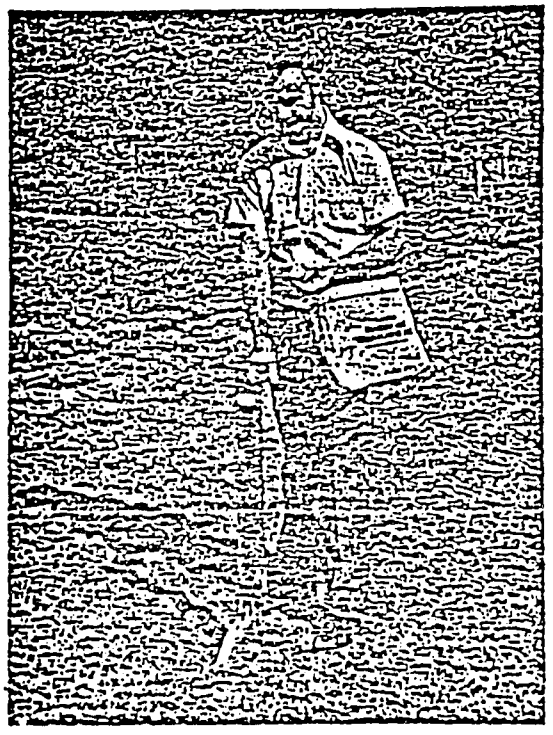
Allan Machine Co.
P.O. Box 112
Ames, IA 50010

Potato Planter

Made of lightweight, corrosion-resistant ma-

41

terials, this unit plants potatoes at adjustable depths. It has a one-year guarantee.



Hand Jab potato planter.
Esmay Products, Inc.

Esmay Products, Inc.
P.O. Box 547, Maple St.
Bristol, IN 46507

Jab-Type Hand Planter

Burrows offers two models, both made of sheet metal and hardwoods. A spring-operated, planting depth adjustment is provided. The 4-pound units are approximately 33 inches high and have an opening 2½ inches by 3 inches at the top of the barrel.

Burrows Equipment Co.
1316 Sherman Ave.
Evanston, IL 60204

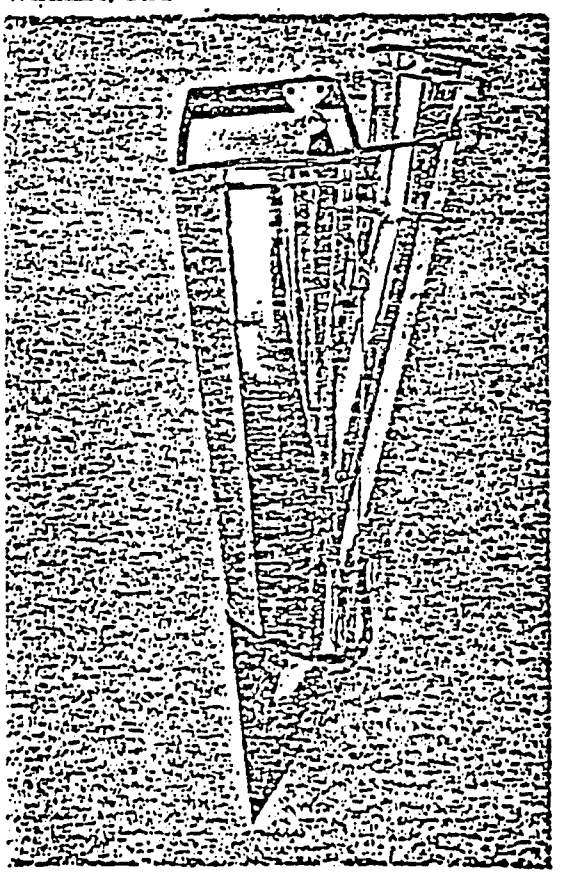
Maquinas Agricolas
Avenida Brazil No. 232
Marilia, Brazil

The Plantmaster

To operate the plantmaster, you select one of a range of seed-metering discs according to the seed size, adjust the foot, place the unit on the soil, and depress the handle. A seed is automatically inserted into the soil. Up to 2,500 seeds can be planted per hour at a depth between 6 and 66 millimeters.

Vandermolen Corp.
119 Dorsa Ave.
Livingston, NJ 07039

Richmond Gibson, Ltd.
Salisbury Rd., Downtown Salisbury
Wiltshire, U.K.



The Cumberland Plant Setter
Cumberland General Store

Cumberland Plant Setter

The Cumberland Plant Setter is a heavy

42

tin tank with a chute grooved and soldered to assure sturdy construction. High-carbon steel shovels with large, curved flanges rake the earth over the roots. It sets, waters, and covers tomato, tobacco, pepper, cabbage, sweet potato, strawberry, and other slip plants in one operation. Shipping weight is 12 pounds, height is 30 inches, and the diameter of the funnel chute is 4½ inches.

Cumberland General Store
Rt. 3, Box 479
Crossville, TN 38555

INTERNATIONAL SOURCES OF JAB PLANTERS

Hand Maize Planter

A single seed is placed in the soil automatically when the stick is inserted. It can be used with one hand and is suitable for small cultivation or experimental work. It weighs 0.5 pounds (0.2 kilograms).

Cossul & Co. Pvt., Ltd.
Industrial Area, Fazalgunj
Kanpur, India

Models PD, PCM, PC, PA

There are five variations of a basic two-handled, hand-powered, spring-operated jab planter.

Marila Industria E. Comercio Sasaki, Ltd.
Avenida Brazil, 232
Caixa Postal No. 196
Marila CEP 17.5000
Estado de Sao Paulo, Brazil

Hand-Operated Seed-Dressing Drum Plans

The object behind this drum was to build a seed-dressing device for village use, the design to be of fairly simple construction so that it could be made by local craftsmen.

The test drum used was an ordinary water tin of approximately 13 inches (330 millimeters) in diameter and 15 inches (382 millimeters) in height.

It was found that this drum had a capacity of 30 pounds (13.6 kilograms) of Chalimbana groundnuts, 35 pounds (15.9 kilograms) of soybeans or maize, and 38 pounds (17.2 kilograms) of fertilizer when filled correctly. In a durability test, a total of 1½ tons of fertilizer was mixed without signs of damage. The drum was also used for seed dressing of groundnuts and maize with satisfactory coverage performance and no apparent adverse effect on germination.

Intermediate Technology Publications, Ltd.*
9 King St.
London WC2E 8HN, England

THE HORN SEED SOWER

The simplest kind of broadcasting seeder, the Horn Seed Sower, consists of a reservoir which funnels seed into a long tube. The operator holds the tube, or horn, at the end closest to the reservoir, and with a skilled flex of the wrist, seed is flung out of the tube. It can be used to broadcast any seed to be grown in a solid stand and, in experienced hands, will result in a more even distribution of seed than would be achieved by hand alone.

SOURCES OF HORN SEED SOWERS

Horn Sower

This device sows primarily smooth grass or grain by swinging its horn back and forth. This sower spreads seed evenly from 30 to 40 feet at a rate determined by the adjustable feed gate in the base or tube joint and by rate of step. It comes with an 11-inch duck bag and an extension funnel attached to a tin distributing tube 22 inches long, 1¼ inches at the base and ¾ inch at the mouth. This sower has a capacity of ¼ bushel and a shipping weight of 1 pound, 8 ounces.

Cumberland General Store
Rt. 3, Box 479
Crossville, TN 38555

The Cyclone Seeder Co., Inc.
Box 68
Urbana, IN 46990

* Intermediate Technology publications can be ordered from International Scholarly Book Service, Inc., Box 555, Forest Grove, Oregon 97116.

43

INFORMATION MEMORANDUM

SUBJECT: Comparative Advantages and Disadvantages of the Use of Root Trainers, Dibble Tubes, Plastic Bags, and Bare-Rooting of Seedlings*

Traditionally, nurseries in the lesser developed countries (LDCs) use either plastic bags for growing tree seedlings or bare-root seedlings grown in seed beds. Often, the nurseries are centrally located and seedlings have to be transported over long distances.

In the bare-root process, seedlings are often injured when they are removed from the seedbeds. Many of the roots are broken, root hairs (essential for nutrient uptake) are torn off and roots dry out easily. Such transplant shock results in a high incidence of mortality. Walters reported that Eucalyptus seedlings in Hawaii, when planted by the bare-root method, suffered as much as 85-95 percent die-back. Because of transplant shock, initial growth is slow, die-back may occur (it may take some more than 3 or more months to recover), and the seedlings are poor competitors with other vegetation.

With seedlings in plastic bags, the weight of the soil (as much as 1-2 kg.) limits the number of seedlings that can be transported (by vehicle and by hand). Frequently, adequate transport is difficult to obtain and planting sites are hard to get to, thus it is difficult and expensive to move large numbers of the seedlings in heavy and cumbersome plastic bags. This increases project costs and reduces the number of seedlings that can be planted during critical planting periods. Also, seedlings are commonly planted in the plastic bag after the bottom has been cut off, which can retard plant growth, cause die-back or increase mortality incidence because the seedlings are restricted from maximum access to available water and nutrients. This is most likely to be a constraint in semi-arid areas or during periods of minimal rainfall. Often, poorly supervised workers will even fail to remove the bottom of the bag which is usually disasterous.

Seedlings grown in plastic bags have poorly developed lateral roots, which are essential and needed to enhance initial establishment and to maximize nutrient uptake. However, excessive growth of lateral roots can cause strangulation of and injure the tap root. When seedlings are grown too long in bags, root-curl occurs, spiraling the root at the bottom of the bags.

When tubes are too small or seedlings are left too long in tubes, the roots at the bottom are deflected emerging from the tube. However, root deformation can occur in any container, especially if seedlings are held too long. Therefore good nursery management is of upmost importance regardless of what system or condition is used.

*A portion of the information used in this memo was taken from the enclosed papers. (TECHNICAL SERIES #4, Compiled by: Mike Benge, S&T/FNR)

Once the root configuration is formed in the seedling stage, the root system continues to grow in the same pattern the rest of the life of the tree. Cannon reports that "The deleterious effects of abnormal root growth are seldom noticed in the first months or even after years of growth." "Rather, it is at more advanced ages and under adverse weather conditions when a deformed tree root system is most likely to fail to provide enough water or nutrients, or to anchor trees against strong winds." "Results indicate that although young seedlings suffer little from container-induced root deformities, several years after plantation establishment a significant proportion of these have grown poorly, fallen over, or died."

An alternative method to growing seedlings in plastic bags and in seed beds (bare-rooting) is a more modern method of containerization. Most of the widely used containers (i.e., root trainers and tubes) incorporate features such as vertical internal ribs designed to minimize root disturbance, to reduce root spiraling in the container and possible future strangulation problems, to maximize lateral root development and shape the roots into a form advantageous to the tree. Basically, the theory behind use of these types of containers is that, "If a tree seedling can be planted with a minimum of root exposure and disturbance, there will be less transplant shock, and survival and growth rates will be higher." [Kingham 1974 as cited by Tinus and McDonald].

Walters reports that for almost 20 years, little forestation was done with Koa (Acacia koa), Hawaii's most valuable native tree, because survival of bare root seeddlings was too poor to be worth the effort. However, several plantings of Koa seedlings (totalling about 75,000) grown in "Hawaii Dibble Tubes" (HDT) have survived at rates of about 85 percent. He goes on to say that survival of bare root Eucalyptus saligna plantings is unpredictable; one planting may result in 90 percent survival, the next in 10 percent. Survival of containerized (HDT) saligna plantings is predictably good; 91.2 percent with a standard deviation of 4.4.

Root trainers and tubes seem expensive when compared to the cost of plastic bags and seedbeds, however the use of them can result in considerable savings by reducing replanting and by increased growth. This often will more than off-set the cost of importing these containers. An additional cost is usually incurred because peat moss or a similar organic mix (which can be developed locally) is almost a necessity if maximum results are to be obtained from using these containers.

However, the costs of root trainers or tubes and buying or developing the planting medium are easily outweighed by the savings obtained by the (1) reduction of seedling mortality, (2) avoiding time lost in growing replacements, (3) avoiding the loss of growth time of replaced seedlings, (4) the advantages of reduced transportation requirements. Further savings are made from the increased

JS

growth rates and stability of trees which have good established root systems. If the root trainers are carefully handled, a high proportion can be reused several times. Tubes last even longer. (If plastic bags cost one cent each, and each tube or cell of a root trainer costs eight cents but can be used eight times, the cost per unit is the same.) Some problems have been reported in the use of styrofoam block containers; such as poor durability and roots growing into the block, making the seedlings difficult to remove thus damaging the roots upon removal.

A seedling (along with the growing medium) grown in an average size root trainer will weigh much less than one-fourth the weight of one in a plastic bag and take up much less than one-fourth of the space. Therefore, there is a large savings in the transportation of these seedlings as well as a more efficient use of space and water in the nursery. The root trainers are more easily stacked in tiers when transported in trucks.

Also, it may be possible to increase seedling survivability and growth rates by impregnating the rootmass of the containerized seedlings with starch graft polymers (ref. Technical Series #2, The Potential of Starch Graft Polymers, "Super Slurpers" for Forestry and Agriculture). This could be a very valuable technology, especially for semi-arid and intermittent rainfall areas.

Some notes of caution--The medium used in root trainers and tubes will hold substantially less water than soil in plastic bags and similar containers. Therefore, these containers and seedlings may need more frequent watering in the nursery and especially during transportation over long distances. A way to deal with this problem is by removing seedlings from the containers and placing them in wax lined cardboard boxes which reduces water evaporation (see Walter's paper). This problem is much more critical with bare-rooting than with containerized seedlings.

Johnson and Menge state that "Most media components--such as pine bark, vermiculite, perlite, builder's sand and peat mosses--are devoid of mycorrhizal fungi." "In addition many nurserymen steam, pasturize or chemically treat media to eradicate harmful pathogens; this also eliminates beneficial organisms, such as mycorrhizal fungi." Also, composts and other locally developed organic mixes generally generate enough internal heat to kill off mycorrhizal fungi and other organisms.

Mycorrhizal fungi facilitate the uptake of nutrients, thus increasing plant growth, and "... have been reported to improve water transport." (Safin, Boyer and Gerdemann, 1971, as cited by Johnson and Menge) Mycorrhizae fungi are capable of transforming unavailable phosphorous into available forms for plant uptake. This is extremely important, especially in phosphorous deficient tropical soils.

Johnson and Menge report that in relation to chemical fertilizer applications required in commercial nursery operations, "phosphorous levels could be reduced by approximately 70% and N, K and micronutrients by 30 to 40% using VA (vesiclar-arbuscular) mycorrhizal fungi."

Ectomycorrhizae are associated with numerous conifers, such as pines, and with other trees, such as casuarina, eucalyptus, oak, beech, birch, willow and poplar. It is an established fact that in the absence of mycorrhizal fungi, the growth of Caribbean pine, casuarina, citrus and other trees will be retarded and in some cases, without inoculation, it may be impossible to establish these trees on some sites. Ectomycorrhizal fungi are associated with Basidiomycetes (mushrooms and puffballs) and Ascomycetes (cup fungi truffles). [Johnson and Menge, 1982].

I am enclosing selected papers relevant to the subject matter and have included some sketches that I have made showing various devices that can be constructed of locally available materials used in conjunction with root trainers. If further information or other Technical Series Papers are desired, please contact me. I would be interested to learn of your results if you do use root trainers or dibble tubes.

Mike

Michael D. Benge
S&T/FNR Agro-forestation
Room 513-D, SA-18
Agency for International
Development
Washington, D.C. 20523
June 29, 1982

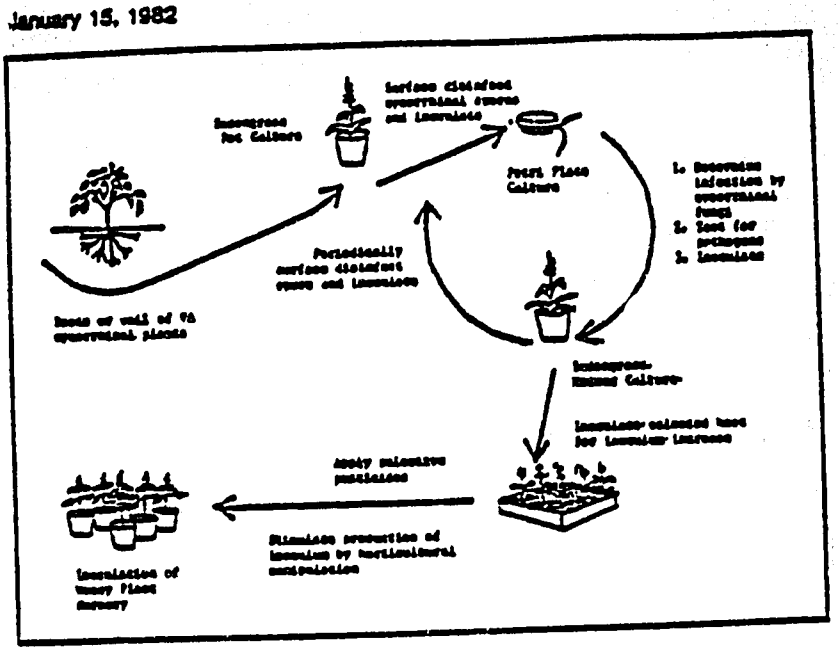


Fig. 1. Proposed scheme for commercial production of mycorrhizal inoculum.

Mycorrhizal inoculum costs

Item	Cost per pot
Cash Costs	
Management salary	7¢
Other wages & salaries	
Potting & inoculation	5
Moving pots	2
Pruning	1
Spraying	1
Watering (drip)	2
Harvesting	3
Grinding & packaging	2
Quality control	2
Maintenance mother culture	5
Plants & seeds	.2
Pots—4-inch	7
Media	2
Fertilizer	.3
Pesticides & other chemicals	1
Other production supplies	1
Repairs & maintenance	1
Insurance	2
Telephone	.5
Electricity & fuel	9
Taxes, licenses & bonds	1.1
Advertising	.3
Rent (land and/or buildings)	.3
Other cash expenses	13
Total Cash Costs	69.2¢
Noncash Costs	
Depreciation on machinery & equipment	2.2
Depreciation on buildings	.9
Interest on capital @ 12%	12
Total noncash costs	15.1¢
Total cost per 4-inch container	84.3¢

Fig. 2. Estimated costs for producing vesicular-arbuscular mycorrhizal inoculum on Sudan grass in four-inch pots.

Mycorrhizae may save fertilizer dollars

By Dr. Charles R. Johnson and Dr. John A. Menge

MYCORRHIZAL FUNGI are associated with the roots of nearly all plants. They form a symbiotic association termed mycorrhizae. Because of their importance to plant growth and their widespread distribution, mycorrhizae must be considered in all aspects of plant science and agriculture.

Mycorrhizal fungi are frequently categorized into four major groupings: entomycorrhizae, vesicular-arbuscular (VA) mycorrhizae, ericaceous mycorrhizae and orchidaceous mycorrhizae. Ericaceous and orchidaceous mycorrhizae are associated with ericaceous and orchidaceous plants, respectively. Little information is available on these two types of mycorrhizae, and their economic importance is limited, so they

Dr. Charles R. Johnson is in the Department of Ornamental Horticulture, University of Florida, Gainesville. Dr. John A. Menge is in the Decartment of Plant Pathology, University of California, Riverside.

Fertilizer cost comparison

Fertilizer: Material	Fertilizer: Rate[2]	Annual fertilization cost for 1,000 gallon containers[1]: Without VA mycorrhizae	With VA mycorrhizae	Potential savings
Micronutrients	2.5 lb/cubic yd	$22.14	$13.28	$ 8.86
Double superphosphate	5 lb/cubic yd	3.06	.91	2.15
Ammonium nitrate	Avg. 130 ppm N	37.81	26.47	−11.34
Potassium chloride	Avg. 30 ppm K_2O	9.58	6.71	2.87
Other nutrients (Ca, Mg)		7.25	5.80	1.45
Totals		$79.84	$53.17	$26.67

[1]Based on January, 1981, price estimates.
[2]Fertilization rates based on commercial woody nursery operations using overhead fertigation system.
[3]Phosphorus levels could be reduced by approximately 70% and N, K and micronutrients by 30 to 40% using VA mycorrhizal fungi.

Fig. 3. Estimated fertilizer costs for woody landscape plants grown in gallon containers with and without VA mycorrhizae.

Best Available Document

will not be discussed further.

Ectomycorrhizae are associated with numerous conifers and other trees, such as oak, beech, birch, eucalyptus, willow and poplar. Ectomycorrhizal fungi are Basidiomycetes (mushrooms and puffballs) and Ascomycetes (cup fungi and truffles). They are characterized by a thick fungal layer, known as a fungal mantle, which covers the host feeder roots.

VA mycorrhizae are found on a majority of the angiosperms of the world. They do not visually alter the structure of roots and often cannot be detected without a microscope. VA mycorrhizal fungi are found in almost any field soil from arctic to tropical regions (17).

Both of these mycorrhizal types penetrate the outer regions of roots (cortical cells), but only VA mycorrhizae penetrate individual cells. Inside host plant cells, VA mycorrhizal fungi form branched structures known as arbuscules and balloon-like structures termed vesicles.

Arbuscules are thought to be the site of nutrient transfer between the symbiotic partners. Vesicles are likely storage organs that the fungus produces to store nutrient materials inside the plant host. Because a great majority of woody landscape species are infected by beneficial VA mycorrhizal fungi, this will be the only group of mycorrhizae discussed below.

What They Do

VA mycorrhizae are capable of improving growth of many woody landscape plants (10, 11, 12, 21). VA mycorrhizal fungi stimulate plant absorption of phosphorus and may be involved in uptake of other ions (4, 15, 16). Mycorrhizal fungi have been reported to improve water transport (19), although this may simply reflect improved nutritional status of mycorrhizal plants.

There is also evidence that mycorrhizae provide resistance to plant disease (20). Many scientists feel that VA mycorrhizal effects on disease are a result of improved phosphorus nutrition caused by the increased absorbing surface conferred by mycorrhizal hyphae.

Container production of ornamentals eliminates or significantly reduces populations of VA mycorrhizal fungi. Most media components—such as pine bark, vermiculite, perlite, builder's sand and peat mosses—are devoid of mycorrhizal fungi. In addition, many nurserymen steam, pasteurize or chemically treat media to eradicate harmful pathogens; this also eliminates beneficial organisms, such as mycorrhizal fungi.

Nurserymen have compensated for the absence of mycorrhizal fungi by applying luxury amounts of fertilizer and water to achieve desired growth. But high levels of nutrition and irrigation will not always be feasible, because of limited petroleum available for making inorganic fertilizer, high costs of fertilizer and rigid restrictions on water use. In addition, high nutrition and subsequent required pesticide applications are being more carefully monitored by environmental regulatory groups.

Inoculating container-grown plants with VA mycorrhizal fungi may reduce the need for current high levels of fertilizer, water and pesticides. This can be done, and it has some economic advantages.

Inoculum Production

Commercial production of VA mycorrhizal inoculum is being attempted at only a few places in the country. Currently, the only way to produce suitable quantities of inoculum is on roots of susceptible host plants. With the proper safeguards, mycorrhizal inoculum that is free of plant pathogens can be produced in commercial greenhouses.

Menge et al (13) proposed a scheme for producing inoculum as shown in Fig. 1. The inoculum is produced in pot cultures of selected hosts that have no root diseases in common with the host plant for which the inoculum is intended. For example, inoculum for citrus could be produced on Sudan grass but never on citrus.

Precautions must be taken to ensure the inoculum is free of nematodes, insects and harmful pathogens. Nemec (18) tested a number of fungicides that are compatible with producing mycorrhizal fungi.

Cost estimates of inoculum production can be generated using current greenhouse business analyses. A reasonably accurate cost estimate of mycorrhizal production, including technical labor and quality control, is approximately $4.3c for a four-inch container of VA mycorrhizal inoculum (Fig. 2). This would be enough to inoculate approximately 50 to 60 gallon containers.

A method similar to the one outlined above is being developed in England for large-scale commercial use (7). In this method, plants are grown in peat blocks that are standing in a shallow nutrient-flow culture. After VA mycorrhizal spores are produced in the peat blocks, the blocks are ground up for inoculation.

Inoculating Woody Landscape Plants

A number of methods have been used to inoculate plants with VA mycorrhizal fungi in greenhouse and nursery trials. Inoculation can be done when potting rooted cuttings into liner or gallon containers by placing five to eight grams of soil inoculum directly beneath roots of the cuttings. Phosphorus levels must be kept low (less than 34 parts per million for citrus) during all phases of plant growth, and other nutrients should be kept low for the first six to nine weeks of mycorrhizal infection.

Infection has also been accomplished by inoculating plants during propagation, shortly after root initiation, using mycorrhizal spores or soil inoculum. The greatest success with infection and subsequent growth response has been realized from early spring to summer.

Various methods have been used successfully to inoculate field-grown plants, including layering the inoculum under seed and banding the inoculum along plant rows (3). Commercial applications of mycorrhizal inoculum using fertilizer banding machinery were successfully carried out in a California citrus nursery (2). Some success has been achieved by pelleting seeds with inoculum (6) and by inoculating seed (3).

Growth and Economic Benefits

Because VA mycorrhizal fungi occur on a wide variety of woody plan species and improve growth of thes plants, the potential of these fungi a commercial "biotic fertilizers" is enor mous.

Researchers have shown that wood landscape plants in containers grov about as well with low to moderat nitrogen and potassium fertilizatio plus mycorrhizal inoculation as they d with luxury fertilization (10).

Benefits of these fungi on importar tree fruits, such as citrus (13), avoca (14) and peaches (11), has prompt inquiries and demand for inoculum improve plant growth.

Fertilization currently constitu two to four percent of the cash nurs production expenses (5). This will c tinue to rapidly escalate.

American Nurseryman

January 15, 1982

With inoculation, the expense of phosphorus fertilization could be reduced by approximately 70 percent. Current levels of nitrogen, potassium and micronutrients could be reduced by 30 to 40 percent.

This potentially could reduce fertilizer expenditures by 33.4 percent, for savings of approximately $26.67 per 1,000 gallon containers annually for woody plants under a typical fertilization program (Fig. 3).

Preliminary research has indicated that an additional benefit is improved establishment and survival of mycorrhizal plants in landscape soils (9). Reduced costs for better water and fertilizer uptake and improved plant survival should create consumer demand for such plants in the landscape.

Summary and Conclusions

Mycorrhizal fungi benefit growth of several woody landscape plants under controlled experimental conditions. Cost benefit figures indicate an economic advantage to using them. Container studies are being established at nursery sites to test the feasibility of using mycorrhizal fungi under commercial cultural programs.

With successful results from such tests and growing interest, more commercial sources of inoculum should develop. Current methods of watering and fertilizing will be radically changed in the next decade because of shortages. Using alternatives like VA mycorrhizae will become common.

Literature Cited

1. Crews, C. E., C. R. Johnson and J. N. Joiner. 1978. "Benefits of Mycorrhizae on Growth and Development of Three Woody Ornamentals." HortScience 13: 429–430.
2. Ferguson, J. 1981. "Production of Vesicular-arbuscular Inoculum and Methods for Inoculation." PhD dissertation, University of California, Riverside.
3. Gaunt, R. E. 1978. "Inoculation of Vesicular-arbuscular Mycorrhizal Fungi on Onion and Tomato Seeds." N. Z. J. Bot. 16: 69–71.
4. Gerdemann, J. W. 1968. "Vesicular-arbuscular Mycorrhizae and Plant Growth." Ann. Rev. Phytopathol. 6: 397–418.
5. Gunter, D. L. 1980. "Business Analysis of Container Nurseries in Florida, 1978." Econ. Information Report, FRE Dept., University of Florida, Gainesville.
6. Hall, I. R. 1979. "Soil Pellets To Introdu[illegible] Vesicular-arbuscular Mycorrhizal F[illegible] into Soil." Soil Biol. Biochem. 11: 85–86.
7. Hayman, D. S. 1980. "Mycorrhizae and Crop Production." Nature 287: 487–488.
8. Jackson, N. E., R. E. Franklin and R. H. Miller. 1972. "Effects of Vesicular-arbuscular Mycorrhizae on Growth and Phosphorus Content of Three Agronomic Crops." Proc. Soil Sci. Soc. Amer. 36: 64–67.
9. Johnson, C. R., and C. E. Crews Jr. 1979. "Survival of Mycorrhizal Plants in the Landscape." Am. Nurseryman 150(1): 15, 59.
10. Johnson, C. R., J. N. Joiner and C. E. Crews. 1980. "Effects of N, K, and Mg on Growth and Leaf Nutrient Composition of Three Container-grown Woody Ornamentals Inoculated with Mycorrhizae." J. Amer. Soc. Hort. Sci. 105: 286–288.
11. LaRue, J. H., W. D. McClellan and W. L. Peacock. 1975. "Mycorrhizal Fungi and Peach Nursery Nutrition." Calif. Agr. 29(5): 6–7.
12. Maronek, Dale M., James W. Hendrix and Jennifer Kiernan. 1980. "Differential Growth Response to the Mycorrhizal Fungus Glomus fasciculatus of Southern Magnolia and Bar Harbor Juniper Grown in Containers in Composted Hardwood Bark-shale." J. Amer. Soc. Hort. Sci. 105: 206–208.
13. Menge, J. A., A. H. Lembright and E. L. V. Johnson. 1977. "Utilization of Mycorrhizal Fungi in Citrus Nurseries." Proc. Int. Soc. Citriculture 1: 129–132.
14. Menge, J. A., R. M. Davis, E. L. V. Johnson and G. A. Zentmyer. 1978. "Mycorrhizal Fungi Increase Growth and Reduce Transplant Injury in Avocado." Calif. Agric. 32(4): 6–7.
15. Mosse, B. 1957. "Growth and Chemical Composition of Mycorrhizal and Non-mycorrhizal Apples." Nature 179: 922–924.
16. Mosse, B. 1973. "Advances in the Study of Vesicular-arbuscular Mycorrhizae." Ann. Rev. Phytopath. 1: 171–196.
17. Mosse, B. 1973. "Mycorrhizae and Plant Growth." In: Structure and Functioning of Plant Populations. Verhandelingen der Kohinkiijke Nederlandse Akademie van Wetenschappen, Afdeling Natuurkunde. Tweede Reeks, deel 70.
18. Nemec, S. 1980. "Effects of 11 Fungicides on Endomycorrhizal Development in Sour Orange." Can. J. Bot. 58: 522–526.
19. Safir, G. R., J. S. Boyer and J. W. Gerdemann. 1971. "Mycorrhizal Enhancement of Water Transport in Soybean." Science.
20. Schoenbeck, F. 1978. "Effect of the Endotrophic Mycorrhizae on Disease Resistance of Higher Plants." Z. Pflanzenkr. Pflanzenschutz 85: 191–196.
21. Wallace, A., E. F. Froiich and G. V. Alexander. 1973. "Effect of Steam Sterilization of Soil on Two Desert Plant Species." Plant and Soil 39: 453–456.

Best Available Document

50

HILLSIDE DITCHING

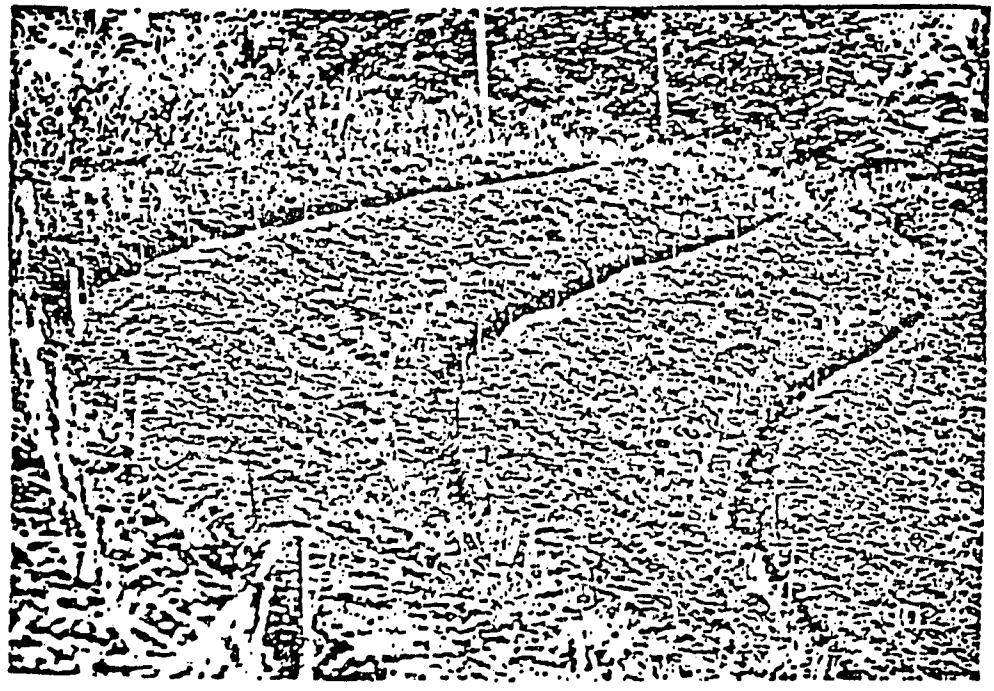


Figure 1

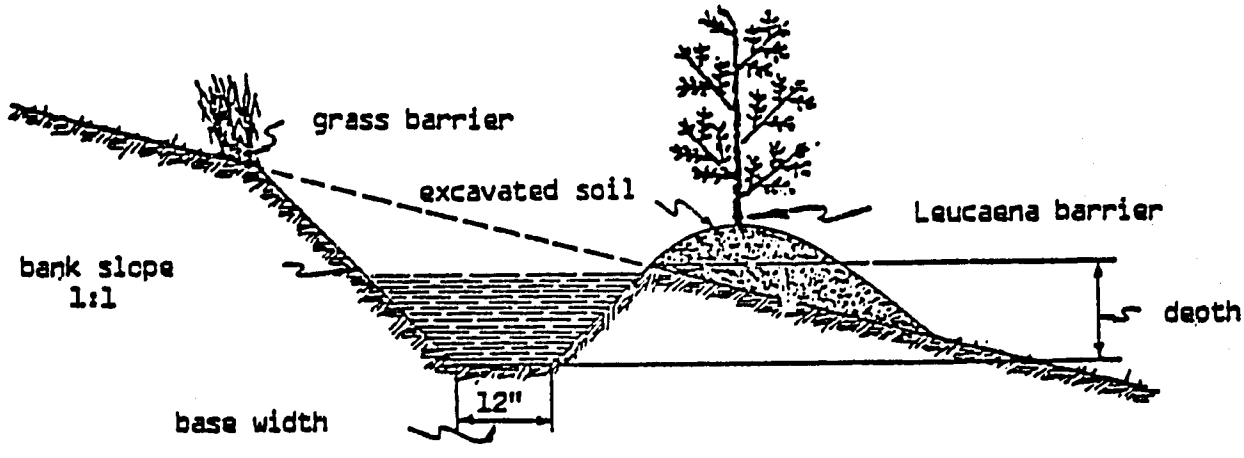
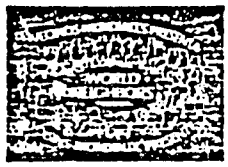


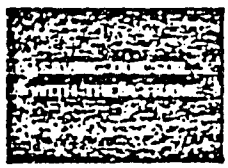
Figure 2

A World Neighbors Filmstrip

SAVING OUR SOIL WITH THE A-FRAME



World Neighbors believes that development cannot be accomplished alone, but is achieved by working and sharing together. Its goal is a better world and its means is the sharing of knowledge, talents, skills, money and most of all, love



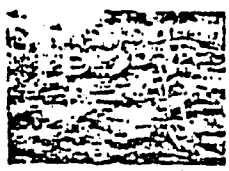
SAVING OUR SOIL
WITH THE A-FRAME

1. A handful of soil . . . how much is it worth? It's the most valuable resource on earth.

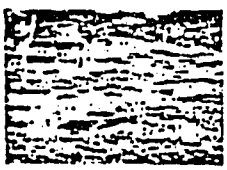
2. All the food we eat, clothes we wear and most of the things we use come from the soil.

3. But if our lands are left unprotected, erosion can destroy our precious soil.

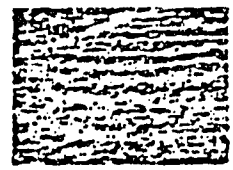
4. Rain is a blessing when it is soaked up by the soil, but long, heavy rains can also wash away the top soil and cut deep gullies in our fields.



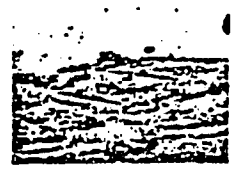
5. When planting on hillsides, we often plant rows running up and down. This is a bad practice.



6. Many farmers burn away corn stalks, leaves, grass, etc. This is also a bad practice. To make the soil better, these things should be turned back to the soil.

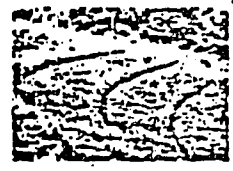


7. We need to protect our slopes and hillsides by planting all our crops on the "contour": that is, in rows running across the slopes and around the hillsides.



8. We also must construct contour canals or barriers running across the slopes and around the hillsides.

9. In rocky places, the rocks can be made into rock walls, which slow down the flow of the rain water and hold back the soil.

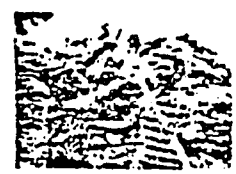


10. Where there are no rocks, level canals can be dug to absorb the rain water. Grass barriers on the upper side of the canals hold back the soil.

11. In order to mark level rows, we need a special tool which is called an A-frame. The A-frame is easy to make and easy to use, plus it is one of the most important tools in the world.

12. Because it can save our soil.

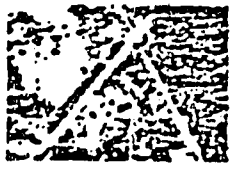
13. These are the only materials you need for making an A-frame: three poles, a piece of cord or vine, a rock and a machete. (Narrow boards, if available, can be used.)



14. First, cross two poles at the top and tie them together securely. (If boards are used, nails can be used to help fasten them.)

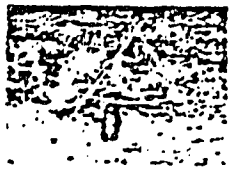
Best Available Document

15. Now tie a shorter pole across the other two to form the letter "A." Tie both ends securely.

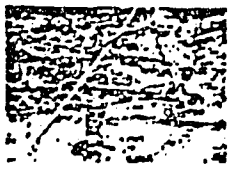


16. Now tie another length of cord to the top of the A and let it hang down below the crossbar.

17. Tie a rock to the end of the cord, below the cross bar.

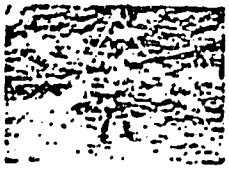


18. Now the A-frame is almost finished but before we can use it to mark level contours, we must find the point on the crossbar which will tell us when the two legs are in a level position.



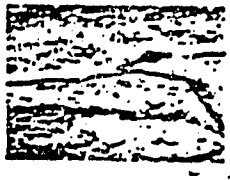
19. First, stand the A-frame upright. Using stakes, mark the points where the legs of the A-frame touch the ground.

20. With a pencil, mark the point where the string passes the crossbar of the A-frame.



21. Move the frame so the placement of the legs is reversed.

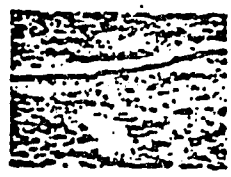
22. The left leg now touches the stake where the right leg was, and the right leg touches the stake where the left leg was.



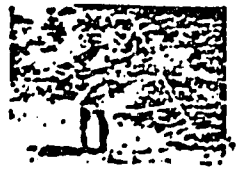
23. Again mark the point where the string passes the crossbar. Usually the two marks will be separate. If the ground is level, the two marks will be at the same place.

24. Now make a third mark halfway between the first two. This is the point on the crossbar which will tell us when the two legs are in a level position.

25. In order to keep from erasing this mark, cut a notch there with your machete.

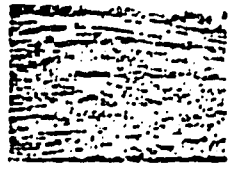


26. When the weighted cord hangs directly in front of the notch, we know that the two legs are level.



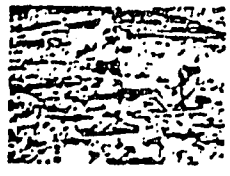
27. Now the A-frame is finished and marked, and we are ready to mark level lines on our hillsides.

28. In our country much of the land is very steep. Many other areas have gently sloping hillsides. Both should be protected with contour canals and barriers, and the crops should be planted in level rows across the slope.



29. Study the area of your field on which you want to construct contour barriers. It is good to start near the top of your field.

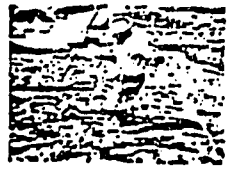
30. First, cut a supply of stakes. These stakes are used for marking the level lines where the ditches will be dug or the rock barriers will be constructed.



31. Drive the first stake at the edge of the field near the highest point. You will begin marking the contour lines at this point.

32. Place one leg of the A-frame just above and touching the first stake. Adjust the other leg so that the string passes the level position point you notched on the crossbar.

33. With the string passing exactly the point of the level position, drive another stake into the ground just below and touching the second leg of the A-frame.



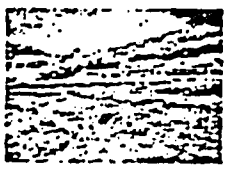
34. Now pick up the A-frame and move it along, placing it so that one leg of the A-frame touches the stake you just drove into the ground.

35. Again adjust the other leg of the A-frame until the string passes the level position notch. Drive another stake just below and touching the second leg.

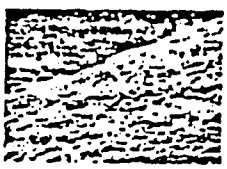
36. Continue across the field this way. Now we have a level line of stakes which tell us where the first contour barrier will be constructed. But one contour barrier is not enough.

37. A hillside must be protected with one contour barrier for every five feet (1.5 meters) of difference in elevation. On steep hills, the barriers will be close together. On gentler slopes, they will be further apart.

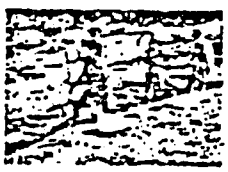
38. Continue marking level contour lines across the field until you reach the bottom of the slope.



39. If the field is rocky, use the rocks to construct rock barriers along the level lines marked by the stakes.

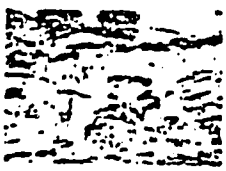


40. Some fields are not rocky, though. Use the A-frame in the same way to mark level contour lines across the field.

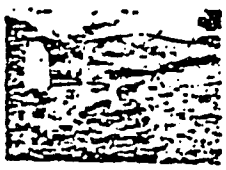


41. Then dig canals along the line of the stakes. The canal should be 1/2 meter wide and 1/2 meter deep.

42. Plant grass along the top of the canal. A tall, thick variety, such as elephant grass, napier grass or guinea grass, is best.



43. Be sure to follow the line of stakes when digging canals. Remember, these stakes mark the level lines across the field.



44. Use a hoe, or hoe and shovel to dig the canals.

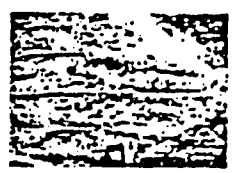
45. On some fields you can make both canals and rock barriers. In rocky areas, construct rock barriers. In other areas, dig canals.

46. When the heavy rains come, the grass or rock barriers will catch the soil and prevent it from being washed down the slope.

47. As the soil is caught behind the grass or rock barriers, terraces will gradually build up.

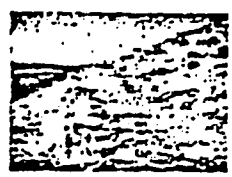
48. Within a few years, our contoured fields will look like this. As the terraces build up, not only is the soil saved, but the fields become easier to work because they are becoming more level.

49. In many parts of our country, soils are already being protected with contour ditches.

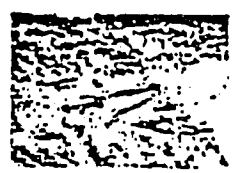


50. Local farmers with the help of government agencies and international groups are beginning to build contour barriers and dig canals like these on their farms.

51. Farmers are beginning to protect their fields by planting their crops on the contour.



52. Even on steep rocky slopes like this the soil can be saved for reforestation.



53. Here's an example of what can be done. Slopes which are too steep or rocky for food crops can produce trees for lumber and fuel. The forests also help to conserve the soil.

54. So when we look at a hillside and see contour canals like these, we know that here lives a farmer who understands the value of his soil and how to conserve it.

55. He knows that the soil is the most valuable resource on earth.

THE END

QUESTIONS FOR DISCUSSION

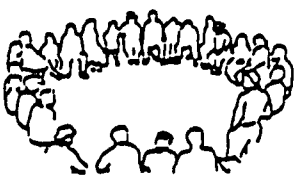
1. Why do you think soil is the most valuable resource on earth?
2. What are some good things rain does for the soil? What are some bad things rain does for the soil?
3. What are some bad farming practices which you have seen in your community?
4. What are some good farming practices which you have seen in your community?
5. What does "planting our crops on the contour" mean?
6. How can a farmer find the contour on his field?
7. Where is the best part of the field to begin marking the contour?
8. Ask someone to explain how to use the A-frame.
9. Name the different kinds of contour barriers.
10. How much difference in elevation should there be between barriers?
11. Does a steep slope have more or less barriers than a gentle slope?
12. After marking the field with stakes, what is the next step?
13. What are the dimensions of the canal?
14. How can rocks and grass be used?

NOTE: Join together with your neighbors to study recommendations given through a filmstrip or film. Many problems cannot be solved by one person working alone. These same problems can be solved when people and communities work together – with each person contributing and cooperating to achieve a common objective.

Materials for education in health, family planning, agriculture and community development.

WORLD NEIGHBORS

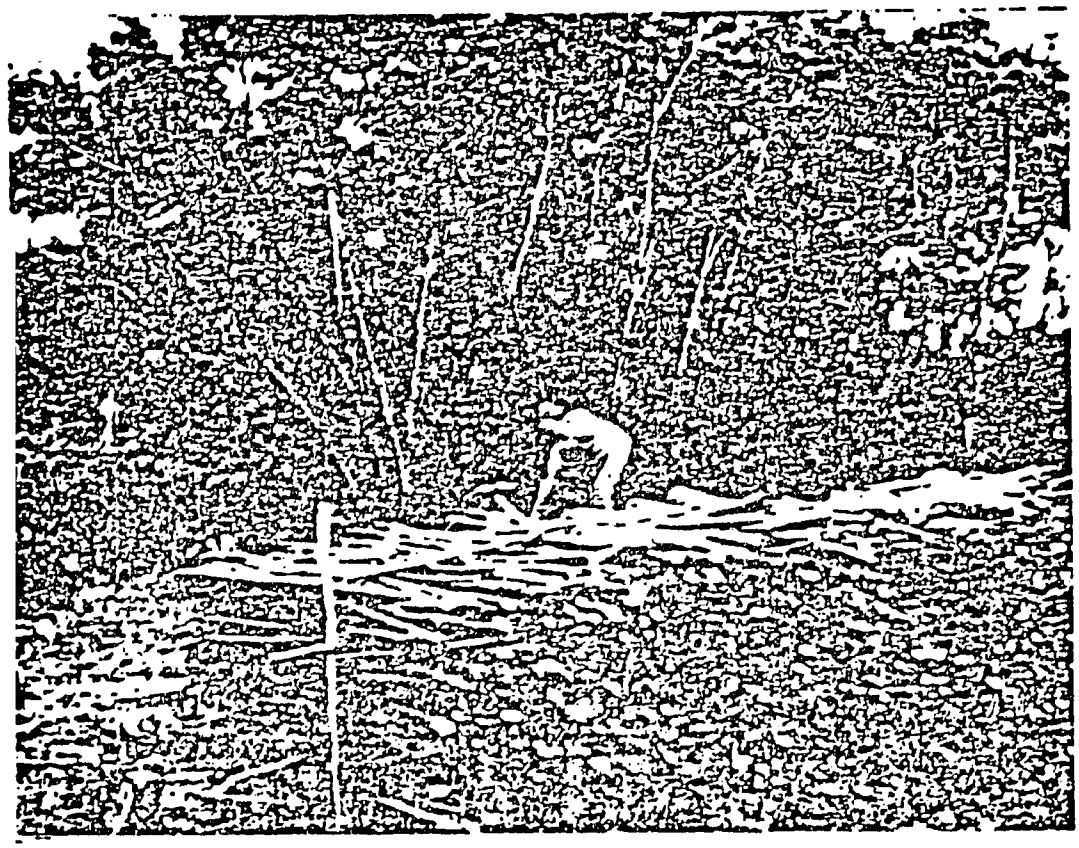
International Headquarters – 5116 N. Portland Ave. – Oklahoma City, Oklahoma 73112 U.S.A.



Overseas Development Materials

LIVING FIREBREAKS

Leucaena planted in Imperata (cogan) grass which shaded out the grass making an effective living firebreak (Cebu, Philippines).



Calliandra calothyrsus closely planted will shade out Imperata (cogan) grass making an effective living firebreak (Indonesia)

Benge

Morris/Ability, C.i

APPENDIX N

Interim rat control measures for Leucaena

Melanda M. Hoque and
Melvyn V. Garrison[1/]

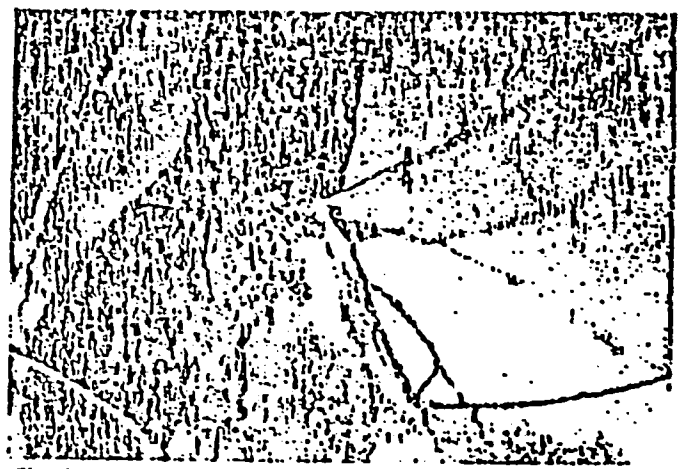


Fig. 1. Rats gnawed portions of bark of mature Leucaena.

Leucaena leucocephala, often referred to as the wonder tree, has not escaped from rat pests. Information reaching the National Crop Protection Center (NCPC) describe damage to Leucaena seedlings in some areas of the Philippines.

Halos (1980) reported that FORI researchers observed a mortality rate of 45% on Leucaena seedlings due to rat damage. NCPC had a damage count of 20 to 60% rat infected Leucaena trees at the dendrothermal pilot project of the National Power Corporation in Magsaysay, Occidental Mindoro.

We have received reports that damage was heavier during the dry than in the wet season. When we visited Mindoro in March and April this year, we observed a lot of damage on six-month to one-and-a-half-year old Leucaena trees. Younger plants were cut off and barks of older trees were gnawed close to the ground. When the bark is completely ringed, the upper portion dries up. Whenever reshooting occurs, regrowth starts where the bark is still intact, e.g., regrowth occur two inches above the collar. This damage either delays growth or completely destroys seedling.

Rat damage in Leucaena causes a growing concern among people involved in Leucaena research and production. However, good management of the pest requires a deeper understanding of the rat's ecology as it affects the crop.

Also, a sound and economical control program should be based on statistics of actual yield losses of Leucaena. This can be better measured if crop's actual losses can be quantified. Such loss may be in terms of reduced

1/ Researcher, and Research Physiologist, respectively, National Crop Protection Center, UPLB-CA.

FORRI, UPLB
College Laguna.

timber yield or delay in maturation or both.

Rat control strategy used in food crops like rice, corn, coconut, etc. may be adopted *ad interim* in the absence of vital information on the pest vis-a-vis Leucaena losses.

This ad interim recommendation is based primarily on previous studies on such species as *Rattus rattus mindanensis*, *R. argentiventer* and *R. exulans* which also damage Leucaena. These same species which also affect food crops have been successfully managed with the sustained baiting method using anti-coagulant rodenticides.

From NCPC's preliminary rat control program in Leucaena in Mindoro comes this ad interim recommendations following the sustained baiting method.

Baiting Procedures:

1. Mix the recommended chronic rodenticides with the bait material (e.g.) rice shorts, corn grits or whole rice). Chronic rodenticides like Ratoxin, Racumin, Tomorin, Diphacin, and Liphadione are available in the Philippines.

2. Start baiting before the dry season or before food and water sources get scarce in the area or, at most, two weeks before planting the seedlings.

3. Select six baiting locations for two hectares, thus, your baiting locations are approximately 100 meters apart. Initially install two bait containers at each location and provide five to six tablespoons of bait material. Bait containers may be made from discarded oil/tin cans, bamboo tubes, etc.

4. Check bait containers at least once a week. If all the bait has been eaten at one location, place two additional containers and provide six tablespoons of bait in all three. Check again after a week.

5. Continue adding bait and bait containers if you notice increase in rat activity, i.e., if consumption increases during your weekly visits.

6. If bait consumption decreases after several weeks of baiting, you may not add bait containers anymore. Visit the area once a week to keep track of animals immigrating to the area. This will help you determine when to resume adding bait/bait containers.

7. Remove and replace bait that becomes moldy or excessively wet.

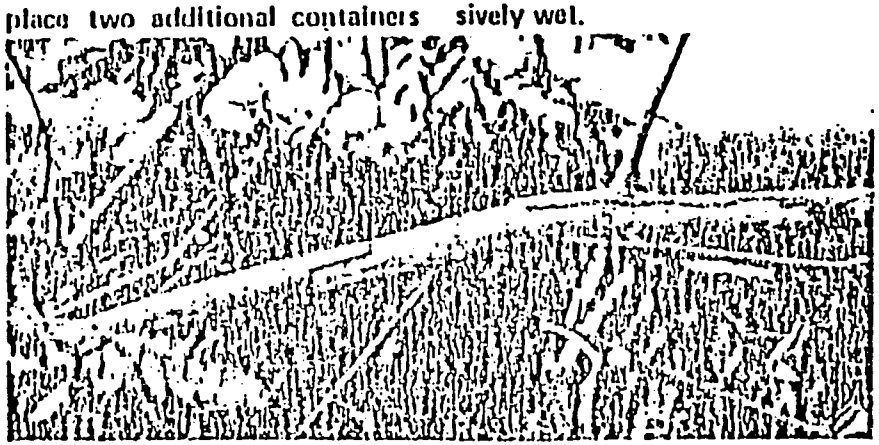
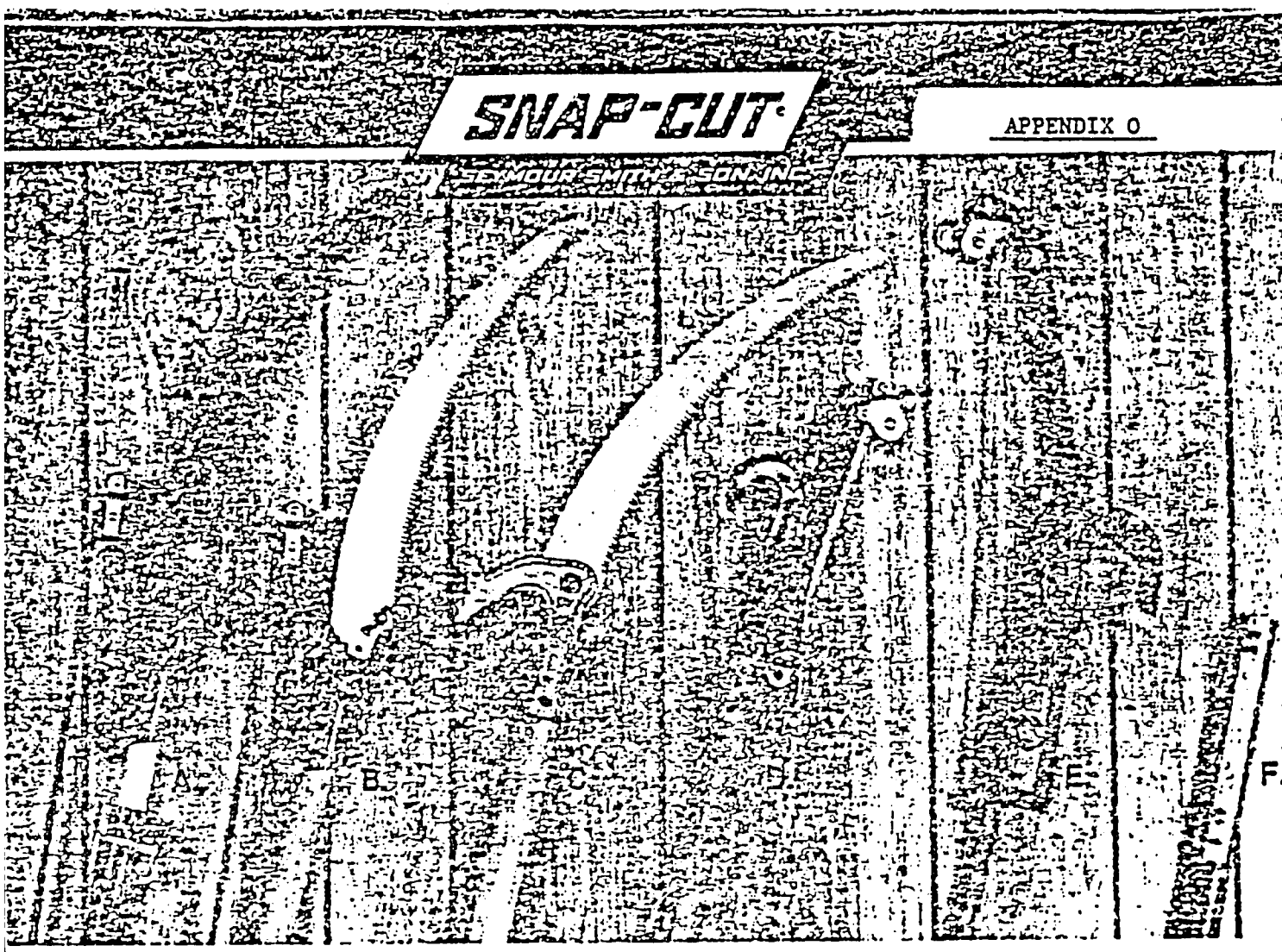


Fig. 2. Twigs showing signs of rat damage.



A. 12 Foot Telescoping Fiberglass Tree Pruner

Cord-actuated pruner blade cuts limbs to 1-1/8" diameter. (A multipower leverage system increases your pull on the cord 15 times for quick, easy cuts.) The 16" needle point saw blade cuts on pull stroke to reduce binding. Telescoping fiberglass pole adjusts from 5' to 12'. Complete with pruning head, 12' cord, pole and saw.

81160	Model 333T. Complete. Sh. Wt. 7 lbs	$43.30
81165	Model 33. Repl. head w/saw, cord. Sh. Wt. 2 lbs.	17.40
81161	Model 302. Repl. pole (6'-12'). Sh. Wt. 4 lbs.	27.30
81038	Model 2011B. Repl. saw blade Sh. Wt. ½ lb.	6.40

B. 15 Foot Tree Pruner with Wood Poles

Cord-actuated pruner blade cuts limbs up to 1-1/8" diameter. (A multipower leverage system increases your pull on the cord 15 times for quick, easy cuts.) The 16", needle point, teflon-coated saw blade cuts on pull stroke to reduce binding. Three 5' wood poles may be quickly assembled and taken apart. Complete with pruning head, cord, three 5' poles, and saw.

81044	Model 34S-10. Complete. Sh. Wt. 7½ lbs.	$31.25
81045	Model 134H. Repl. head pole. 5'. Sh. Wt. 1½ lbs.	5.70
81046	Model 134E. Repl. ext. pole. 5' Sh. Wt. 1¾ lbs.	5.70
81038	Model 2011B. Repl. saw blade. Sh. Wt. ½ lb.	6.75

C. Pole Pruning Saw

Durable, 16" saw blade adjsuts to three different positions on the aluminum head. Large hook for pushing branches, raising ropes, etc. Built-in paint brush holder for applying tree wound paint. Sawhead only. Order poles separately.

81048	Model 20 Sawhead. Sh. Wt. 1 lb.	$12.35
81050	Model 102 Head pole for 81048. Length: 5¾'. Diameter: 1¼". Light, durable spruce. Sh. Wt. 2 lbs.	15.40
81051	Model 103. Extension pole for 81048. Length: 6'. Diameter: 1¼". Light, durable spruce. Sh. Wt. 2 lbs.	17.60
81052	Model 1P12. Single section pole for 81048. Length: 12'. Diameter: 1¼". Light, durable spruce. Sh. Wt. 3¾ lbs.	25.30
81146	Model 106FG. Fiberglass pole. Fits 81048 head when equipped with 81147 adapter (below). Fits 81050 head pole directly. Sh. Wt. 2 lbs.	18.80
81147	Model 3FG. Adapter for attaching 81146 to 81048. Sh. Wt. ½ lb.	5.30
81049	Model 20B. Repl. blade for 81048. Sh. Wt. ½ lb.	6.00

D. Tree Trimmer Head Cuts 1" diameter limbs.

Strong, malleable iron pruner has steel chain working through a ball bearing pulley for a powerful "center-cut" action. Trimmer head only. Order poles separately.

81030	Model 111 Trimmer Head. Sh. Wt. 1½ lbs.	$15.0
81050	Model 102. Head pole for 81030. Length: 5¾'. Diameter: 1¼". Light, durable spruce. Sh. Wt. 2 lbs.	15.4
81051	Model 103. Extension pole for 81030. Length: 6'. Diameter: 1¼" Light, durable spruce. Sh. Wt. 2 lbs.	17.6
81052	Model 1P12. Single section pole for 81030. Length: 12'. Diameter: 1¼". Light, durable spruce. Sh. Wt. 3¾ lbs.	25.3
81146	Model 106FG Fiberglass pole. Fits 81030 trimmer head when equipped with 81147 adapter (below). Fits 81050 head pole directly. Sh. Wt. 2 lbs.	18.3
81147	Model 3FG. Adapter for attaching 81146 pole to 81030 trimmer head. Sh. Wt. ½ lb.	5.3

E. Tree Trimmer Head Cuts 1½" diameter limbs.

Heavy-duty, malleable iron pruner head has steel cable chain working through a ball bearing pulley for a powerful, "center-cut" action. Trimmer head only. Order poles separately.

81031	Model 12 Trimmer Head. Sh. Wt. 4 lbs.	$31.7
81032	Model 202. Head pole for 81031. Length: 5¾'. Diameter: 1¾". Light, durable spruce. Sh. Wt. 1½ lbs.	18.5
81033	Model 203. Extension pole for 81031. Length: 6'. Diameter: 1¾". Light, durable spruce. Sh. Wt. 2½ lbs.	23.0
81107	Model 21. Tapered pole for joining 1¾" wood poles to 1½" wood pole. Length: 6'. Sh. Wt. 3 lbs.	22.0

F. Fiberglass Tree Pruner Pole

Fiberglass with foam core for greater dielectric strength. Length: 6' Diameter: 1¼". Fits 81048 Pole Pruning Saw and 81030 Tree Trimmer Head when equipped with the 81147 adapter (below). Fits 81050 head pole directly.

81146	Model 106FG. Sh. Wt. 2 lbs.	$18.8
81147	Model 3FG. Adapter for attaching 81146 pole to 81048 saw head or 81030 trimmer head. Sh. Wt. ½ lb.	5.3

Forestry Suppliers, Inc.

205 W. Rankin St. - P.O. Box 8397
Jackson, MS 39204 TELEX 585-330 FORSUP INC JKS.

Order TOLL FREE 1-800-647-5368 24 hours
MS 1-800-682-5397 24 hours
AK, HI CALL COLLECT 0-601-354-3565 8 am - 5 pm CT.

BILL TO: Customer Number _____

TYPE OR PRINT

SHIP TO: UPS shipments must have street or highway address.

TYPE OR PRINT

Date _____ P.O. No _____ Authorized Signature _____ Phone _____

PRICES in this catalog were current at press time. If the price of an item you order has increased by a reasonable amount, your order will be shipped and billed at the higher price. If the increase is substantial, we will call or write for your permission to ship at the higher price. If you want to be notified of any increase before your order is shipped, check here ☐.

PAGE NO.	STOCK NO.	QTY.	UNIT ea. etc.	DESCRIPTION	UNIT PRICE	TOTAL PRICE
NOT REQUIRED						

PAYMENT METHOD

☐ VISA ☐ MasterCard

If MasterCard include numbers above your name

Expiration Date _____ Signature _____

☐ PAYMENT ENCLOSED
☐ CHECK
☐ MONEY ORDER
☐ C.O.D.
☐ OPEN-ACCOUNT CHARGE. See back.

TOTAL	
SALES TAX of 6% on shipments to Mississippi addresses	
SHIPPING & INSURANCE CHARGES (See Back)	
TOTAL AMOUNT	
AMOUNT ENCLOSED, if any	

PLEASE X THE APPROPRIATE BOX

In my opinion my work is best related to the following:

1. Forestry: ☐ Practicing ☐ Research ☐ Education
2. Wood Products Industry: ☐ Wood Production ☐ Wood Mfg
3. Agriculture: ☐ Production ☐ Research ☐ Education
4. Engineering Surveying ☐
5. Utilities: ☐ Electric ☐ Water ☐ Gas ☐ Phone ☐ Sanitation ☐ Oil
6. Mines Minerals Geology: ☐ Location ☐ Protection ☐ Reclamation
7. Recreation: ☐ Parks ☐ Wilderness Areas ☐ Museums ☐ Libraries
8. Wildlife Biology: ☐ Practicing ☐ Research ☐ Education
9. Construction: ☐ (Not Eng. or Surv.) ☐ Real Estate
10. Education (Other than above) _____
11. Environmental Protection: ☐ Land ☐ Water ☐ Air ☐ Industry
12. Other: _____

My employer is

1. Government: ☐ Municipal ☐ County ☐ State ☐ Federal
2. ☐ Private Industry
3. ☐ Self
4. ☐ Other _____

Thank you for this order. Each of us at **Forestry Suppliers, Inc.** hopes this merchandise will make your day easier and more rewarding.

Send Catalog 32 (for 1982-83) to:

Name _____
Employer _____
Address _____
City, State, Zip _____

INSTRUCTIONS FOR BUILDING A ZIG ZAG AIR SEED SEPARATOR

You can build a Zig Zag Air Separator easily from materials available on the market. In these instructions, the terms for specific parts refer to terms used on page 3 of the enclosed brochure, "Solve Your Separator Problems." These terms are underlined.

If you sell a Zig Zag Air Separator that you build, based on the design of Scientific Separators, Inc. you may be infringing on patent rights.

Make the Zig Zag Air Separator column from 3 inch PVC plastic pipe and 60° angle elbow/couplers (also PVC). The straight pieces should be approximately 14 inches long.

Make the cyclone collector from a metal can or wooden box with the bottom open. Make the bottom portion of the cyclone collector from canvas or rice bags (to control the seed cleanings) hung around the open bottom of the can or box.

Make the input hopper from a metal can, a plastic container or a wooden box. A wooden box is better, for the bottom should be slanted, narrowed to a one inch opening to feed the seed into the open portion of the tube housing the auger. A plastic or metal tube with a portion of the tube cut out 6 inches in length (top cut out to ½ the diameter of the tube) in which a 1 inch auger is inserted (could be slightly larger or smaller) to serve the same function as the air seal rotary feed. A "geared" motor is suggested as the power source for the auger, which would provide a slow-adjustable speed to regulate the rate of seed being fed into the air separator column.

Insert a one inch plastic pipe into a hole made in the air separator column and make it air tight to serve as the gravity discharge. Fit a window or hardware screen over the end of a straight piece of PVC plastic pipe (no. 10) and into a sleeve or coupler (no. 12) to prevent seed from going into the blower pipe. Connect the flex-tubing comming from the air source to the other end of the PBC plastic pipe (no. 11).

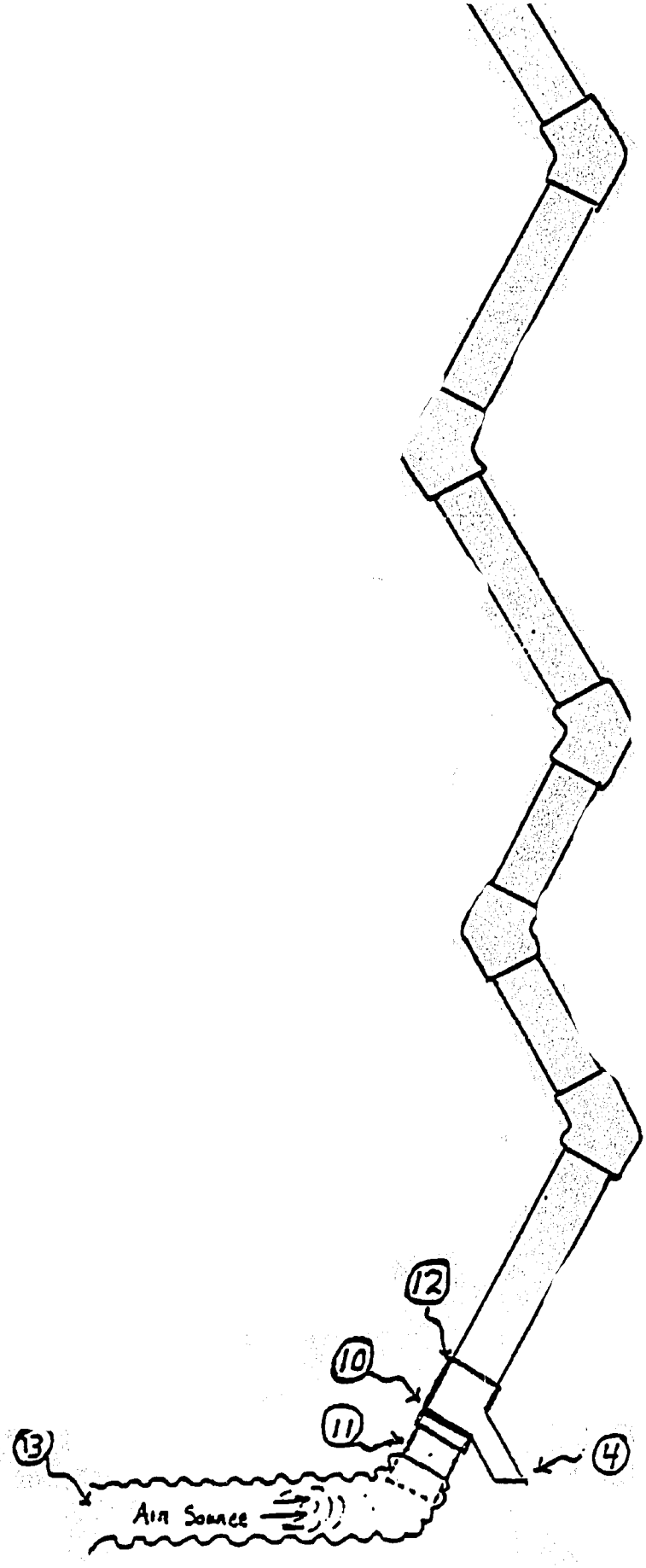
The air source (blower) can be provided by a gasoline powered ECHO - SOLO Back Pack Power Air Blower, Model PB400, or, if electricity is available, a similar electric air blower (see attached).

The throttle on the blower motor controls the speed of the motor, which in-turn regulates the air flow. The speed of the auger and rate of seed fed into the separation column is regulated by changing the gear ratio of the gear motor. The two are adjusted until the desired seed separation is obtained.

When assembled, fasten the Zig Zag Air Seed Separator to the side of a building, a large sheet of plywood or a tree for operation.

MDB

(CUT ALONG DOTTED LINE AND ATTACH TO FIGURE 1 on NEXT PAGE)

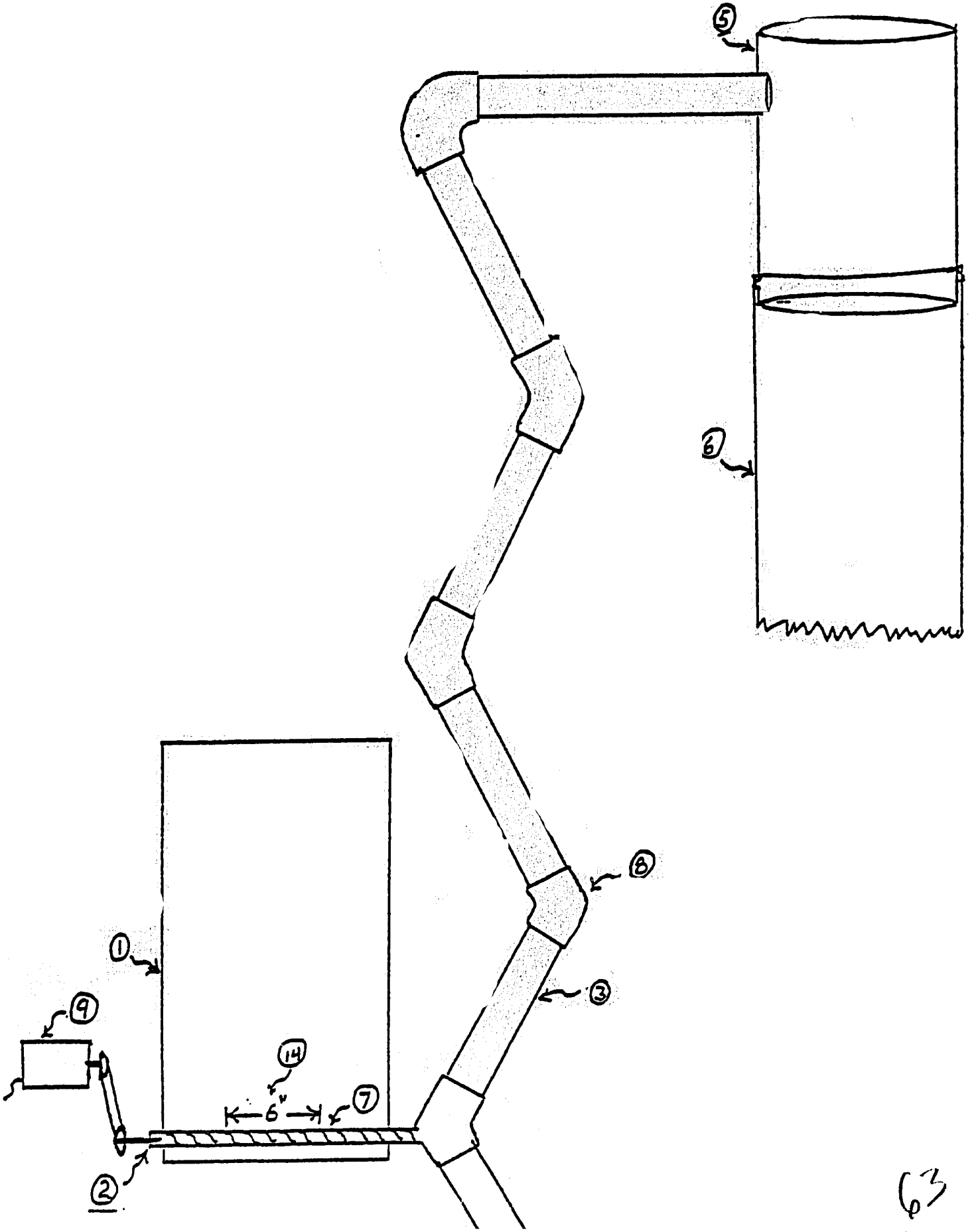


NOT DRAWN TO SCALE

LEGEND ON ATTACHED PAGE

FIGURE 2

FIGURE 1



LEGEND

1. Imput hopper made from wood and slanted at bottom so that seeds feed into auger.

2. Rotary feed made from a one inch auger (or from a wood drill bit or similar tool).

3. Zig Zag air seperation column made from straight pieces of PBC plastic pipe.

4. Gravity discharge for seed.

5. Cyclone collector made from a metal can or wooden box with open bottom.

6. Lower part of cyclone collector made from rice bags or canvas.

7. Auger housing made from a metal or plastic tube which has a 6 inch section cut out (top half of tube) to allow seed to enter the auger.

8. 60° angled elbows/couplers.

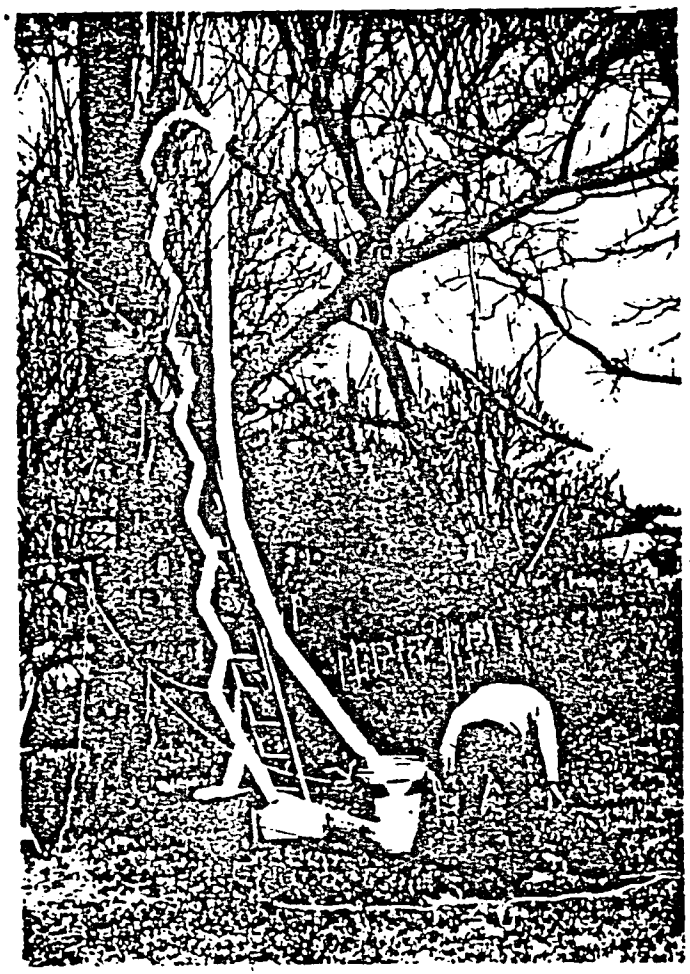
9. A gear motor (suggested) as the power source to drive the auger.

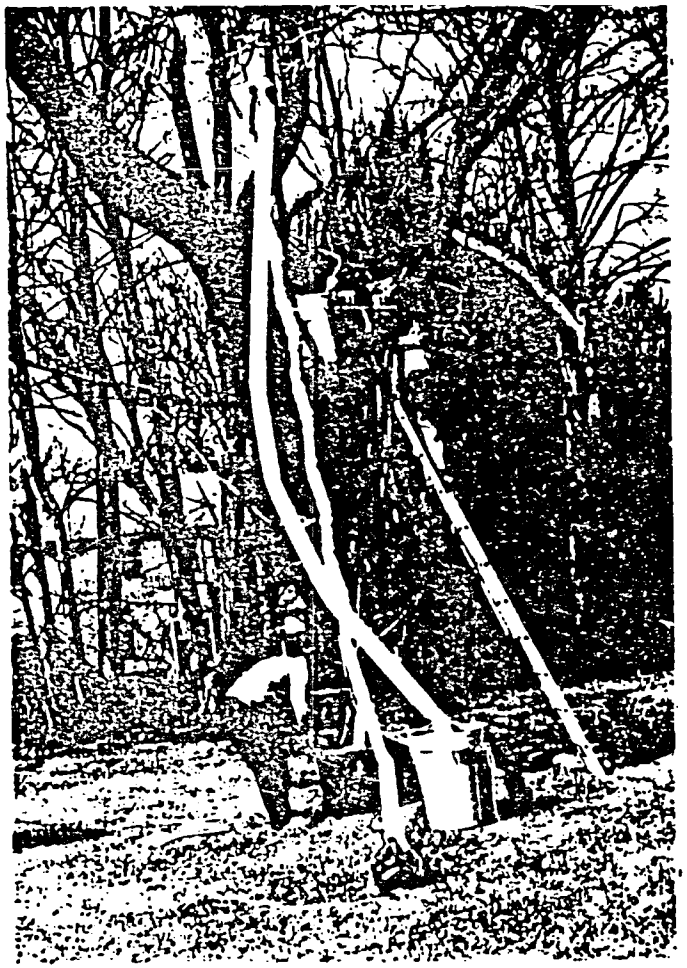
10. Screen (window or hardware screen) to keep seed out of the blower tube.
11. St
11. Straight piece of PBC.

12. Sleeve or coupler.

13. Source of air from blower (see attached for sample blowers).

14. A 6 inch opening in the auger housing to allow seed to flow into the auger.





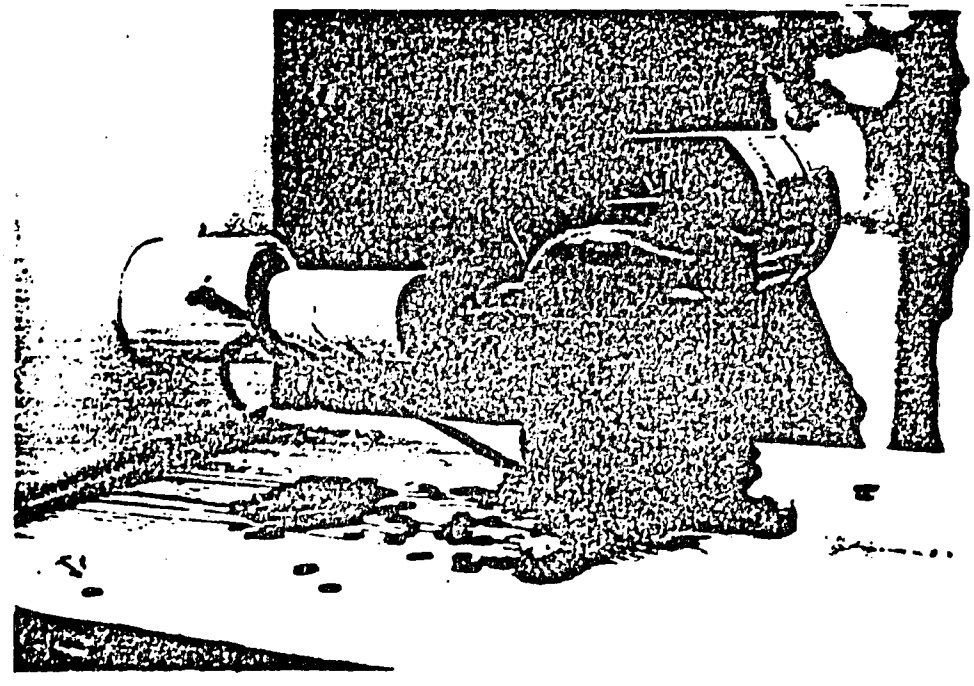
The picture to the left shows a side view of the Zig Zag Air Separator secured to a tree and in operation. In the lower right of the picture, the air source - blower - is shown (#13), the lower left the gravity discharge container for the seed (#4), the middle (in the fork of the tree) the input hopper (#1), and the very top middle the cyclone collector - discard discharge (#5) to which a polyethelene tube is fastened , feeding the discards into a plastic container (#6). In the picture to the right, the input hopper (#1) is being refilled with seed.

BEFORE -- Leucaena seeds before cleaning by Zig Zag Air Separator. Notice high concentration of trash and small, broken, fungus-covered, mutated and insect-damaged (small bore holes caused by tamarind weevils) seed.

AFTER -- Seeds are free of trash and damaged seeds. Also, the seeds are relatively uniform in size.

DISCARDS -- Although it is hard to see in the upper picture, all of the seeds were either damaged by insects, covered with fungus, broken, small or mutated. Approximately 8-10 % of the seed becomes discards when the seed is processed through the Zig Zag Air Separator. If the seed is sized by screening and processed through the separator, approximately 15 % becomes discards.

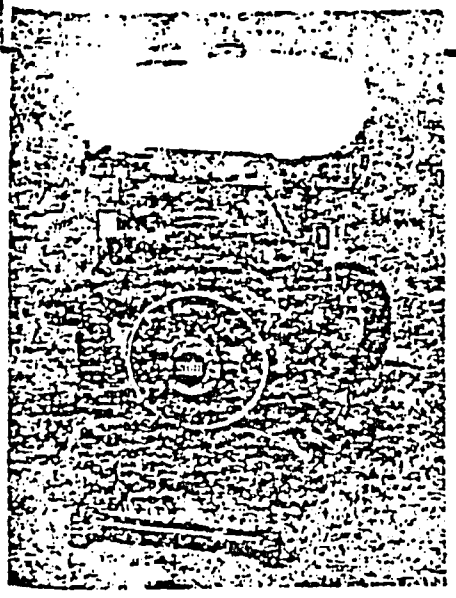
The picture below is of a AC-DC 1/15 HP gear motor with an electric speed control (#9). This is the power source for the auger (#7) which feeds the seed from the input hopper (#1) to the separation column (#3).



PG
Prices Guaranteed on selected items till Nov. 1, 1982.

Mist Blowers, Air Blower...

...for all your spraying, misting, fogging, or blowing needs.



High Concentrate Mist Blower

Consists of engine/blower unit only. (You supply formula tank and transportation.)

Discharges mist through 8 moveable nozzles; reach is 20' up or across. DISCHARGE RATE: 1 quart to 4½ gallons/min. Powered by 12½ hp, 1 cylinder, 2 cycle SOLO engine. FUEL: two cycle mix of 1:25 to 1:50; fuel tank holds 3½ gallons. Available with teleblast gun nozzle for 35' reach in whatever direction nozzle is pointed.

13200 MIST BLOWER w/o FORMULA TANK. Supplied with 10mm (3/8") i.d. hose to connect to formula tank. For connecting hardware, see Formula Tank Connecting Set. Sh. Wt. 83 lbs. **$953.50**

13201 MIST BLOWER with TELEBLAST GUN NOZZLE. For 35' reach in direction selected. W/o formula tank. With 10mm (3/8") i.d. hose to connect to formula tank. For connecting hardware, see Formula Tank Connecting Set. Sh. Wt. 95 lbs. **1,089.50**

Formula Tank Connector Set. All hardware needed to connect tubing from the 13200 or 13201 mist blower to the formula tank. Includes 2 nipples, 2 nuts, 2 O-rings and 2 clamps.
13202 Sh. Wt. 4 lbs. **7.50**

Formula Agitation Kit. All tubing and hardware needed to extract some moving air from mist blower and inject it into the formula tank for agitation.
13203 Sh. Wt. 1 lb. **23.95**

OPTIONAL ACCESSORIES

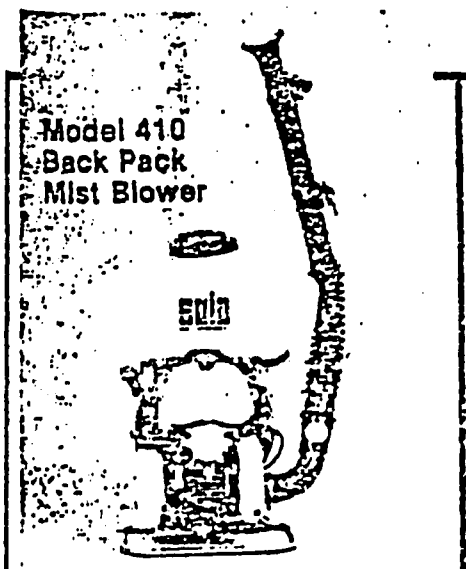
Hand Spray Gun Attachment. For low pressure (up to 30 psi), directional spraying. Includes wand with nozzle, on-off spray control, pressure gauge and 30' of tubing for connecting to mist blower.
13204 Sh. Wt. 10 lbs. **$72.95**

Herbicide Boom. Mounts on mist blower for no-drift herbicide applications. Boom is 7' long. Each end has a spring-loaded, flexible extension with 1 flat, fan-spray nozzle. Boom is fed by the mist blower hydraulic pump while the 8 blower nozzles are capped (see nozzle caps at right). 3 additional nozzles (optional, order separately) may be added for complete 7' wide coverage.
13205 Sh. Wt. 3 lbs **$165.95**

Optional Boom Nozzle.
13206 Sh. Wt. 4 ozs. Each **$19.25**

Nozzle Caps. Eliminate air blow from mist blower during boom usage. (8 required.)
13207 Sh. Wt. 1 oz. Each **.75**

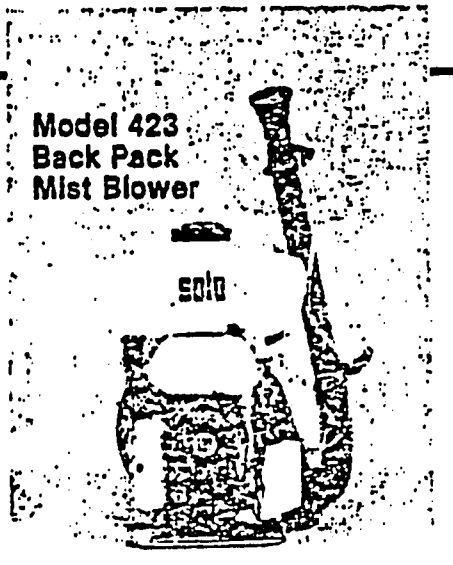
Teleblast Gun Nozzle Only. Interchanges with 8-nozzle attachment on 13200 mist blower.
13208 Sh. Wt. 21 lbs. **269.95**



Discharges mist 25' horizontally, 19' vertically. Single-cylinder, air-cooled, two-cycle engine produces 3 HP and has fuel tank holding 9 U.S. quart. Formula tank holds 2.6 U.S. Gallons. Corrosion-proof plastic frame over tube steel reinforcements. Translucent formula tank with content level marks. Padded adjustable carrying straps. DIMENSIONS. 24" x 16" x 8". WEIGHT. 16 lbs. empty.

13194 Sh. Wt. 23 lbs. **$411.95**
13197 Dusting Kit. Sh. Wt. ½ lb. **13.95**

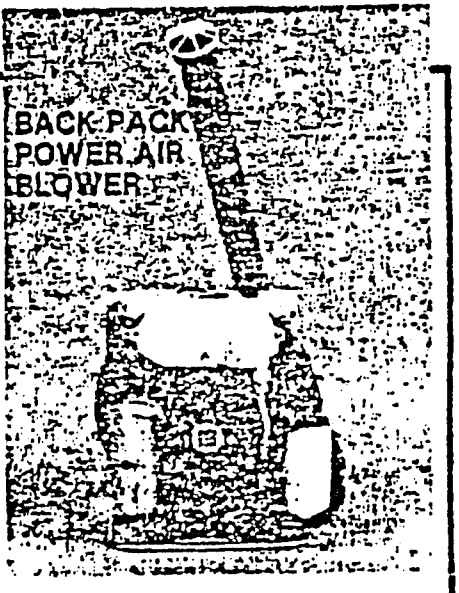
Dosage Pieces for Granulate Chemicals.
Use with 13197 to apply granular chemicals. Includes 9 dosage pieces for regulating output from 10 oz./min. to 148 oz./min.
13185 Sh. Wt. ½ lb. Per set of 9 pieces **$9.50**
13192 Flame Thrower Attachment for Model 410. Sh. Wt. 3½ lbs. **$84.50**



Discharges mist 33' horizontally, 25' vertically. Single-cylinder, air-cooled, two-cycle engine produces 5 HP and has fuel tank holding 1.6 U.S. quarts. Formula tank holds 3 U.S. gallons. Corrosion-proof plastic frame over tube steel reinforcements. Translucent formula tank with content level marks. Padded, adjustable carrying straps. DIMENSIONS. 27" x 18" x 12". WEIGHT: 25 lbs., empty.

13196 Sh. Wt. 32 lbs. **$537.50**
13198 Dusting Kit. Sh. Wt. 1¼ lbs. **34.95**

Dosage Pieces for Granulate Chemicals.
Use with 13198 to apply granular chemicals. Includes 9 dosage pieces for regulating output from 10 oz./min. to 148 oz./min.
13185 Sh. Wt. ½ lbs. Per set of 9 pieces. **$9.50**
13193 Flame Thrower Attachment. Sh. Wt. 3½ lbs. **$83.50**



A 5 HP (SAE), 2-cycle, air cooled SOLO engine creates a powerful 225 mph air blast. Designed to be carried like a backpack, the Power Blower weighs a comfortable 22 lbs. With the accessory 5 foot extension tube attached, foresters can construct fire lines by blowing away the leaves, litter and duff from the forest floor - in much less time than is required when using fire rakes. Horticulturists can clean lawns, flower beds, and rock gardens. Maintenance personnel can "sweep" litter from around seats in theatres or sports arenas.

13175 Sh. Wt. 24 lbs. **$472.50**
13176 SOLO 5' Extension Tube. Sh. Wt. 1½ lbs. **$19.95**

Forestry Suppliers, Inc.

205 W. Rankin St. - P.O. Box 8397
Jackson, MS 39204 TELEX 585-330 FORSUP INC JKS.

Order TOLL FREE 1-800-647-5368 24 hours
MS 1-800-682-5397 24 hours
AK, HI CALL COLLECT 0-601-354-3565 8 am - 5 pm CT

BILL TO: Customer Number _____

TYPE OR PRINT

Date _____ P.O. No _____ Authorized Signature _____ Phone _____

SHIP TO: UPS shipments must have street or highway address

TYPE OR PRINT

PRICES in this catalog were current at press time. If the price of an item you order has increased by a reasonable amount, your order will be shipped and billed at the higher price. If the increase is substantial, we will call or write for your permission to ship at the higher price. If you want to be notified of any increase before your order is shipped, check here ☐.

PAGE NO.	STOCK NO.	QTY.	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE

NOT REQUIRED

PAYMENT METHOD (Check one)

☐ VISA ☐ MasterCard

If MasterCard, include numbers above your name

Expiration Date _____ Signature _____

☐ PAYMENT ENCLOSED
☐ CHECK
☐ MONEY ORDER
☐ C.O.D.
☐ OPEN-ACCOUNT CHARGE. See back

TOTAL	
SALES TAX of 5% on shipments to Mississippi addresses	
SHIPPING & INSURANCE CHARGES (See Back)	
TOTAL AMOUNT	
AMOUNT ENCLOSED, if any	

PLEASE IN THE APPROPRIATE BOX

In my opinion my work is best related to the following:

1. Forestry: Practicing . Research . Education
2. Wood Products Industry: Wood Production . Wood Mfg
3. Agriculture: Production . Research . Education
3. Engineering Surveying
5. Utilities: Electric Gas Phone Telephone Oil
6. Mineral Minerals Geology: Location Production Reclamation
7. Recreation: Parks Outdoorman Area Museums Libraries
8. Wildlife Biology: Practicing Research Education
9. Construction: (Pulp Log or Saw) Heat Fuel
10. Education (Other than above)
11. Environmental Protection: Land . Water . Air Industry
12. Other

My employer is

1. Government: Municipal County State Federal
2. Private Industry
3. Self
4. Other

Thank you for this order. Each of us at **Forestry Suppliers, Inc.** hopes this merchandise will make your day easier and more rewarding.

Send Catalog 32 (for 1982-83) to.

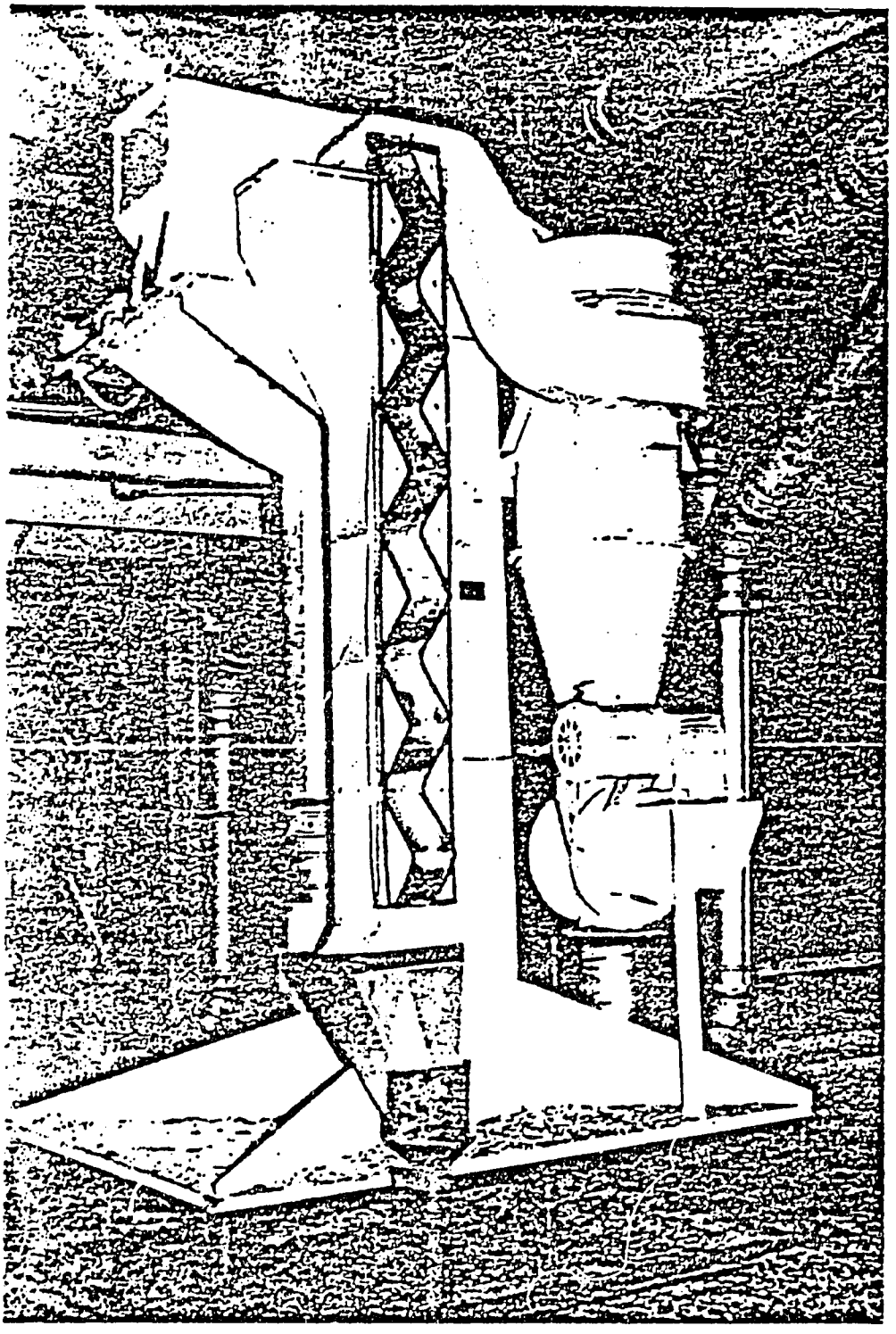
Name _____
Employer _____
Address _____
City, State Zip _____

Sears CRAFTSMAN

979933

ELECTRIC PowerBlower

For fast, easy clean-up
all around your home



SOLVE YOUR SEPARATION PROBLEMS

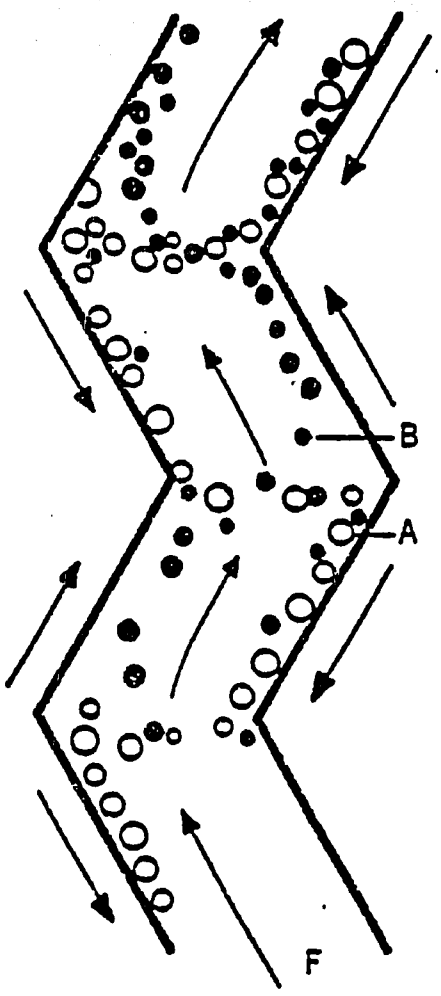
Patented-
Dry Particle-
Air Classifier

SCIENTIFIC SEPARATORS, INC.

621-17th Street, Suite 1515
Denver, Colorado 80293

• TEL. (303) 623-6178

71



The sketch above depicts how separation of dry, particulate materials are made. Arrows on each side of the column indicate direction of material flow. Coarse, heavy, material, "A", cascades down the zig-zag column. Finer, lighter material, "B", is carried upward in the air stream.

Product is exposed to upward air flow, "F", at each bend in the column, thus giving the effect of a multi-stage separation. It is this principle that enables our equipment to accomplish extremely precise classifications with extremely minute density differences in the material.

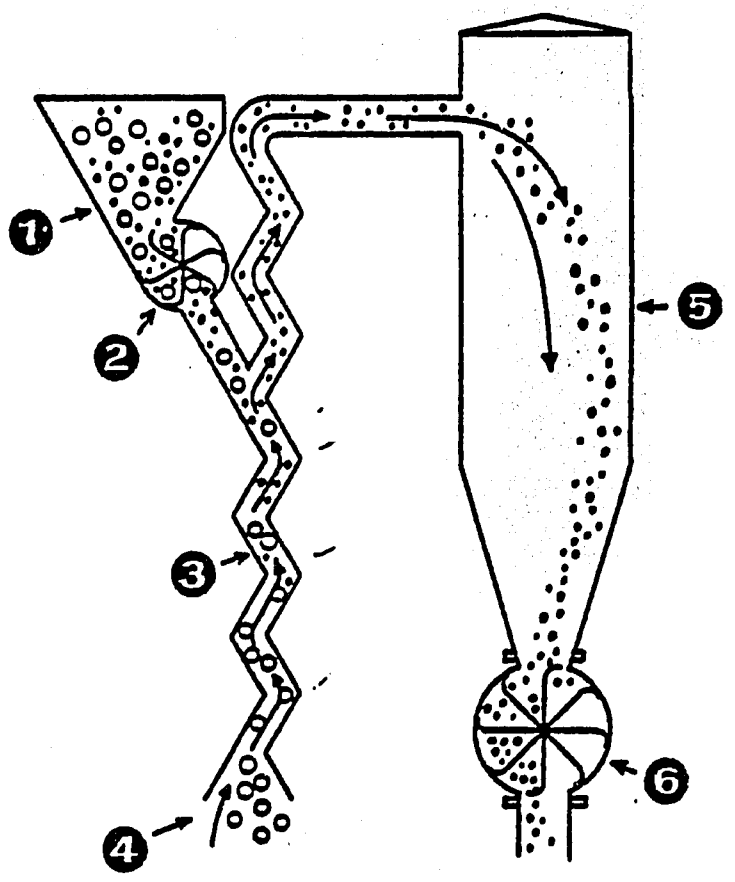
The Scientific Separator is a multistage air classifier for use in separation of dry particulate materials. Its basic features are as follows:

- No moving parts in actual separation process.
- Gentle action minimizes product damage.
- Separates product mixes that have previously not been feasible to separate economically.
- Heavy gauge metal construction.
- Low cost installation, operation and maintenance.
- Dust free operation.
- High capacity at low power consumption.
- Air exhaust may be recirculated to create a closed system.

The Scientific Separator employes a multi-stage zig-zag column. Air is drawn up this column, through a cyclone and out the exhaust blower. Product to be classified is fed into the column at an intermediate point. Actual separation takes place at each zig-zag in the column. Lighter (or smaller) material is drawn up through the column and into a cyclone collector. Heavier (or larger) material settles down and out the bottom of the column. Materials can be classified as to size, density, shape, or surface texture. Any particles larger than 100 microns can be classified. Operates as efficiently at low loadings as at design load.

Applications of Scientific Separators range from dehydrated foods to chemicals. Some uses include removing bone chips from bone meal, spider webs from mushrooms, sand from powdered mushrooms, alfalfa leaf from stems, skins from meats of dehydrated onions, cleaning of raw materials such as peanuts or beans, dedusting of borax and other chemicals, removal of contaminated seed from pure seed, and recovery of salable material from various kinds of waste streams. The chart on this page will help you visualize how our equipment applies to your product. Many progressive companies are replacing outdated, less efficient machinery with SSI trouble-free air classifiers.

1. Input hopper
2. Air seal rotary feed
3. Zig-zag air separation column
4. Gravity discharge (heavy material)
5. Cyclone Collector
6. Air seal rotary discharge (light material)



STANDARD MODELS (12 ZIG-ZAG STAGES)

MODEL	A-154	A-26	A-312	A-418	A-630	A-848	A-1060
Lbs. Per Hour*	250	500	1,500	3,000	7,500	16,000	25,000
Column Cross Section	1½" x 4"	2" x 6"	3" x 12"	4" x 18"	5" x 30"	8" x 48"	10" x 60"
Blower:* H.P.	½	1	2	3	5	10	15
CFM	65	130	390	780	1,950	4,150	6,500
Cyclone:* Diameter	12"	14"	16"	23"	33"	51"	62"
Height	3'	3'8"	4'3"	5'10"	8'8"	14'4"	17'2"
Overall: Length	4'4"	5'3"	6'	8'	10'	11'	12'
Width	2'8"	3'9"	4'3"	4'9"	5'6"	6'	7'3"
Height	5'2"	6'6"	7'4"	12'9"	14'	18'4"	21'6"
ADDITIONAL FEATURES Rotary Feed and Discharge	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Variable Feed	Std.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.
Plexiglass Front	Std.	Opt.	Opt.	Opt.	N/A	N/A	N/A
Air Meter	Std.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.
Stainless Steel	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.

*Capacities are based on average material encountered (bulk density 30 lbs. per cubic foot). Actual capacity, cyclone size, and blower horsepower will depend on actual material to be separated. Actual capacities will range from ⅓ to 3 times the listed capacities depending on bulk density and aerodynamic character of the material.

Due to variety of uses, it is not uncommon to modify various components sizes, such as a change in column dimensions, size of blower, cyclone or hopper; or ceiling mounting may be desirable.

Each individual customer's requirements are reviewed by our staff to determine modifications that may be required.

We would be pleased to separate a 10 to 20 lb. sample of your product in our laboratory. Results of such samples will be returned to you without charge for your examination.

Any dry particulate product mix varying in size, shape, bulk density or aerodynamic character.

CAPACITY	APPLICATION
As required — up to 100,000 lbs. per hour in a single unit	Any dry particles 100 microns and larger

ADVANTAGES

Minimum product damage

Continuous flow

Dust free operation

Automatic operation

Low maintenance

Economical operation

Few moving parts

High capacity

SCIENTIFIC SEPARATORS, INC.

621-17th Street, Suite 1515
Denver, Colorado 80293

• TEL. (303) 623-6178

MECHANIZED EQUIPMENT FOR SEED PURITY ANALYSIS

- Laboratory seed separating equipment
- Mechanized seed separating equipment
- Seed inspection equipment
- Mechanized plot research equipment
- Rapid, accurate aids for determining seed quality
- Modernize purity analysis

With today's high cost of labor, most laboratories must minimize the time spent in manual manipulation of seed. This equipment relieves some of the tedious time-consuming manual work involved in seed purity analysis. Permits the operator to examine the maximum number of seeds in the minimum amount of time, while maintaining the accuracy of manual inspection. MAT-OSU high quality, high integrity equipment helps to assure high caliber laboratory work.

VIBRATORY SEED SEPARATOR Single deck. Furnished with 5 interchangeable decks. Complete with electric vibrator feeder, electromagnetic vibrator, 6 precision controls. Self-cleaning, versatile. Makes many difficult seed separations. Does not require air; uses textured deck to separate on the basis of shape and surface texture. Eliminates hand labor for separating specific mixtures. Used in laboratories all over the world for handling small quantities of seed. Makes separations not possible with specific gravity machine. Capacity about ½ lb. per hour.

1-1459 Separator $2524.50

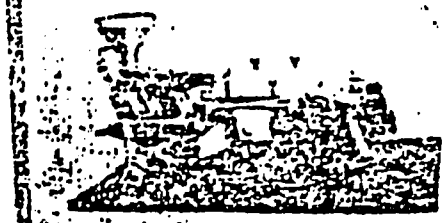
30-DECK VIBRATORY SEPARATOR Handles larger volumes of difficult seed separations. Precision machine successful in purifying grass seed, carrot seed, clovers and other crops. Permanently textured aluminum decks (30), uniform vibrator feeding. Capacity about 15 lbs. per hour. Complete with electric vibrator, precision controls, dividers, and seed pans.

1-1460 Separator $5995.00

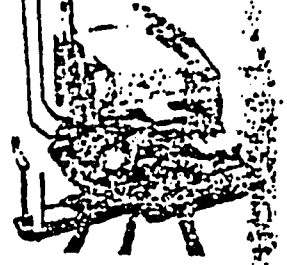
VELVET ROLL SEED SEPARATOR Separates seeds on the basis of surface texture. Easy inspection, clean out, and control of machine variables. No possibility for contamination between seed lots. Vibratory feeder meters seed from hopper to fabric-covered rolls. Adjustments are readily made for each separation. Used by seed laboratories to check for dodder in alfalfa and other legumes. One pound samples of seed are easily run and allow a good monitor on certified seed quality. Complete with electromagnetic feeder, controller rheostat, aluminum housing, precision adjustments, permanent frame, and covered rolls

1-1461 Separator $4471.50

Best Available Document



Vibratory Seed Separator



30-Deck Vibratory Separator

INCLINED DRAPER SEPARATOR Separates flat, rough, or elongated seeds from round, smooth seeds; useful for tailings in laboratory separations. Vibrator feeder meters seed from hopper to endless belt. Machine provides for variation in angle of incline and speed of belt. Readily cleaned. Complete with free-standing steel frame, belt, variable speed gear motor, electromagnetic vibrator feeder, galvanized catch pans, and V-belt drive.

1-1453 Separator $6010.50

LABORATORY DEBEARDER Easy to operate. Can handle very small quantities. Does not damage the seeds. Gently mills awns against each other and special baffles in the agitator drum. Removes difficult awns, hairs, separates doubles. Vibrator feeder meters seed to drum. Complete with steel hopper, vibratory feeder, drive, and outfeed door.

1-1454 Debearder $2210.00

TREATED SEED INSPECTION STATION Protects the seed analyst from toxic dusts and vapors from treated seed during purity analysis. Includes an exhaust system to remove dust and fumes from enclosed working area, vibrator feeder to move the seed along a trough, vacuum pick-up for contaminants (other crop seed, weeds, inert matter), combination magnifying glass and light, table, lamp, and foot switch.

1-1455 Inspection Station $2359.50

MICROSCOPIC INSPECTION STATION Uses the best magnification system available to examine the maximum amount of small-seed legumes, grass seed, and other seed types (grain, flower, tree, etc.). Operator can learn to use with very little practice. Two vibratory feeders move seed under stereozoom microscope. Useful for treated seed. Microscope can move forwards and backwards for examination of a section of the band of seed. Magnification can be readily increased when required for identification purposes. Diaphanoscope available. Vacuum pick-up with probes supplied for removing contaminant seeds.

1-1456 Station $2920.50

(lists stereozoom microscope and light)

Stereozoom microscope and light (mounted) 1188.00

Optional diaphanoscope [illegible]

CONTINUOUS SEED BLOWER Provides all advantages of standard pneumatic separator with additional features of uninterrupted feeding and separation of large and small samples, requires minimum operator attention. Capacity: 10-140 lbs. per hour, depending on seed weight. Disassembly of separating tube not required between separations. Versatile tool for crop specialists; effective in making difficult separations. Quality features include fine wood cabinet on casters. Stainless steel tubes, precision controls. Free-standing cabinet. Handles small quantities or larger lots available for larger capacities. Complete with vibrator feeder, blower unit, collecting receptacles, mounted in cabinet with required controls.

1-1457 Blower $4680.50

AUTOMATIC DIVIDER SUBSAMPLER Solves one of the most difficult problems of seed lot inspection: obtaining small representative samples from larger lots. Will obtain samples of less than 1 gram. Produces representative subsamples of large and small seed lots of either large-seeded or small-seeded species. Includes accurate, precise electronic shut off device for controlling sub-sample weights. Vibrator feeder regulates and places seed exactly over chromed dividing cone. Precision made for precision work. Complete with vibrator feeder, Dial-O-Gram balance, electric and electronic controls, seed hopper, and seed containers. Mounted on base.

1-1458 Subsampler $6088.50

All MAT-OSU mechanized equipment comes completely wired. Ready to operate, when connected to available power supply. 115v or 220v, 60 cycles. 50 cycle control additional. Operation and Maintenance manuals supplied for all equipment.

Also available: 500-Deck Vibratory Separator • Vibrating Inspection Trough • Fluidized Seed Conveyor • Indent Cylinder Separator • Vertical Rotary Screen Separator • All Purpose Plot Threshers • Bean and Pea Plot Thresher • Plot Separator • Precision Planter Equipment • Seed Sample Crusher • Suction Seed Remover • Indent Cylinder • Custom built Equipment.

[illegible]

Seedburo Equipment Co.
[illegible] WEST JACKSON BOULEVARD, CHICAGO, ILLINOIS 60607
PHONE (312) [illegible]
TWX 910-221-[illegible]

TAIWAN

Hu, Ta-Wei and Chih-Cheng Liu. Division of Silviculture, Taiwan Forestry Research Institute, 53 Nan-Hai Road, Taipei, Taiwan, R.O.C.

VEGETATIVE PROPAGATION OF LEUCAENA BY LEAFY CUTTINGS UNDER MIST SPRAY

Due to some hybrids of Leucaena leucocephala with other Leucaena spp. are fast-growing but sterile, research for practical methods of vegetative propagation is necessary. In August, 1980, twigs were taken from 1- and 3-year old trees of leucaena (K72) and cuttings of 15 cm long were made into the following 3 categories: 1. Leafy twig cuttings with 3 leaves and the terminal shoot retained, 2. Leafy twig cuttings with 2 to 3 leaves retained and 3. Leafless twig cuttings. A 2 x 3 factorial test in complete randomized block design with 5 replications was conducted in greenhouse under intermittent mist spray. Twenty cuttings of each plot were inserted in coarse sand of the propagation bed in two rows. The spacings of each cutting in one row is about 6 cm and row to row is 15 cm apart.

Thirty-five days after the establishment of the test, number of rooted cuttings was examined and the results are shown as follows:

Age of ortet trees	Category of cuttings	No. of cuttings tested	Cuttings rooted (%)	Ave. % for age class
1-Yr	Leafy twig cut. with shoot	100	100	
	Leafy twig cut. without shoot	100	97	
	Leafless twig cut.	100	52	83
3-Yr	Leafy twig cut. with shoot	100	50	
	Leafy twig cut. without shoot	100	37	
	Leafless twig cut.	100	0	29

The figure shows that vegetative propagation of leucaena by leafy twig cuttings under mist spray is highly possible. Twigs from younger trees have higher percentage of rooted cuttings. Juvenility of ortet trees seems an important factor for vegetative propagation by cuttings. Ramets from adult ortet trees may be rejuvenized under cultivation and can be used for supply of cutting materials for vegetative propagation.

LEUCAENA RESEARCH REPORTS, Vol. 2, July, 1981, Council for Agricultural Planning and Development, Taiwan.