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EXPERIENCE IN BARBADOS WITH INTER-CROPPING AND ROTATIONAL-CROPPING WITH SPECIAL EMPHASIS ON MECHANISATION

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ABSTRACT

The Barbados Sugar Industry has a long history of inter-cropping and rotational-cropping, especially with root crops like sweet potatoes and yams. As recently as 1946, 25% of the acre-months were devoted to non-cane crops on sugar farms. The paper summarizes interesting aspects of this experience. Special attention is paid to mechanisation on the non-cane crops in the context of cane farm technology, mainly in Barbados.

INTRODUCTION

Contrary to popular belief, most of the older cane industries were "diversified" for much of their history and the sight of extensive areas of land growing nothing but cane is a relatively recent phenomenon.

The need to supply the labour and working animals with food, and the poor ratooning characteristics of early varieties, meant that sugar cane was typically harvested from less than half of the available acreage each year. For example, in Barbados we know that sugar cane was not reaped from more than half the arable acreage until the early years of this century and documents surviving from the early nineteenth century show a fascinating balance between cane production and non-cane crops (Hudson, 1987 b).

These old "sugar" farmers were constantly looking for useful alternative crops as well as seeking alternative products from sugar cane itself. It is worth making this point to encourage agronomists and planners to do more research into the "diversification" wisdom of the last century. For example, in Barbados the first reference to the production of mechanically harvested sweet potatoes (rotated with cane) is dated 1811 (Anon 1811)!

Barbados' Diversification in this Century

A threatened submarine blockade during the 1939-45 war forced the Government to instruct our sugar industry to try to produce much of the basic food required by the population whilst maintaining a good level of sugar production. This was successfully accomplished, except for the protein supply, part of which had to be imported in the form of salt fish, corned beef and milk powder. Since our population density was about 10 persons per hectare of arable land, the success was hailed as unique in the Weetern Hemisphere, though it certainly would not have been counted as unique in the Far East where elaborate cane/non-cane rotations can be found.

More details of this experience were given by Hudson (1987a) at the Geplacea Symposium on diversification held in Santo Domingo. The production of non-cane crops reached its peak around 1944 when the compulsory order to plant 35% of the acreage in non-cane crops resulted in approximately 25% of the arable acre-months being devoted to food crops. In 1946 the total production of non-sugar crops for human consumption amounted to 135 kg. per head per annum, whilst maintaining a sugar production for local consumption and export greater than today's.

For several years after the war the pattern was maintained and the 1950 FAO Agricultural Census records:

Total arable land being farmed - 26,700 hectares
Sugar cane was reaped from - 16,690 ha
Yams, sweet potatoes, beans, pigeon pea, maize, cassava, eddoes, fine vegetables and cotton were inter-cropped or rotationally-cropped on 6,847 hectares
The balance of 3,163 hectares included young plant cane without inter-crops and a small amount of fallow land.

The same census also records 15,000 head of cattle and 49,000 sheep and goats, which were supported partly on rough grazing but also depended heavily on cane tops, molasses and sweet potato vines. This production was equivalent to about 3/4 of a sheep per person, a significant contribution to the Island's protein supply.

The planting and harvesting of the non-cane crops was by hand. They were all planted on the banks between rows of "cane holes" into which the cane was subsequently planted. Applications of pen manure and mulching with grass and "bush" were usual. The "cane holes" formed a perfect erosion control on the typically sloping fields; the system is very ancient, probably originating in Greek times in the Mediterranean, and I believe it was used in north Brazil as well as other Caribbean Islands. A modern comparison is "basin listing" or "tied ridging" -- common in East Africa for example.

When, in the interests of cheaper production, cane holes were replaced in Barbados by ridge/furrow systems, erosion became serious. But it also simplified the growing of inter-crops and rotational-crops. These were grown on the banks, cane being planted in the furrows.

When the non-cane crop was removed, the furrows were later filled in to increase the depth of cane stalk anchored in the soil (i.e., as in Australia). However the difficulties of mechanising inter-cropping and partial inter-cropping where the non-cane crop is planted and reaped as "pure stand" and the cane is planted as soon as possible after removing the crop. On some farms a succession of crops may be taken from a field before returning it to cane. This is especially true of the farms producing irrigated vegetables.

Sadly, the policies ennunciated to maintain the war-time level of diversified production were not matched by guaranteed marketing arrangements and since sugar brought a more assured income per acre, the quantity of non-cane crops dwindled. Today we produce less than 20% of the traditional root crops which were produced during the war. However the Island is again

nearly self sufficient in fine vegetables now mainly grown in rotation on larger cane farms rather than by smallholders, and we have restarted a small cotton industry also grown in rotation with cane.

As well as considerable agronomic experience with non-cane crops, increasing labour shortage has forced us into mechanisation, including a few examples from other countries.

Mechanisation of Non-Cane Crops on Cane Farms

Specialized machinery is expensive so we do all that we can to utilise existing cane equipment in our non-cane crops. For example we grow these crops at row spacings which allow standard cane tractors to be used, and where necessary double (or triple) rows are planted between the wheel lines. An example is the planting of Sea Island Cotton at 1.6 meter spacing, where conventional practice is to plant it much closer. Actually, yields have not been found to suffer and picking is easier, but if this had not been found to be so then double-row planting would have been adopted.

Sometimes the tractors themselves are modified, such as a cane tractor which can have tracks quickly added to allow spraying of vegetables when timing is crucial and the soils are wet. This would not normally be critical in cane production.

Some tool bar equipment adapts ideally to the special demands of inter-cropping. Stanford (1988) records that the John Deere Flexi 71 planter is excellent for sowing double rows of cow peas and kidney beans in two cane inter-rows without any modification. On the other hand some tool bars are restrictive and although the working units are ideal they must be mounted on a custom made frame.

On smaller farms it is often possible to use a piece of equipment for more than one purpose. An interesting example on one of our farms is a piece of cultivation equipment designed originally to subsoil and weed cane inter-rows; this was subsequently found to be ideal for preventing erosion in the wheel tracks between vegetable beds by adding a Dammer Diker (Anon, 1984). Also, by reversing the weeding points it turned out to be ideal for lifting carrots. A small number of field workers have a high output in completing the reaping.

Another example where basic cane equipment can be adapted to serve both cane and non-cane concerns fertiliser application, such as a Vicon broadcasting unit to which alternative baffles can be added to place a narrow band of fertiliser on 3 rows of cane, or 3 broad bands on vegetable beds.

The most ingenious adaptations of cane equipment I have seen were in Australia. In one case, a 50 year old cane planter had been adapted to sow melon seeds, and in another case a 20 year old cane planter was adapted to insert stakes for tomatoes grown in rotation with cane!

However not everything can be done with modified cane equipment and there must also be some specialised equipment on a cane farm growing other crops. Some examples are described below. However, even with specialised units there are some useful things to bear in mind. First, where farms are not very large the equipment should be built with the idea of sharing and cooperative ownership, since the acreage of the non-cane crop on any one farm is likely to be small, at least during the introductory stage. This means that the equipment should be ruggedly constructed and "friendly" to sharing and cooperative use. A cassava/yam digger with examples of such sharing-friendly ideas has been built; PTO shafts and pins which may get lost should be secured to the implement, if shear bolts are needed a rack holding spares is useful, and stands to prop the dismounted machine are essential.

Secondly, the machinery will often be used by operators with a "cane mentality", who may not treat it as considerately as one would wish. Some over-building will be necessary and torque-limiting devices should always be inserted in PTO drives to protect moving parts against the use of oversized tractors.

Erosion

Successful integration of other crops in Barbados depended for 250 years on the use of "cane holes", together with the application of organic manures and mulches and the use of cover crops. With the abandonment of these practices, erosion has been serious.

There is no engineering problem in performing basin listing (called "tied ridging" in some countries). It is very effective; for example, the effect of the "Dammer Diker" on the water-acceptance rate of the wheel tracks between vegetable beds submitted to high intensity irrigation. The problem with more elaborate basin listing is that if the basins are large enough to be immune from overflow then they will present subsequent tractor passes with a rough ride. In East Africa this problem is solved by breaking the ties and reforming them after each tractor pass. Another approach would be to conduct all operations after planting (fertilising, spraying, weeding) with a 4WD "all terrain" mini-tractor; and we are pursuing this idea, such as with an ATV equipped with an applicator to band fertiliser on two rows of crops planted at cane spacing (1.6 m).

Strip tillage

However, there is one particularly powerful approach which can lead to a considerable reduction in, or perhaps elimination of, erosion for larger growing crops rotated with cane, like cotton, eggplant, peppers and okra; this is often called strip tillage. Strip tillage is not a new idea but only recently has it been possible to create really efficient equipment for achieving it with tractors of modest (70 - 85) horse power. Our locally developed version was publicized recently by de Boer and Hudson (1987), and is summarized as follows:

After the last ratoon is reaped, trash is respread evenly over the field. A single subsoil tine is passed through each row of stools, preceded by a disc coulter which cuts through the trash. Two rows are done at a time, the tractor wheel running on the rows of old stools. About 10 days later pairs of

staggered tines are passed more deeply along each row and after a further 10 days a final pass made to full depth, the tines being a little wider apart than for the second pass. Thue a strip of land is cultivated where the old cane stools were; the soil ie disturbed to perhaps 50 cm. depth. We use tines developed in Australia, which cause virtually no soil inversion.

Of course one crop which can be planted into theee tilled strips is cane, but with further refinement, other crops can be planted. A rotavator with the outer biades removed will refine the strip tilled area, incorporating fertiliser on one eide and simultaneously sowing cotton, etc. This seeding could be done with many other tractor-drawn or hand- puehed units; the "jab planter" for example.

Mechanisation of Cassava and Yame

A number of mechanical planters for cassava have been developed in South America and Africa and even by European manufacturers (e.g. Agri- Products Ltd.). The same principal can be use for the mechanical planting of yams and similar root crops. Such a planter has been developed in Barbados. As far as I know, it is the first such machine which is specifically cane-farm oriented and can be changed in a few seconds from planting cassava to yams by changing the "magazine" into which planting material is placed. The spacing is dictated by the wheel against the tractor rear wheel.

Like planters, there are several digging machinee for caseava and yams, including a hand-operated cassava digger developed in the Far East. However, we found that these machines were too delicate for our cane farm conditions. In the case of yame they also damage the tubers too much. We therefore adapted a European idea for lifting parenips. An under-cutting share digs well under the crop and reciprocating fingers pivoted from behind the share bounce the soil up and down, freeing the tubers without the fingers actually engaging them.

Mechanical planters for sweet potato vines are available, Louisiana being the specialist producer. However the rough conditions left after cultivating cane fields appear to make eome adaptation necessary. An important point is that sweet potatoes require closer spacing than yams to maximise their yield -- usually a double row planted at typicai cane spacings. This means that the same machine suited to yam/cassava digging is too narrow, and the same principle has been adapted to make a wider, but shallower, digger. This machine would be more appropriate for some varieties of caseava also. Farmers report that damage from uee of these machines is about a quarter of that normally associated with hand digging.

An interesting bonus from the use of mechanical root crop diggers is the good soii tilth ieft after their use. This tilth has allowed cane to be planted immediately after lifting the root crop and excellent yields have been recorded on one farm in Barbados which practices this rotation. Interestingly one of the reasons why those producing sugar beet have an advantage over cane producers is the cultivation benefit of harvesting the beets. In this yam/sugar cane rotation we have this same result!

Mechanisation of Inter-Crops with Cane

Where there is a shortage of labour there must be a shift from inter-cropping to rotational-cropping to allow mechanisation. This has been discussed recently by authors such as Lombardi and Villaveces (e.g. Anon, 1987). The same problem may deter expansion of ratoon inter-cropping practiced in some countries like Mauritius. But need we assume that the mechanisation of inter-cropping is indeed too difficult? Three examples are given which suggest we should not.

In Réunion interesting work has been carried out by CEEMAT[1], comparing hand-operated equipment for planting, fertilising, etc., including work in ratoons where a trash rake is used to clean a strip for inserting the short-term inter-crop. I believe PLANALSUCAR is also working on the mechanical seeding of cereals into inter-rows. Mauritian and Reunion workers are also applying their ingenious inter-row work to double-row planted cane (cf. work in Brazil and Columbia).

The cane planter developed in Barbados plants two rows at a time, the tractor wheels being the pressing agent. This machine therefore lends itself to the simultaneous sowing of inter-crops on the bank between the two cane rows. A hydraulically powered seeder was used to plant the double rows of cow peas. Of course this technique will establish the inter-crop only on alternate banks, but is should not be difficult to install seeding units outbroad of the cane planter. Alternatively, the banks can be planted by mechanical planters behind the wheels of tractors which pass after planting the cane (e.g. Stanford, 1988). There is also a range of hand-operated planters which can satisfactorily mechanise the seeding of inter-row crops; the jab planter in Africa is probably the most interesting. Using either hand planters or the planters attached to the two-row cane planter, it is simple to develop the double rows of maize and legumes applied in Brazil and Columbia.

The third example comes from Mauritius, where a machine has been devised to harvest maize as an inter-row crop. This machine would be more stable and easier to design if cane producers would adopt a double-row approach being developed in a number of countries, including Brazil, Columbia, Reunion and Mauritius.

Transportation of Non-Cane Crops

The final examples of interesting mechanisation of non-cane crops concerns transportation of the harvested crop. A good example would be the conversion of push-pile loaders to act as simple all-terrain fork lifts. This is being effected in Barbados and I am sure it must exist in other countries too.

A carrying box designed in Malaysia has been adapted also to cane farm

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[1] Centre d'Etudes et d'Experimentation du Mechanisme Agricole Tropical. I am indebted to Dr. Alain Caumont for supplying relevant reports from Réunion.

situations, including being able to grade roads. It is easy for such a carrying box to have a roof so that perishable crops like sweet peppers can be harvested and immediately shaded from the sun.

CONCLUSION

It is impossible to cover all the interesting mechanisation developments related to growing other crops on farms. I have relied heavily in these examples on work with which I am personally familiar in the West Indies. Certainly similar work is going on in many other countries, especially in Brazil and by CEEMAT in French territories. I would be grateful for workers who can add to the examples given here and who could send me photographs and/or papers which could be used in a review paper for the ISSCT Congress to be held in Brazil next year. The examples show that this is a rich field for ingenuity and that many problems have been solved which were perhaps regarded as insolvable some years ago. The weakest area of development appears to be in the mechanisation of inter-row cropping.

REFERENCES

Anon. 1811. Minutes of the Society for the Improvement of Plantership in the Island of Barbados. Thos. Kaye, Liverpool.

Anon. 1984. "It Works!" Dammer Diker implanted reservoir system. Promotional literature form Ag. Engineering & Development Co., Tri-Cities, Washington, USA.

Anon. 1987. Seminario Internacional Del Uso Alternativo de la Caña de Azucar Para Energia y Alimento. Inazucar-Geplacea-PNUD, Santo Domingo, Rep. Dom., Mayo 12-15, 1987.

de Boer, H.G. and Hudson, J.C. 1987. Developing Strip Tillage to Reduce Cultivation Costs. Sugar y Azucar, April 1987, 30-34.

Hudson, J.C. 1987a. Integrating Other Crops with Sugar Cane. Boletin GEPLACEA, IV, No. 7, July 1987.

Hudson, J.C. 1987b. The Diversification Story. Proc. Ann. Conf. Barbados Sugar Technologists' Association, Sept. 1987.

Lombardi, A.C., R. Villaveces, and other contributions in Anon 1987.

Stanford, D.C. 1988. Inter-cropping Sugar Cane with Short-Term Crops. Proc. XXIII, West Indies Sugar Technologists' Conf., Barbados, p. 390-393.