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New Crops from Brazil

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INTRODUCTION

Brazil and especially the unexplored regions of the Amazon, are extremely rich sources of plant germplasm with potential as new crops. Establishing the correct selection criteria is important to evaluate the true potential of the many promising species by calling attention to their assets and to the missing information and problems facing each species. This must be accomplished efficiently to justify the considerable investment in relevant research needed to develop the most promising plants into commercially viable crops.

Much of the current interest in new crops arises from the over production of traditional cereals and soybeans by major producer and exporting countries. This has led to the expensive practice of paying farmers to leave land idle in the USA, clearly an undesirable situation. Furthermore, traditional markets like Europe and the developing world are increasing their own production to relieve their shortages and reduce their imports. In some cases, these countries are even compelling in export markets with their surpluses. Examples are the

explosion of rape seed in Europe and the large amount of soybeans now being produced by Brazil and Argentina. The tendency is to replace imports, hence the interest in the USA in finding alternatives to rubber (e.g. guayule), lauric oils (e.g. *Cuphea*) and cellulose (e.g. kenaf). This in turn will force traditional producers of these products to search for alternative crops as well.

There are many other good reasons for looking to new crops. These include the need to diversify from vulnerable dependence on the few major grain crops, the increasing interest in novelty foods, the industrial requirement for new compounds (e.g. new colorants, polyvinyl plastics), and new nutritional recommendations (e.g. gamma linolenic acid and new low calorie sweeteners). There is also a need for new crops to expand agriculture into marginal lands, especially in the tropics where few viable alternatives are found. New systems like agroforestry and biomass production also may require new crops.

SELECTING NEW CROPS

Ideally, having decided on a precise need, one would then look for a plant that has the desired characteristics. In practice what has tended to happen is that a botanist studies an interesting species and then tries to find a market for it. However, there are a series of characteristics that a wild plant must have if it is to ever make the large jump from botanical curiosity into viable crop. These include agricultural industrial and marketing characteristics (Arkcoll and Clement 1989). It should be easy to propagate, precocious, rustic, productive, be easy to harvest, and fit into current farm practice. The product must be easy to transport, store, and process. It should also be able to enter an established market at a competitive price or should be so attractive that a new market can be easily created.

We have been evaluating some of the most interesting species in this light in an effort to reduce the number to a few with the greatest potential. These and other species being developed in Brazil, are examined below to draw attention to the current stage of development, the missing data and the major problems that each one faces.

Bactris gasipaes (Peach palm, Pejebaye)

The Peach palm has attracted much attention in the last decade because of the texture and composition of the fruit mesocarp which is usually similar to that of a starchy cereal or root crop. It is consequently an important backyard tree in much of tropical Latin America and is used as a dietary staple by some Amerindian tribes (FAO 1986, Clement and Arkcoll 1989). The small crown and very high yield of some trees have suggested that it could be a useful plantation crop capable of producing large amounts of basic food in the wet tropics. We have been studying this potential as an important part of attempts to create ecologically attractive "food forests" to produce food from a permanent perennial system (Arkcoll 1978, 1979, 1984). Some introductions are very rich in oil (62% of mesocarp dry matter) suggesting that selecting for this character would be an interesting alternative because of the local and world markets for oil and protein rich meals (Arkcoll and Aguiar 1984). Most fruit have a bland taste that is not exotic enough to export, however some with a sweetish flavor may have more potential as a table fruit and at least expand local markets. The crop has only been grown on a large commercial scale for palmhearts in Costa Rica where over 2000 ha have been planted. The viability of this venture has been dependent on Government subsidy as it is difficult for plantations to compete with raw material coming from wild *Euterpe edulis* in Brazil. It is especially interesting as a source of palmhearts because it tillers and grows extremely fast (Gomes and Arkcoll

1987). Unfortunately, this vegetative vigor is proving to be a problem in fruit production as the fruit are produced too high above the ground to harvest after a few years. Precocity has been observed and there are signs of different growth rates suggesting that researchers might locate dwarf phenotypes. Managing tillers as in banana plantations, is also being considered. While individual stem yields of over 80 kg/yr. have been recorded, plantation yields have been frustrated by uneven bearing and tremendous fruit drop caused by poor pollination, drought, nutrient deficiencies, and principally pests and diseases. It is hoped that these problems can be controlled the crop is better understood. The successful selection and combination of desired characteristics could make this crop as important as the coconut in the wet tropics.

Astrocaryum aculeatum (Tucuma)

Tucuma, a heavily spined palm, is of interest because of the oily mesocarp and large kernel. A very brief examination of a few dozen introductions from the Manaus market, identified one with over 30% oil in the fresh fruit (Arkcoll et al. 1986, Arkcoll 1988). However, the species is only used locally for the direct consumption of the very thin pulp. This is bitter, nutty, and oily and rarely appreciated by the newcomer. However, it is so appreciated by locals that it costs as much as a dollar a dozen. Despite the premium price, tucuma is not grown commercially because there are enough native trees to satisfy demand. The species often becomes dominant in secondary forests because of resistance to fire and perhaps this characteristic can be used to recover worn out and abandoned pasture (FAO 1986). Difficulty in breaking seed dormancy and slow initial growth, have dampened the enthusiasm of research workers, but the large variation found in *A. vulgare* (Lima et al. 1986), a similar species with several stems, suggests that both species deserve more attention.

Acrocomia aculeata (Macauba)

Macauba palm is somewhat similar to the last palm in that its fruit have a large amount of both pulp and kernel oil and together with several very similar species, is widespread throughout central and Latin America often on poor soils. Its apparent tolerance to drought, makes it an attractive species for producing oil in regions that are too dry for the African oil palm and coconuts. The very high yield predictions of 6 t/ha (Wandeck and Justo 1982) have not been confirmed yet because of difficulties in breaking dormancy and slow early growth. Rapid hydrolysis of the mesocarp oil and difficulty in separating oil from the moist, fibrous and mucilaginous pulp, are among the other problems that still have to be faced (FAO 1986, Arkcoll 1988).

Cuphea spp.

The several hundred widely spread species in this genus have been of interest for about a decade, because of the unique composition of their seed oils. This varies with species, with the most interesting having over 80% lauric acid (Graham et al. 1981, Graham and Kleiman 1985). As most species are small herbaceous plants and many are adapted to the colder regions of highland Mexico, it is hoped that a mechanized crop suitable for temperate climates might be developed and reduce the dependency of lauric oil importing countries on wildly fluctuating supplies from coconut producers. Satisfactory yields have not been achieved in the USA because of shattering (Hirsinger and Knowles 1984, Hirsinger 1985). Attention has been drawn to several other problems such as seed dormancy, slow growth and the variable chromosome numbers and fatty acid composition observed in different species (Arkcoll 1988). Many wild species have not yet been studied and an effort is being made to collect this germplasm in order to locate desirable characteristics. Research is also in progress to obtain indehiscence through mutations and also to splice the appropriate *Cuphea* genes into a

conventional crop such as rape (Thompson 1984, Tokay 1985). Sudden success in either of these efforts could lead rapidly to the development of an important new crop to supply the enormous market for lauric oils. It would also help to expand markets for medium chain (mixtures of C8 and C10) triglycerides that have considerable commercial potential, especially as lubricants and nutritionally desirable and medically useful oils (Bach and Babayan 1982). There is considerable interest in the pharmacological properties of extracts from the whole plant of some species used as a cure-all in local folk medicine in Brazil. There is now scientific confirmation of several potentially useful separate effects including depression of the central nervous system and the ability to reduce blood pressure in experimental animals (Ericeira et al. 1984).

Annona muricata (Soursop)

The large fruit of the soursop is much appreciated in several Latin American countries mainly as a sweetened juice but also as an ice cream and yoghurt flavoring. Several small commercial plantations are now in operation with about 2000 ha planted in Brazil and more planned. Yields have been disappointingly low, rarely reaching 7 t/ha in plantations sown from seed. Yields from individual trees very significantly suggesting that considerable improvement could be achieved via clonal selection. Production problems include low fruit set due to poor pollination and adverse climatic conditions and the attack of several devastating pests and diseases (FAO 1986). The flavor is somewhat volatile so pasteurized products are less attractive than fresh ones, and the off white color can become an unpleasant grey unless oxidation is prevented. The premature sale of several poor bottled products is thought to have limited market penetration. Frozen and chilled products seem more successful elsewhere (Arkcoll 1987), especially in regions where the fresh fruit is well known and appreciated.

Eugenia stipitata (Araçá-boi)

Araçá-boi, a little known fruit from the Western Amazon is very attractive in appearance and has an exquisite fragrance. Although extremely sour to the taste, the sweetened juice has performed well in acceptance trials. In early performance trials two-year old bushes produced high yields (FAO 1986). The main production drawbacks are susceptibility to anthracnose, soft fruit texture and volatility of aroma. Consequently, resistance is being sought, firm fruit are harvested a little green with small loss in quality and the market will probably be restricted to fresh and frozen products. Studies on the aroma are planned as this may have a market in its own right.

Psidium angulatum (Araçá-Pera)

This is one of the most interesting of the many wild acidic guavas known collectively in Brazil as Araçá. Its sour juice is so concentrated that it must be diluted 10 times and well sweetened to produce a very acceptable drink. Once again, the delicate flavor is affected by heating so that fresh and frozen products are superior to pasteurized juices. The fruit comes from the eastern Amazon and there are only a few experimental plantations at the moment. Initial impressions are that the plant is rustic and productive although the yields are low compared to guavas. Interspecific breeding may be promising. The leathery skin should avoid damage during transport and together with the high acidity, give some resistance to insect attack. Fruit are quite variable and clonal selection is needed to obtain superior introductions (FAO 1986). Another wild acidic guava receiving attention *is Feijoa sellowiana* from the extreme south of the country (Mattos 1986).

Spondias lutea (Taperebá, Cajá)

Taperebá or Cajá is one of the most popular fruit in the North and Northeast of Brazil. The fruit itself is rarely eaten directly as the pulp is thin and usually quite sour, however it makes a superb sweetened juice and ice cream or ice lollipop of excellent flavor. The flavor is volatile and pasteurized products are not attractive. No plantations are known which is surprising as the demand is in excess of the current supply from the many large trees found scattered at low density over a wide area of forest. Trees grow fast from seed but take over 5 years to fruit. Like most *Spondias,* they can be propagated easily from large cuttings to fruit quickly and reduce the size of the trees. This is important as the very soft fruit are often bruised when harvested from the ground beneath large trees. Most fruit are small and have a large seed and thin layer of pulp so a search is on for fruit said to be as large as *S. dulcis*. The tree appears to be rather rustic and productive although no data on yields is available (FAO 1986).

Theobroma grandiflorum (Cupuassu)

A highly perfumed pulp surrounding the seeds of Cupuassu, a large relative of Cacao, is much appreciated in the Amazon region for making sweetened juice, ice cream or charlotte desserts. It fetches the highest price of all fruits in the local markets and there are now several hundred hectares planted to supply the Belem and Manaus markets. Newcomers often find the aroma a little overpowering at first, but soon acquire a liking for it. This volatile aroma could be extracted and might find a market in the flavor and perfume industry. Yields are low in the field (Calzavara 1987) and there is only about 40% pulp in most fruit. Seedless fruit are known with larger amounts of pulp. However, the seed can be made into a number of chocolate-like products and so could become a useful byproduct if large scale production becomes viable (Arkcoll and Clement 1988). Selection for higher yield and resistance to witches broom is needed (FAO 1986).

Couepia longipendula (Egg nut)

Apart from the major Brazilian nuts, (cashew and brazil) there are many other interesting examples. One of these is *Couepia longipendula* (egg nut) because of its excellent flavor. This large tree is common in the forest around Manaus but although widely eaten in the rural areas, it never reaches the local market so is little known. The shell is hard and thick requiring an ax to break it. Nuts with thinner shells are said to exist in the forest. Trees are rather slow growing so grafting onto the more vigorous rootstock of *C. subcordata* is being considered (FAO 1986). The kernels are rich in oil which appears to have some unusual polyunsaturated fatty acids.

Couma utilis (Sorva)

Over 5000 t of sorva latex are exported from this plant each year as a substitute for chicle gum. Much of it is obtained by destructive tapping of wild trees. Because these are being decimated quickly, *Achras sapota* trees are slow growing and increasingly rare and industrial substitutes are contaminated with heavy metals, there is considerable interest in establishing plantations of *C. utilis*. A few experimental trees have grown very fast on poor soil but tapping yields have not been obtained yet. The tree is also very decorative and the good flavored fruit are sold in local markets. The fruit might become a useful subproduct of latex plantations, however, they are too soft and not thought to be interesting enough to consider more seriously in their own right (FAO 1986).

Paullinia cupana (Guaraná)

Roasted seeds of this plant are ground up to make an interesting cola type drink called guaraná. Over 1000 t are now produced annually in Brazil on about 5000 ha of poor oxisols. Vegetative propagation of selected plants is starting to increase yields and the local market is now thought to be saturated. An export drive is now in progress and seems to be having some success, especially in Japan. The drink owes much of its popularity to the stimulation produced by its high caffeine content and the widely held belief in its rejuvenating and aphrodisiacal properties (Cavalcanti 1988). Well formulated products can be very good although several of the most popular brands contained very little or no real guarana until recent legislation, aimed at supporting growers, made the inclusion of a small amount compulsory.

Stevia rebaudiana (Stevia)

Dried leaves from this small shrub from the south of Brazil, have been used as a local sweetener and cure-all for generations. The main active ingredient, stevioside, is said to be up to 300 times as sweet as sucrose. Extraction processes have been developed in Japan and Brazil and over 100 t/year sold in a purified form until recently when doubt has been cast over its toxicity and the mutagenicity of the metabolite, steviol (Pezzuto et al. 1985, S. Cascon pers. commun.). Studies are in progress to clarify this situation and some derivatives that are believed to be safe, have been synthesized and patented (Dubois et al. 1984). About a 100 ha are now planted annually in Brazil to satisfy the local demand, mainly by natural health shops for dried leaves. Yields of 2 to 3 t/ha of leaf with about 10% stevioside are obtained.

Bixa orellana (Annatto)

Restrictions on the use of many synthetic colorants and the relative instability of most other carotenoids, are leading to the increasing use of bixin, especially in the dairy industry. World production, estimated at about 3,000 t of annatto seed in 1983 (Anand 1983), is now thought to have risen rapidly to over 10,000 t, about half of which comes from Brazil. Until recently, annatto (or urucum as it is known in Brazil) was little more than a back garden crop. However, high prices and the good yields have resulted in a few farmers planting it on a larger scale. Yields, after 4 years, can pass 2 t/ha with 0.9 to 6.9% (average about 2.5%) bixin covering the seeds in a sticky resin (Nicholson 1964, I. Guimaraes pers. commun.). Yields from seedling trees are very variable as the crop is cross pollinated. Variation in the exact composition of the colorants in the final extracted products limits marketability. Vegetative propagation is easy and should make rapid advances possible especially if the crop is selected for a combination of yield and bixin content. The relatively small market for colorants could quickly become saturated so there is interest in the potential of this rustic perennial crop as an alternative grain for growing on exhausted tropical soils. The high yield potential despite any scientific attempts at improvement, makes it a very promising crop.

CONCLUSIONS

The above species have been identified by a series of multidisciplinary criteria as some of the best Brazilian options for development into new crops. They are found in various stages of development from early germplasm collection to small commercial plantations. Attention is drawn to some of the missing data and problems that they face if they are to overcome the risks of early commercial plantations and make the large

jump from botanical curiosities to useful crops. Appropriate research is now underway to collect the missing data and to resolve the problems, however it is bedeviled by a lack of continuity. Germplasm maintenance and work with tree crops, especially breeding, are very long term projects that funding bodies have failed to face so much research has been wasted in the past (Arkcoll and Clement 1989). Thought is needed on how one forms and keeps a multidisciplinary team together over many years in countries with wildly fluctuating economies and poor working conditions.

It is also well known that few crops have been successfully exploited on a large scale near their center of diversity because of indigenous pests and diseases, so that local research will probably benefit other regions of the globe. Thus, improvements in the exchange of germplasm are important if many new crops are to be fully evaluated and developed.

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