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Jojoba—An Alternative Agriculture in the Caribbean Area

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The need for a substitute for sperm whale oil and for a lubricant to replace depleting fossil fuel reserves has been a strong incentive for the development of jojoba, a plant native to the southwestern U.S. and northern Mexico. Its popularity now is based upon its ability to grow in soils of marginal fertility, needs little water, withstands salinity and seems not to need fertilizers and chemical treatments. Jojoba can be grown, but can we afford to produce a crop? How much will it cost to produce? What will it yield? What will it sell for once production increases? These are major questions. Continuing research is needed to determine optimum plant spacing, male-to-female ratios, fertilization, weed-disease-insect control, cultivation and harvesting techniques. Answers to these questions take time and continuing genetic breeding must be done before consistently high yielding can be expected. The cost of producing jojoba appears to be economically feasible now, based upon existing knowledge. Plantations now need to be developed on large enough scales to demonstrate jojoba growing feasibility. This system will provide a basis for establishing this industry in the Caribbean when the need for raw materials becomes acute.

JOJOBA: What is it?

A 45-ton 75-foot long sperm whale and a desert bush share a natural miracle: both produce highly prized unsaturated oils that have a multitude of industrial and consumer product uses. But because the hunted leviathan is an endangered species, its oil cannot be imported into the United States. Actually jojoba is a better natural substiture. An acre of jojoba could replace the oil taken from 30 sperm whales.

Jojoba (pronounced ho·*bo*'·ba) is a shrub of the Sonoran Desert that has recently received widespread attention. Its almond-shaped seeds contain an oil for which many uses have been suggested. Much of the popular attention jojoba has received is due to the fact that jojoba can be substituted for sperm whale oil.

An important industry based on utilization of jojoba is now present in the southwestern U.S., Mexico and Israel. New experimental plantations exist in Brazil, Argentina, Spain, India, Paraguay, Chile, West Australia, Italy and Sudan. Two factors point optimistically toward a successful jojoba industry:

1. Extensive stands of jojoba exist throughout the southwestern U.S. and northern Mexico in numerous suitable locations with a minimum of irrigation.
2. A wealth of scientific literature and laboratory tests indicate considerable potential for a variety of jojoba products.

General Information

The native habitat of jojoba is in the Sonoran Desert of Arizona, California, and Mexico covering 100,000 square miles between latitudes 25 degrees and 31 degrees North. Extended, this area would be in the Bahamas and Southern Florida. There are many populations varying from a few individuals to several hundred per acre, and some populations where millions of individual plants occur. In the Sonoran Desert this dioecious (male and female flowers occur on separate plants) evergreen shrub generally occupies elevations between 2,000 and 4,000 feet. However, in Baja, California and some locations in Sonora it occurs at sea level. Rainfall throughout its range is 5" to 18" annually. Temperatures range from highs of 115°F. to lows of 15°F., but seedlings are sensitive to frosts. Jojoba is considered an important year-round forage plant for many desert animals. It is also excellent browse for game and livestock, and the seeds are utilized by birds and rodents. However, seed meal is highly toxic to humans and most animals unless detoxified.

Potential Uses

The oil is actually a liquid wax made of straight-chain acids and alcohols that are difficult and expensive to artifically produce.

Small manufacturers are using all they can lay their hands on to produce high-priced cosmetics like moisturizers, conditioners, shampoos, sun screens, and after-shave lotion.

In its solid state, jojoba oil can be a cheaper replacement for carnauba wax, beeswax, and other plant-derived waxes now selling for up to $2 per pound. This shorter term market is a billion dollar one itself; imports of carnauba and beeswax to consuming nations total 20,000 tons.

Sperm whale oil used to be the best natural, high-pressure lubricant available, but now jojoba can tolerate higher tensions without breaking down and is faster migrating. It requires little or no refining and is easily sulfurized into lubricants for auto transmissions, heavy machine parts, and even artificial hearts. As a crankcase additive, some vehicles have increased gas mileage by 13%.

Solid jojoba wax is almost identical to polyethylene and can be mixed with it for cheaper manufacturing of petrochemical-based plastics. Other uses include detergents, auto and floor waxes, inks, carbon ribbon coatings, candles, linoleum, varnish, protective coatings on fruit and paper containers, and sizing for yard goods.

One pharmaceutical manufacturer uses jojoba oil as an excellent antifoaming agent in the production of penicillin and in the making of tetracycline. Even the oil extracted meal has value as an animal feed supplement, yielding 20-30% protein and as a high-nitrogen fertilizer.

Economics

Total production figures for 1984 are not currently available but should exceed 500,000 pounds of oil . . . nowhere enough to meet demands from cosmetic firms, small oil companies, and larger corporations doing industrial research and production. However, pricing for jojoba oil is running at $40-$50 per gallon in 55 gallon drums and during this most recent season seed pricing remains high at $5-$7 per pound. It takes about 2½ pounds of seed to make one pound of oil using current methods of extraction. There are 7.2 pounds of oil to the gallon. Thus, jojoba oil selling for $6-$8 per pound makes jojoba the highest priced agricultural product in the world with the exception of opium and marijuana.

Current research shows that an acre of plantation jojoba can produce up to 3,750 pounds of seed when the plants have

reached maturity. Therefore, if you had just one acre producing only 3,000 pounds it would gross $9,000 to $16,500 in existing dollars. That is exciting to growers! But let's be realistic and understand that forecasts by experts for 1990 estimate four million pounds of jojoba oil to be available, and economists believe that pricing for seed and oil must drop due to this increased supply and that oil will sell for $1.50-$3.00 per pound by the mid-1990's. Their predictions are based upon late '70's dollars and don't count on inflation. If we assume $1.05 per pound for jojoba seed in 1990 and a yield of 3,000 pounds per acre, the gross profit per acre would be over $3,150 which is very high when compared to other cash crops.

Long-Term Investment

An investment in the planting of jojoba must be considered as a long-term proposition. Forecasts show that an acre of jojoba should return $1,125 gross cash yield in the fifth year, gradually increasing to just over $3,150 in the tenth year. We are assuming 750 producing females per acre, each averaging four pounds of production in the tenth year. Realistically, there should be no produerion during the first four years, with plant yield in the sixth year averaging one pound and increasing to four pounds by the tenth year.

Jojoba: How to Grow It

There are many unanswered questions regarding jojoba's domestication as a monoculture crop. Anyone deciding to grow jojoba should do so with a clear understanding of the risks involved. In fact, all commercial plants should be considered research projects. Much agricultural research is needed to determine aspects of jojoba cultivation such as spacing, male-to-female ratios, disease and insect control techniques, control chemicals, water requirements, fertilizer requirements, tissue culture methods, and sex identification characters. Further, many of these aspects will vary depending on local temperature, precipitation, and soil type. The following comments and suggestions for growing jojoba are based on data obtained from farmers and published sources.

Land Preparation

In nature, jojoba usually is restricted to well-drained, coarse mixtures of gravel and clay desert soils. Thus, most well-drained soils should be suitable for jojoba cultivation. The amount of land preparation necessary depends upon the site condition and type of irrigation system to be employed. Precise leveling is not very necessary with sprinkler or drip irrigation systems. I highly recommend drip irrigation using biwall tubing in the Caribbean area due to reduced water losses by evaporation.

What to Plant

The basic materials available for planting are seed, seedlings, and propagated material. Each of these materials offers certain advantages which are highlighted below. In every case the source of parent material should be known. The chances of a plantation yielding large quantities of seed are substantially increased if the parent is located in a similar environment.

Direct Seeding

Many large plantations have been planted by direct seeding with the seed placed about one inch below the surface. Soil should be moist several feet below the surface and should be amply watered from the time of planting until shoots emerge. Maintenance of soil moisture is important to provide fast and deep growth of the tap root, although poorly drained water-saturated soil will cause the seed to rot and will drown the seedling. The major factor of direct seeding is the reduced cost. The major disadvantage is possible lack of a uniform stand due to ro low rates of seed germination.

Seedlings

Potted jojoba seeds germinate in almost any well-drained soil or soil mixture. A mixture that has worked well consists of 25% topsoil, 25% sand, 25% peatmoss and 25% bark soil conditioner by volume. Jojoba seed should germinate in one to two weeks if a morning soil temperature of 80-85°F. is maintained. Jojoba may be transplanted after three to six weeks in a hothouse. Older plants have the advantage of hardiness at the time of transplant and thus may have a higher first year survival rate. A variety of seed pots are available commercially. Most common are cylindrical plastic or square open-ended cardboard sleeves. However, losing plants from root damage has been a problem. In addition, pulverized paper or milk-carton type pots which will decompose if planted directly in the ground (so manufacturers claim) have been designed. The major advantage to planting a seedling is that you have planted something that is growing and should continue to grow, whereas seeds will not all germinate and grow. Further, the rodent problem is not as severe with seedlings.

Propagated Material

Cuttings—Jojoba has been propagated by making stem tip cuttings of new growth. All leaves should be left on the cutting except for the length of the stem that is placed in the rooting medium. A rooting hormone is helpful. Place cuttings in vermiculite or sand and, if possible, keep them under mist conditions or keep the root medium saturated. Rooting by this method may take approximately 30 days and is often successful without expert attention.

Tissue culture—Tissue culture is a highly specialized laboratory technique. Plants are cultivated on a culture medium from shoot tips, lateral buds, and nodes of mother plants. Although still in an experimental stage, tissue culture potentially offers a "prescription approach" to plant selection whereby combinations of disease resistance, high yield, growth form, site specificity, and sex determination could be controlled.

How to Plant

Plant spacing is one of the major unknown factors. Researchers differ in opinion as to how many rows and plants of jojoba to have per acre. The most widely accepted approach is to have 800 to 900 shrubs per acre with a ratio of female to male of 6:1, or 750 female plants. With this technique, rows would be 10 feet apart with plants spaced 5 feet apart in each row. Some have gone to 5 foot spacing of rows 20 feet apart so that they could intercrop. Others have found an intercrop detrimental to growth. Plant and row spacing continues to be guesswork. In the second and third year after planting seeds, remove excess or unhealthy plants. You must wait two or three years before thinning because until the shrubs flower, you cannot tell whether they are male or female. Females have a small, bell-shaped blossom while males have a cluster of tiny flowers.

Irrigation

Native jojoba populations have been known to grow in areas with less than 12 inches of rainfall per year, but little is known about their ability to produce seed during periods of drought. Plantation may survive and produce seed in areas with only 15 to 20 inches of rainfall, but areas with less rainfall will almost certainly require supplemental irrigation.

Fertilizing

Natural populations of jojoba grow in areas of marginal fertility. Greenhouse experiments indicate that jojoba responds to nitrogen and phosphorus treatments.

Cultivation

Enough cultivation should be provided throughout the years to reduce the competition from weeds, whose growth will be enhanced by irrigation. Pre-emergent herbicides have been used with some success.

Male:Female Ratios

Jojoba is a wind-pollinated plant. Only the females produce the seed; the males provide the pollen. Thus both male and female plants are necessary in the plantation. Since light breezes carry the pollen several feet, male plants should be present every few feet on the row ranging from 1 male to 7 females to a 1:5 ratio. The optimum number of male plants per acre and their planting pattern may have to be determined on the basis of prevailing wind direction, velocity and frequency.

Seed Production

Since jojoba is still a wild species, the response of individual plants to cultivated conditions will vary greatly, and it can be expected that seed productivity will vary greatly between female shrubs. The first year of blooming should occur during the plant's second or third winter. The first seed set will amount to only a handful with seed production increasing each year until plant maturity at 10 to 12 years of age.

Harvesting

At present, most native stands are hand-harvested. Mechanical harvesting on some plantations is being attempted using modifications of existing fruit and nut picking equipment such as plastic nets, sweepers, vacuums, or shakers. Continuing work is being done with improvements on such equipment.

Exaggerated claims about the ease of growing jojoba *commercially* could not be further from the truth. Jojoba will grow with very little care and spatse water, but the key word is commercial. There are many factors involved in developing a plantation that has consistent commercial yield, which is vital to any cash crop. Site selection is the key to maximum commercial yield. Early Caribbean commercial producers will benefit most from current high prices. A price drop will improve prospects for those with the foresight to plan for it. With careful planning and ongoing management of a jojoba investment, your plantation just might turn you into a unique sort of oil tycoon who capitalizes on a renewable resource instead of drilling holes in the ground or destroying majestic sea creatures.

Status of Jojoba Growing in the U.S. Virgin Islands

The original intention of attempting to grow jojoba on St. Croix was to have the oil source near existing commercial markets on the U.S. East Coast, thereby reducing transportation costs of either seeds or oil. Through the assistance of Dr. Darshan Padda of the C.V.I. and the Extension Service, two experimental plots were made available for the planting of seeds, each on successive years. Each plot was approximately one-half acre in size. The 1981 plantings were started in seed pots while the 1982 plantings were directly seeded into the ground. In both cases, minimum attention was given to the seedlings after they germinated, *i.e.*, only rainfall watering, no fertilizer and minimum cultivation. This was really a difficult test but we wanted them handled under almost adverse situations. The three year old shrubs, now over a meter tall, have blossomed and need only to be culled and sorted by sex to increase production and to allow additional experimentation to occur.

Another one-half acre planting was made by direct seeding through the helpful assistance of the Department of Agriculture in St. Croix. I was advised of total failure of this attempt due to the cows in an adjacent pasture succeeding in breaking down a fence and eating the seedlings.

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