More than agronomic factors must be taken into account when promoting cassava in developing countries

MESSAGE TO AGRONOMISTS

JEAN-MARC FLEURY

"When you promote cassava in Third World countries, first be sure that you are not running the risk of inducing new diseases as a result of its toxicity.

"The first step is agronomic: introduce varieties low in cyanide content. Second, make sure the inhabitants' iodine intake is normal. Otherwise, the introduction of cassava risks provoking goitre and mental retardation."

If Dr François Delange, pediatrician at the Saint Pierre Hospital in Brussels, permits himself to make such recommendations to agronomists, it is because he belongs to a Belgian team of researchers who, in cooperation with l'Institut de recherche scientifique du Zaïre (Zaire Scientific Research Institute), have definitively disproved the conventional belief that iodine deficiency is the sole cause of endemic goitre. When iodine intake is below normal — as in the case of the inhabitants of Idjwi Island in Lake Kivu, and of the Ubangi region in the northwestern part of Zaire — the consumption of cassava plays a determining role in the development of endemic goitre and cretinism.

It is no news that cassava may have toxic effects. In communities where cassava is a regular part of the diet, stories abound of severe poisoning. They tell of diarrhea accompanied by bleeding, convulsions, coma, and occasionally death — particularly in the case of young children — following the consumption of large quantities of raw cassava, at least of bitter varieties. Poisoning is due to cyanide, which is present at various levels in cassava dishes. According to Dr B.O. Osuntokun of the University of Ibadan, Nigeria, 60 mg of cyanide is sufficient to cause death, and people in Nigeria ingest as much as 50 mg a day. This poison is present in cassava, a kilogram of which may contain anywhere from 30 to 150 mg of cyanide, depending on the variety.

Yet cassava is a staple food for 300 million people, and its popularity is steadily increasing. That cassava is so widely consumed is due, in part, to the fact that there are many ways of eliminating the cyanide. In fact, it is not directly present in the tuber. When growing in the field, the plant contains linamarin, a cyanogenic substance — that is to say, one that is capable of being transformed into cyanide. The plant also contains linamarase, an enzyme that turns linamarin into cyanide on contact, through hydrolysis.

As long as the plant remains intact, the substrate and the enzyme are kept apart. When the plant is harvested, however, damage and deterioration bring the two substances into contact. This is why the traditional processing methods of wetting, mashing, and drying in the sun — which seem to be ideal for bringing linamarin and its enzyme together — are in fact means of eliminating the cyanide through evaporation in the sun or by solution in water.

Yet there is always a certain amount of cyanide left, and in Indonesia and Nigeria chronic cyanide poisoning is the cause of a well-known pathological condition called tropical neuropathy. The disorder shows up as neurological disturbances associated with the action of cyanide on the spinal cord and peripheral nerves. Tropical neuropathy — a disease of those too poor to afford food supplements richer in protein — affects three percent of the inhabitants of certain regions of Nigeria, according to Dr Osuntokun.

WHAT CAN BE DONE?

According to WHO some 200 million people throughout the world are affected by iodine deficiencies, but Dr Delange says that this figure is a gross underestimation. The problem persists because people still believe that the solution lies in the distribution of iodized salt.

"This is a total misconception. We have been fighting WHO for years," says the pediatrician, "because it still believes that salt is the answer. In many countries these programs are ineffective because of logistical problems — the inadequate preparation of salt and poor distribution networks."

As part of their work in Zaire, the Belgian researchers wanted to prove that in an emergency situation a program focused specifically on the distribution of iodine was necessary. The method used consists of injections of iodine in an oil solution; the iodine is resorbed slowly, giving protection for three to seven years, depending on the individual's sex and age. After treating the people of Idjwi Island, the research team undertook to examine all the inhabitants of the Ubangi region, one by one. By the end of 1979 half a million people had been examined, making the Zaire program the most extensive of its kind.

"This is an extremely effective, totally harmless, and inexpensive method," states Dr Delange.

Thanks to massive injections of iodine in oil solution, which greatly alter the iodine/thiocyanate ratio in favour of the iodine, the number of goitre cases and mentally handicapped children in northern Zaire is dropping steadily and will continue to do so . . . at least for a few years.

Cyanide not only has a toxic effect on the nervous system; it also attacks the thyroid gland. It is now known that this toxic effect is due to a metabolic process that transforms cyanide into thiocyanate, a substance that prevents iodide, or salt of iodine, from being absorbed by the gland. The prime function of the thyroid is to synthesize hormones in which iodine is an essential constituent. These hormones stimulate the processes through which all the cells carry out their synthesizing functions. A shortage of these hormones slows growth and upsets all the metabolic processes. When daily iodine uptake drops below 100 micrograms, the pituitary gland "instructs" the thyroid cells to multiply, the gland hypertrophies or grows unnaturally, producing goitre.

The first person to attribute goitrogenic properties to cassava was Dr O.L. Ekpechi of the Faculty of Medicine, University of Nigeria at Enugu, in 1964. He had been struck by the disparities in the goitre rate of various villages. At Eha-Amufu, for example, he discovered that 38 percent of the inhabitants were suffering from goitre, whereas only 9 percent of the inhabitants of Nsukka were goitrous. He found that the water of Eha-Amufu contained three times as much iodine as that of Nsukka, a fact totally inconsistent with the conventional findings that a shortage of iodine in drinking water was the cause of goitre. A study of diet then led Dr Ekpechi to suspect cassava, and experiments on rats seemed to confirm an anti-thyroid action of cassava. It remained to prove the hypothesis and demonstrate the mechanism in humans. This was the goal of the team of Belgian and Zairean researchers, whose work was supported by IDRC.

The team began by examining the 38 000 inhabitants of Idjwi Island in the middle of Lake Kivu — an iodine-poor body of water — in northeastern Zaire. The researchers made a surprising discovery: the rate of goitre, both in humans and in rats, was extremely high, 55 percent on the northern part of the island, whereas it was only 5 percent in the south. "As goitre is caused by a shortage of iodine (the traditional explanation), we expected to see a relatively significant iodine shortage in the north," said Dr Delange. Much to their surprise the researchers found equally low levels in both regions — an average daily intake of only 13 micrograms of iodine. The traditional explanation was no longer valid, and another one had to be found. Could it be a matter of genetic differences? Impossible — everyone had the same ancestral background. The environment was also the same. But what struck the researchers was that, despite very similar diets, the people in the north consumed greater quantities of cassava than those in the south. They thus arrived at the same conclusions as Dr Ekpechi.

In 1973 the researchers left the region. A treatment program consisting of injections of iodine in an oil solution had eliminated goitre and, along with it, the possibility of continuing research. They then tackled the Ubangi region of northwestern Zaire, where endemic goitre afflicts 65 percent of the two million inhabitants. The region also has an unusually high rate of cretinism: between one and eight percent of the total population.

The iodine shortage of the region would in itself explain the presence of goitre, but the research team has shown

that the inhabitants' high levels of thiocyanate — due to the consumption of cassava — aggravated the effects of iodine deficiency. The effects of high concentrations of the compound showed up particularly in newborns and young children, among whom there is an extremely high congenital hypothyroidism rate of 15 percent. Many children suffer from neurological disorders so severe that they are labelled "cretinoids", and even children who exhibit no sign of cretinism show impaired psychomotor development. In fact, the ingestion of cassava by expectant mothers seems to be a significant factor in the development of the thyroid disorders observed in infants. "This disease in large part explains the intellectual and economic stagnation of the Ubangi region," concludes Dr Delange.

In short, the research team has proved that endemic goitre in northern Zaire, characterized by an exceptionally high rate of (myxedematous) cretinism compared with findings in most of the other instances of endemic goitre, results from an imbalance in the iodine/thiocyanate uptake ratio. The critical threshold is 4 micrograms of iodine for each milligram of thiocyanate. Thus, there is no opposition in principle to the consumption of cassava.

"Determine the amount of iodine ingested by a given population," says Dr Delange, "and you [agronomists] will know the amount of thiocyanate to which it can be exposed. As long as you are above this ratio no nutritionist can reproach you." □

Small farmers, like these in Senegal, could benefit from high-yielding cassava varieties, resistant to diseases and pests.

ICED CASSAVA

Because the diseases that affect cassava are not the same from one continent to another, the exchange of plant material between breeders is very strictly controlled to guard against any spread of disease. The mosaic virus, which infects cassava plants in Africa and India, prevents those areas from exporting their best varieties to other producing areas.

In Canada, scientists at the Prairie Regional Laboratory of the National Research Council of Canada in Saskatoon are currently working on a method that may hasten the unrestricted exchange of disease-free cassava material. Working with the financial support of IDRC, they have regenerated complete plants from a few cells taken from the tips of cassava stems. These cells form meristems; it is their multiplication that ensures the growth of the plants. Generally, meristems are not immediately susceptible to infection by viruses. As all parts of the cassava shrub grow from meristems, it is possible to grow plants free of mosaic by using only them.

Having completed this step, the Canadian team is now trying to perfect a procedure for storing meristems — which are barely 0.2 mm long — at −196°C, the temperature of liquid nitrogen. The researchers have already succeeded with beans and strawberries. If they can achieve the same results with this tropical plant, the cost of storing the genetic material will be reduced considerably and international exchange facilitated.

IF NOT DISEASE ...INSECTS

In the past 10 years or so, researchers have made giant strides in their efforts to improve cassava. In Africa, they have identified several varieties that are resistant to leaf mosaic, the tuber's number one enemy on the continent. In Southeast Asia and Latin America, so great is the fear of African mosaic that severe restrictions are placed upon exchanges of genetic material with Africa.

Just when the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, was beginning to produce some mosaic-resistant varieties that could have signaled a "cassava green revolution", along come two insects from South America that put researchers right back to square one.

The green spider mite is a cassava pest that has been making inroads in Uganda since the beginning of the 1970s. In some areas, small farmers lose up to half of their potential harvest to the pest. At present, the Institute has not found a mite-resistant cassava, although indications of resistance have been discovered in a Tanzanian variety. The IITA is hoping shortly to incorporate this quality in its high-yielding varieties.

But no one has yet discovered any varietal resistance to the cassava mealybug. In their struggle against this pest, researchers have resigned themselves to a long campaign of biological control. (see page 6)

Cassava experts scarcely expect to see the day when they have permanently vanquished all the enemies of the tuber. Still, they would very much like African farmers to benefit from new varieties that are low in hydrocyanic acid (HCN) (see page 8) and yield between 40 and 68 tonnes per hectare.