Tropical Root Crops
RESEARCH STRATEGIES FOR THE 1980s

Proceedings of the First Triennial Root Crops Symposium of the International Society for Tropical Root Crops ~ Africa Branch
TROPICAL ROOT CROPS: RESEARCH STRATEGIES FOR THE 1980s

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Terry, E.R.
Oduro, K.A.
Caveness, F.
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INTERCROPPING OF PLANTAINS, COCOYAMS, AND CASSAVA

S.K. KARIKARI

AGRICULTURAL RESEARCH STATION, UNIVERSITY OF GHANA, KADE, GHANA

At the University of Ghana, Agricultural Research Station, Kade, the yields of marketable products obtained from pure stands of plantains, cocoyams, and cassava were compared with those from mixed stands. There were four mixed groups: plantains—c cocoyam—cassava; plantains—c cocoyam; plantains—cassava; and cassava—c cocoyam. The plantain—c cocoyam intercrop showed a slight increase in yield (5%) for the plantains, but in all other mixes the intercrop yielded less than did the pure stands. The decline in yields when plantains were one of two intercrops (with either cocoyam or cassava) was not significant. However, when plantains, cocoyams, and cassava and when cocoyams and cassava were intercropped together, the decline in yields compared with pure stands was very highly significant. The results of this work provide useful agronomic considerations for the design of plantains, cocoyams, and cassava cropping patterns.

La Station de recherche agricole de l'Université du Ghana à Kade a comparé les rendements des produits commercialisables de plantains, de taros et de manioc cultivés en monoculture avec ceux de culture associée. Cette dernière a porté sur quatre récoltes: plantains + taros + manioc; plantains + taros; plantains + manioc; et manioc + taros. L'association plantains + taros a donné un rendement inférieur de 5%, et dans toutes les autres associations, les rendements ont été inférieurs à ceux de la monoculture. La baisse de production de taros ou de manioc lorsque cultivés en association avec le plantain était relativement peu importante. Cependant, elle s'écartait des rendements de la monoculture lorsque l'association comprenait plantains + taros + manioc et taros + manioc. Les résultats de cette recherche apportent d'utiles considérations agronomiques à la détermination de modèles de rotation pour les plantains, les taros et le manioc.

In the humid tropics, which cover most of West Africa, plantains, cocoyams, and cassava form the main starchy staples. These crops may be grown either in pure stands or in mixed or intercropping systems. In an intercropping system, the crops are grown in a sequence, with some variation from one ecological zone to another. In the forest zone of Ghana, for example, the cropping sequence has been described elsewhere by Doku (1967) and Kari kari (1971a,b). Intercropping is very widespread and is practiced in other areas of the humid tropics (Jurion and Henry 1967; Ruddle 1974; Wilson 1976), but there is very little published information comparing the productivity of pure stands with that of mixed cropping of plantains, cocoyams, and cassava.

Devos and Wilson (1978) compared the productivity and efficiency of plantain—c cocoyam intercropping in Nigeria and found a high land-equivalent ratio (LER) — the land area in pure stands giving yields equivalent to 1 ha of land in mixed stands — for the combination, indicating its suitability for regions where pressures on land are high. This is the only published information available on this subject in recent years. My work, therefore, was undertaken to produce more information on productivity of different cropping systems in which plantains, cocoyams, and cassava were used in various combinations.

MATERIALS AND METHODS

The planting materials used for this experiment were the sword-type of suckers of plantains, variety Apanu, corms of cocoyams, variety Mankani pa (as described by Kari kari 1971a), and stakes of cassava, variety Ankara. All the materials were selected from healthy mother plants. The plantain suckers were pared of all adhering tissues, washed, and dipped into a solution of 2000 ppm Nemagon. The cocoyam corms were cut into sets weighing 100—120 g each, dipped into a solution of 1000 ppm Benomyl, and dried in the sun for 24 hours. The cassava stakes were cut to 20 cm long.

The experimental plot covered an area of approximately 4 ha. The area had been cultivated with two crops of maize and winged beans in the
previous 2 years. It was divided into seven equal plots, each plot measuring approximately 0.5 ha with 3 m between each plot as border rows.

The following treatment combinations were assigned at random to the plots: pure stands of plantains, cocoyams, and cassava and mixed stands of plantains—cocoyams—cassava; plantains—cocoyams; plantains—cassava; and cassava—cocoyams. Before the planting, all plots received nitrogen, 50 kg/ha (urea, 46% N); phosphorus, 50 kg/ha (triple superphosphate, 22% P), and potassium, 10 kg/ha (muriate of potash, 45% K).

The plantains were planted $3 \times 3$ m apart, the pure stands having 225 plants; the cocoyams and cassava were planted $1.5 \times 1.5 \text{ m}$ apart — about 800 plants per plot in the pure stands. The same spacings and number of plants were arranged in the mixed cropping plots. Planting was done from 9 to 13 May 1977.

Harvesting of the cocoyams was done between 20 and 24 February 1978, i.e., 40 weeks after the planting; the cassava was harvested between 8 and 12 May 1978, i.e., 52 weeks after being planted; and the plantains were harvested as they matured; the first harvesting being done on 12 April 1978. The harvesting of the plantains continued for 6 months, the last harvest being taken on 12 October 1978 by which time 80% of the crop had been harvested. The weights of all marketable products from the harvests were recorded.

RESULTS

The yields of marketable plantains, cocoyams, and cassava from pure stands were, respectively, 22.4 t/ha, 8.0 t/ha, and 33.6 t/ha. In the plantain—cocoyam—cassava intercrop (Fig. 1), however, the yields were 16.4 t/ha, 4.7 t/ha, and 15.0 t/ha, corresponding to a decline in yields of 26.8%, 41.3%, and 35.4%, respectively. In the plantain—cocoyam intercrop (Fig. 2), the marketable products were 23.5 t/ha and 7.8 t/ha, a 5.0% increase in the yield of plantains and a 2.5% decline in the yield of cocoyams. With the plantain—cassava intercrop (Fig. 3), the yields were 20.4 t/ha and 32.0 t/ha, corresponding to 10.7% and 4.8% declines, respectively. There was a much higher decline in yields from the two root crops, cocoyams and cassava, when planted together, the yields being 4.6 t/ha and 20.8 t/ha and corresponding to declines of 42.5% and 38.1%, respectively.

The land-equivalent ratios (LERs) were 1.8, 2.1, 2.0, and 1.2 for the plantain—cocoyam—cassava; plantain—cocoyam; plantain—cassava; and cocoyam—cassava intercrops respectively.

DISCUSSION

Mixed cropping is the simultaneous growth of two or more useful plants on the same plot. The practice
has been considered primitive, less productive, and less efficient than sole cropping. This misconception may be due to the fact that the system is very limited in terms of mechanized agriculture, to which sole cropping can be more easily subjected. Mixed cropping is, however, widespread in tropical Africa and is especially complex in the rain forest where plantains and root crops form the main staples.

In traditional Ghanaian practice, the crops in mixed cropping are rarely grown in rows and usually one crop takes prominence over the others. It is always the predominant crop that is planted first and more often allowed to establish before other crops are planted in a system of relay. The population of the relay crops is only a proportion of the predominant crop.

For experimental purposes and uniformity, however, I had all the crops planted at almost the same time without considering any one crop as predominant. Also, the populations used in the pure stands were maintained in all plots. In this experiment, the yields of the plantains, cocoyams, and cassava in the sole cropping compared favourably with yields reported in the literature (Doku 1966; Karikari 1971a, b, 1974; Devos and Wilson 1978).

The high reduction in the yields when the three crops were planted together was expected because of competition. Although the plantains were spaced widely, the planting of two other crops probably brought about a high interspecific competition mostly in the form of shade, resulting in low yields. Both cocoyams and cassava are root crops, which are very demanding in their nutrient requirements, and may compete for nutrients as well.

The LER of 1.8 obtained under this system was high, but slightly misleading, because the contributions made by individual crops was low — 0.7, 0.6, and 0.4, respectively, for the plantains, cocoyams, and cassava.

The increase in the yield of plantains by 5% when they were intercropped with cocoyams is interesting. Although the cocoyams' yield was lower (decline of 2.5%) in the mix, their presence with the plantain leaves caused early closure of the canopy, thus suppressing weeds, maintaining soil moisture, and increasing the efficiency of the system. It was,

Fig. 2. Plantain—cocoyam intercrop.
therefore, not surprising that the LER in this cropping was 2.1 and the highest among the systems. The plantain–cassava intercrop showed a yield decline of about twice as much as the plantain–cocoyam intercrop with an LER of 2.0. This decline may be due to the poor contribution of cassava in forming the canopy. The cocoyam–cassava intercrop produced the lowest yield and was the system in which the highest decline of both crops was observed. Correspondingly, the LER of 1.2 obtained for the cassava–cocoyam intercrop system indicated the lowest utilization potential. This might have been caused by the fact that both are root crops and may demand similar soil nutrients. Also, the canopy formed was not close enough to check weed growth.

CONCLUSIONS

Plantain–cocoyam–cassava intercropping appears to be well-suited to the humid tropics, including the forest zones of Ghana. In one way or another, each crop appears to benefit from the presence of the other. There is a general yield reduction of different magnitudes when two or more of the crops are planted as intercrops rather than in pure stands, but the efficiency of the combination corresponds with the LER. Some agronomic observations of the cropping pattern were that:

- Yields were significantly lower when the three crops were planted together;
- When plantains were used as one of the intercrops with one root crop (i.e., cocoyam or cassava), the system became more efficient;
- The two root-crop system reduced yield very significantly and was least efficient; and
- Regardless of economic factors, the suitability of the systems was in descending order, plantains–cocoyams; plantains–cassava; plantains–cocoyam–cassava; and cocoyams–cassava corresponding to LERs of 2.1, 2.0, 1.8, and 1.2, respectively.