Cassava Productivity in Intercropping Systems

Author: James Emewulu Okeke, National Root Crops Research Institute, Umudike Umuahia, Nigeria.

ABSTRACT

Performance of cassava in various associations with maize, cowpea, yam and upland rice was evaluated in two ecological zones of Nigeria to determine suitable food crops(s) for intercropping with cassava. Fresh root tuber yields of sole cassava were significantly higher than the yields under the various mixtures. Cassava/cowpea and cassava/maize gave the lowest cassava yield reduction of 11% and 15% respectively. Cassava intercropped with maize, however, gave the highest energy yield which was significantly higher than the returns from cassava/maize/cowpea/rice polyculture. The highest LER was observed with cassava/maize intercrop. Planting cassava in double rows between two rows of maize, cowpea or yam significantly improved cassava productivity over cassava monocrop. Choice of adequate planting time and plant densities could further improve efficiency of the double-row system.

Cassava, Manihot esculenta Crantz, is traditionally grown in association with other food crops in Nigeria. The short-term food crops--yams Dioscorea spp., maize Zea mays L., cowpea Vigna sinensis and vegetables--are usually harvested earlier, leaving cassava and weeds as "cassava/grass fallow" for more than 6 months before piecemeal harvesting of the crop begins.

Thus, cassava is almost always subjected to severe competition with other food crops and grass and a better exploitation of the hybrid vigour of recommended improved varieties is not always realized. Cassava yield under this system is known to be relatively low. Although increasingly mono-cropped, a majority of farmers grow crop mixtures involving cassava and over 95% of the total output of cassava root tubers in Nigeria is by this system. The reason is that it is more profitable to intercrop (Ezumah and Okigbo, 1980). Risk of crop failure from pests, diseases, and inclement weather is considerably reduced by the practice.

Research should therefore focus more on improving the productivity of the system. The potential is large for increasing yields of component crops of the various mixtures in relation to their yields when planted alone. Improvements have been achieved by the right choice of planting time and adequate spacing (Ezumah and Okigbo, 1980). Generally, intercropping produces maximum benefits when interplant competition is minimized (Trenbath, 1976; Burgos, 1980). This paper reports work to determine best crop species to go with cassava and the optimum spatial arrangement for cassava-based polyculture in the savannah and rainforest zones of Nigeria.

## Materials and Methods

Used were the following crop combinations: cassava/maize, cassava/rice (upland), cassava/maize/cowpea, cassava/cowpea, cassava/maize/cowpea/rice and sole crops of cassava, maize, cowpea, and rice. They were tested in 1980/81 at Umudike in the rainforest zone (7°33'N, 5°29'E) and at Otobi (7°39'N, 8°32'E), in the savannah belt of Nigeria. Cassava was planted at 1x1 m spacing, maize, cowpea, and rice at 0.3x1 m spacings. Upland rice variety OS6 was seeded at 10 seeds per hole. Cassava (variety TMS30211), maize (Farz24) and cowpea (Ife Brown) were used.

Maize, cowpea and rice were planted on top of the ridge between two cassava stands in the two-crop combination treatments. In three to four crop mixture treatments the crops were staggered on the space between two cassava stands at uniform spacing of 0.3 m. The Umudike and Otobi experiments were established in April and July 1980, respectively.

Another experiment to determine the best spatial pattern for the crops was set up at Umudike in April 1981. The treatments were: cassava and yam, with cassava in double row and yam in single row; cassava in double row and cowpea; cassava interplanted with maize, and sole crop of cassava as control. Two types of seedbed-ridge and flat were the main treatments which were split for the various crop associations. Cassava was spaced at 0.6x1 m and yam at 1x1 m. A density of 33,000 was maintained for cowpea and maize. Fresh tuber yields of cassava and yams were taken at harvest. Grain yields were recorded at 14% moisture. Energy yields were computed using the method of Onyenuga (1968). Land equivalent ratio (LER) was computed using the formula:

$$LER = \sum_{i=1}^{m} \frac{y_1}{y_{11}}$$

where $y_1$ = yield of crop in a mixture

$y_{11}$ = yield of the sole crop

(IRRI, 1974, 1975)

## Results and Discussion

The effect of various crop mixtures was invariably a lowering of cassava yields relative to its yield as sole crop. Effects varied with crop mixtures and ecological conditions (Table 1). The main reason for the low yields observed at Otobi was a high incidence of the cassava mealybug, Phenacoccus manihoti Mat-Fer, and green spider mite, Mononychellus tanajoa Bondar, complex. The pests were on the plant longer because of the long dry season prevailing in the zone (October - May). Consequently, cassava yields were unusually low for the zone.

The Umudike results appear to represent the normal performance of the crop. Cassava performed better with cowpea or maize than with upland rice in two-crop combination system. Yield reduction in cassava increased with increase in the number of component crops in the mixture with four-crop combination giving the lowest yield of cassava root tubers. The fourth crop--upland rice (OS6)--had good vegetative growth but failed completely to head at the Umudike site.

Table 1. Fresh root tuber yields of cassava in various mixtures with food crops in two ecozones of Nigeria, (t/ha) 1980/81.

| Crop mixtures | Location | | Losses from intercropping | |
|---|---|---|---|---|
| | Otobi | Umudike | Otobi | Umudike |
| | | | % | |
| Cassava (control) | 27.0 | 30.70 | 0 | 0 |
| Cassava/cowpea | 7.90 | 27.30 | 71 | 11 |
| Cassava/maize | 6.30 | 26.20 | 77 | 15 |
| Cassava/cowpea/rice | 10.30 | 24.50 | 62 | 20.20 |
| Cassava/maize/cowpea | 9.5 | 24.00 | 65 | 22.00 |
| Cassava/rice | 9.5 | 22.80 | 65 | 26.00 |
| Cassava/maize/cowpea/rice | 5.8 | 18.8 | 78 | 39 |
| S.E. ± | 0.87 | 2.5 | | |

Energy yields (EY) and land equivalent ratios were computed for a better evaluation of the various crop combinations. Table 2 shows that cassava/maize gave the highest energy yield although the mixture did not yield significantly better than other 2- or 3-crop mixtures. Three-crop component mixtures appeared to be the limit for the highest energy returns. Cassava sole crop was the highest energy yielder compared with sole crops of maize or cowpea.

Cassava and maize intercrop gave a higher LER than cassava and cowpea mixture (Table 3). Both energy yields and LER of the cassava/maize/cowpea combination compared favourably with values for cassava/maize combination and indicate an advantage for intercropping. With LER above unity the crop components apparently made complementary use of growth resources (Ludwig, 1950). In the case of cassava/maize combination the aerial and soil environments might have been better exploited by differential canopy profiles and rooting depths, respectively.

An attempt was made to minimize competition between component crops and exploit border effects in the double-row cropping experiment at Umudike. Data (Table 4) show that two rows of cassava flanked by single rows of either maize, yam or cowpea yielded significantly higher than the sole crop of cassava at normal planting densities of the crops. Maize again appeared as a better companion crop of cassava, encouraging significant cassava yield increases over cowpea or yam-cassava associations. Planting on ridge or flat made no significant difference on the yield of cassava. Cassava appears to benefit from component crop interaction when planted in double-rows than when mixed with other crops in the row. It is evident that cassava monoculture is wasteful of growth resources: the initial runoff and soil loss before the canopy closes, nutrients lost in drainage and runoff; Burgos in 1980 showed that five times as much phosphorus was lost in cassava monoculture as was absorbed by the crop; he also observed larger soil magnesium loss than absorption; aerial environment is usually inefficiently exploited due to mutual shading of leaves.

The double-row system exploits the border effect (de Mattos et al., 1980) minimizes mutual shading and intraplant competition, consequently increasing yield of cassava above the level as a monocrop.

It may be concluded that land productivity is higher under cassava-based polyculture than under cassava monoculture. In cassava-based polyculture, the double-row spatial arrangement improves performance of the cassava crop over its monoculture. Greater improvements are possible with better adjustments in planting time and plant densities.

Table 2. Energy yields of crops grown sole and in various mixtures with cassava in a rainforest zone of Nigeria.

| Crop mixtures | Energy yield ($10^6$ Cal/ha/yr) |
|---|---|
| Cassava/maize | 22.9a* |
| Cassava/rice | 21.8a |
| Cassava/maize/cowpea | 21.7a |
| Cassava | 21.6a |
| Cassava/cowpea | 21.2a |
| Cassava/maize/cowpea/rice | 16.5b |
| Maize | 2.7c |
| Cowpea | 0.4c |
| Rice | 0 |
| S.E. | ± 0.8 |

*Same letters indicate no significance by the Range Test.

Table 3. Yields of component crops and LER of the various crop mixtures at Umudike.

| Crop mixtures | Yields (t/ha) | | | |
|---|---|---|---|---|
| | Cassava | Maize | Cowpea | LER |
| Sole | 30.7 | 1.8 | 0.4 | 1 |
| Cassava/maize | 26.2 | 1.7 | - | 1.8 |
| Cassava/cowpea | 27.3 | - | 0.22 | 1.4 |
| Cassava/maize/cowpea | 18.8 | 1.2 | 0.15 | 1.8 |

Table 4. Fresh root tuber yields of cassava under various crop mixtures and two tillage practices. 1981-1982.

| Crop mixtures | Ridge | Flat | |
|---|---|---|---|
| Control (cassava sole) | 12.6 | 10.0 | ± 0.22 |
| Cassava/maize double row | 16.9 | 14.8 | |
| Cassava/maize interplanted | 15.7 | 12.1 | |
| Cassava/yam double row | 14.6 | 13.7 | |
| Cassava/cowpea double row | 13.7 | 13.5 | |
| Mean | 14.76 | 12.82 | ± 1.42 |
| LSD 5% for comparison within mainplots (ridge, flat) = 0.91 t/ha | | | |

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References

Burgos, F. Carlos. Soil-related intercropping practices in cassava production. Proc. of a workshop on cassava cultural practices held in Salvador, Bahia, Brazil (IDRC 151e) 1980. 75-81.

de Mattos Pires, Luis Pedro, Souza da Silver, L., and Caldas, C.R. Double row planting systems in Brazil. IDRC Series 151e 1980. 54-58.

Ezumah, H.C. and Okigbo, B.N. Cassava planting system in Africa. IDRC Series 151e 1980. 44-49.

IRRI, International Rice Research Institute, 1975. Annual Report 1974. Los Baños, Philippines.

Ludwig, W. Zur theorie des konkurrenze: de annidation al: funfta evolutionsfaktor, Zool. Anz. Enganzunsband zu Band 145: 1950. 516-537.

Onyenuga, V.A. Nigerian foods and feeding stuffs. Ibadan University Press 1968. 44-47.

Trenbath, B.R. Plant interactions in mixed crop communities. Amer. Soc. Agron. Special Publ. No. 27; 1976. 129-160.