INTERCROPPING - THE HIDDEN REVOLUTION: A SOLUTION TO LAND SCARCITY AND HOUSEHOLD FOOD SECURITY

K. Spio
Department of Agricultural Economics, Extenson and Rural Development, University of Pretoria

Many development economists have regarded intercropping as a traditional way of growing crops, which to them cannot stand up to present day realities. The results in this paper and other research results give a different picture. It shows that intercropping has a higher total productivity per unit land area and greater stability of yields and revenues than its monocropping counterparts. It could therefore be seen as a system which could be used to fill the gap created by the problem of scarcity of land as well as using it to improve household food insecurity.

TUSSENVERBOUING - DIE VERSKUILDE REVOLUSIE : 'N OPLOSSING VIR GRONDSKAARSTE EN HUISHOUDELIKE VOEDSELSEKURITEIT
Heelwat ontwikkelingsekonome het tusserverbouing bestempel as 'n tradisionele gewasverbouingsmetode wat nie die realiteite van vandag kan akkommodeer nie. Die resultate in hierdie referaat en 'n klompie ander navorsingsresultate gee 'n ander prentjie. Dit toon dat tussenverbouing 'n hoër stabiliteit in opbrengste en winste het as sy enkeloes mededingers. Dit kan dus beskou word as 'n sisteem wat gebruik kan word om die gaping geskep deur die probleem van grondskaarste te oorbrug, en ook gebruik kan word om huishoudelike voedselsekuriteit te verbeter.

1. INTRODUCTION

African agriculture has for the past two or three decades been in a parlous state; and the picture continues to look blurred. The FAO report (1987) indicates a deterioration in access to land for the majority of farmers in the developing world (continued persistence of large inequalities in the size of land holdings), large increases in very small and marginal holdings and increased landlessness. According to other reports, many African households simply lack the means to secure consistent access or entitlement to the amount of food which allows them to lead an active, health live (Spio & Groenewald, 1996). One effective way to overcome these problems may involve land and capital saving innovations and sustainable production systems such as intercropping which will ensure that the very little land and capital in the hands of the small rural farmer are used efficiently through multiple use. This should bring about better yields per unit of land and capital, greater reliability and hence improve household food security. Intercropping or mixed cropping has been practised for years, but the modern concepts about them are relatively new; very little research has been reported. Various commentators of African agriculture have failed to recognise the significance of indigenous developments in this area. Richard (1985) suggested that in extreme cases intercropping was further evidence of the intrinsic "backwardness" of African agriculture. Krants (1979) suggested the following reasons for this attitude:

- The advent of mechanical harvesting, especially in developed countries, caused the practice of intercropping to be abandoned.
- Since intercropping is generally associated with traditional agriculture and subsistence farming at low input, plant breeders concentrated on developing genotypes for monocrops and not for intercropping.
- A general belief that intercropping advantages are manifested only at low levels of inputs and technology.

The topic of intercropping has however lately begun to attract the attention of many scientists (Willey, 1979; Rejat De & Singh, 1970; Norman, 1971; Steiner, 1982). Recent research has shown substantial yield advantages of intercropping at medium to high levels of technology. Igbozyrike (1977) describes intercropping as "a route to an indigenous agricultural revolution". He regards intercropping not as a set of traditional techniques, but as evidence of progress towards an agricultural revolution well adopted to the tropics, especially West African conditions. He based this view on the following premises:

- Intercropping systems are better adapted to soils of low and indifferent fertility than monocropping; marginal gains to intercropping are higher on less fertile soils.
- Intercropping systems have higher optimum plant populations than comparable monocropping systems. Some degree of crowding seems to stimulate intercropping plants to perform better. Thus, intercropping tends to result in higher yields both in areas of land shortage and in areas where low population density correlates with low soil fertility.
- Research has shown that best results are obtained when modern inputs are applied on intercropping farms, using local management practices rather than "improved" cultivation practices. FAO fertilizer trials in Plateau State of Nigeria compared fertilizer use on "sole" crop and intercropped farms. Higher returns are obtained with monocropping with improved cultivation practices. However, intercropping yields better results under farmers' own management practices.

2. INTERCROPPING SYSTEM AND PRACTICES IN GHANA

Intercropping is a common feature of Ghanaian agriculture. This system is both complex and diverse, as is indicated by large numbers of crops grown in association. As many as thirty different crop combinations can be identified. Crop combinations vary according to local environmental, economic and social conditions. This complexity and diversity results from farmers' desire to achieve multi-purpose profit-oriented objectives as well as subsistence-oriented requirements. Intercropping has been associated with small scale farmers (producing about 90 percent of the total food production) who may not have enough land to diversity cropping by planting different pure crops on several fields, or do not have the capacity to take the risk of crop failure in monocropping systems. Other distinguishing features include :

i) The nearer the plot is to the home, the more complex and pronounced is the crop mixture.

ii) Combinations tend to be largest in the forest zone, where the range of possible crop combinations is greater.

iii) In combinations which involve cash crops as main crop (eg. Oil palm/plantain/vegetables), the man carries out the bulk of the work on the main crop (oil palm) and the woman is responsible for the subsidiary intercrops (plantain and vegetables).

iv) In an effort to achieve a desirable results, the farmer manipulates three variables: planting dates, maturity period and harvest time. Skilful scheduling is required. For example, planting quick and long maturity varieties together or staggering planting so that different crops ripen together (Richard, 1985).

v) In the savanna regions, spatial organisation in terms of planting are more pronounced than in the forest belts because of the topography and the inability to clear and stump the big trees in the forest.

This paper reports on a study on the economic evaluation of intercropping .

3 METHODOLOGY

A survey was conducted in Ajumako-Enyan-Essiam district in the Central Region of Ghana. One hundred farmers were interviewed with a designed questionnaire. In addition, personal interviews, farm visits and documentary information were used.

3.1 Evaluation of land productivity

The concept of the land equivalent ratio (LER) was used to compare the productivity of intercropping to monocropping. LER is defined as the ratio between crop yields in mixtures over yields in monoculture under similar management practices or alternatively as the total productivity of the same crop equal to that of one hectare of intercrop. Another way to measure it is the area of pure stand that is required to produce the same yield as intercrop under the same management practices.

The statistic used is

$$LER = \frac{\Sigma Cmi + \Sigma Bmi}{\Sigma Cmo + \Sigma Bmo}$$

Where:

LER = Land equivalent ratio
Cmi = Mean yield of crop C, in combination with otther crops.
Bmi = Mean yield of the other crop B, in combination with crop C.
Cmo = Mean yield of C as monocrop.
Bmo = Mean yield of B as monocrop

The ratio could be equal to one , less than one or more than one. If it is equal to one, the productivity of monocropping and intercropping is equal. If less than one, monocropping namely that intercropping is superior to monocropping, is more productive than intercropping. The opposite, prevails if LER exceeds one.

3.2 Cost and revenue estimations

The statistics used for the cost is

$$Cp = \frac{\Sigma Cp_i}{N}$$

Where:

Cp = Mean cost of production
N = Number of farmers interviewed
Cp_i = The cost of production incurred by the ith farmer

The same model was used to estimate the revenue, but the variable Cp_i was replaced by Rs_i, where Rs_i is equal to the revenue obtained by the ith farmer.

4 RESULTS

4.1 Reasons for practising intercropping

Table 1 indicates that 28 percent of the farmers regard intercropping as a solution to land scarcity. Reasons which are more or less related to household food security - to satisfy domestic needs and safeguard against uncertainty constitute about 20 percent. Thus about 50 percent regard intercropping as a solution to the problem of land scarcity and household food security.

Table 1: Reasons given by farmers for practising intercropping

Reasons	Percentage
Land scarcity	28.0
Traditional ways of growing crops	24.2
Save labour	21.1
Satisfy domestic needs	17.3
Control weeding	5.0
Against uncertainty	2.0

4.2 Yields

Yields for monocropping and intercropping are presented in Tables 2 and 3 respectively.

Table 2: Yields for monocropping

Crops	Average yield (kg/ha.)
Cassava	7 637.5
Maize	2 100
Plantain	10 500

Table 3: Yields for intercropping

Crops	Average yield (kg/ha.)
Cassava + Maize	5 569.5 + 1 125
Cassava + Plantain	5 640 + 6 960
Plantain + Maize	7 800 + 1 025

4.3 Land equivalent Ratio (LER)

The land equivalent ratios (LER) for the various crop combinations are presented in Table 4. The partial land

Table 4: LERs for the various crop combinations

Crop combination	Yields (kg/ha.)			LER
	Maize	Cassava	Plantain	
Pure Maize	2 100			1
Pure Cassava		7 637.5		1
Pure Plantain			10 500	1
Maize + Cassava	1 125	5 569.5		1.27
Maize + Plantain	1 025		7 800	1.23
Cassava + Plantain		5 640	6 960	1.40

equivalent ratios for maize and cassava intercrops are 0.54 and 0.73 respectively, giving a LER of 1.27. Thus, the total productivity is 27 percent higher than monocropping and the land equivalent ratio is 1.27 hectares. Maize and plantain intercrops yield partial LERs of 0.49 and 0.74 respectively, giving LER of 1.23. Productivity of intercropping is 23 percent higher, and its land equivalent is 1.23 hectares. The partial land equivalent ratio for cassava and plantain are 0.74 and 0.66 respectively, giving a LER of 1.40, indicating that intercropping has a yield advantage of 40 percent over its monocrops; its land equivalent is 1.40 hectares.

Although yields for the both crops are lower with the intercropping system, the combined yields are higher than those under the monocrop system. Willey (197() attributes the higher yields to better use of environmental resources.

4.4 Net revenue analysis

Although the total productivity of intercropping exceeds that of monocropping, farmers will adopt intercropping only if it is economically viable. Table 5 presents a summary of net revenues for intercrops and monocrops. The results in Table 5 show intercropping to have a monetary advantage over monocropping. When maize and cassava, cultivated as monocrops, the expected monetary gains are ¢ 256 187.50 and ¢228 937.50 respectively; when intercropped, the expected monetary gain is ¢415 437.50 . The intercropping system has a monetary advantage of ¢159 250.00 and ¢286 500.00 over maize and cassava respectively. The same analogy can be drawn for the other monocropping and intercropping systems; the intercrop of maize and plantain has a monetary advantage of ¢801 125.00 and ¢12 158.50 over maize and plantain respectively. The intercrop of cassava and plantain has a monetary advantage of ¢835 813.00 and ¢19 597.00 over cassava and plantain as a monocrop respectively.

5. LAND SCARCITY, HOUSEHOLD FOOD SECURITY AND INTERCROPPING

Poverty is the basic factor contributing to household food insecurity. Poverty is determined by a number of factors, including access to basic agricultural resources, particularly land. The trade-off between land security and productivity highlights the necessity of developing technical innovations and packages that are profitable to farmers in the short run, while conserving the land and its long term potential. The existence of a negative relationship between farm size and land productivity confirms that small farms follow an intensification strategy when land is scarce. Intensification is achieved through crop substitution towards higher yielding crops per unit land, higher sowing rates, more intensive and careful weeding, reduction in fallow land and the expansion of mixed cropping or intercropping (Blarel, 1994).

Intercropping ensures higher yields and gives rise to higher and dependable revenues. This higher yield may be due to optimum utilisation of resources. Research results confirm that intercropping levels out yield fluctuations (Richards, 1985). Dependency and catastrophes (bad weather, pests, diseases and poor prices) associated with monocropping are overcome or minimised. Table 6 shows the coefficients of variation found in this study.

Table 5: Cropping systems and their net revenues

Cropping system	Yield (kg/ha.)		EMV (¢) Rs/ha
	As monocrop	As intercrop	
Pure maize	1 500.0		256 167.50
Pure Cassava	7 637.5		228 937.50
Maize + Cassava		1 125.0 5 569.5	415 437.50
Pure maize	1 500		256 187.50
Pure Plantain	10 500.0		1 045 153.00
Maize + Plantain		1 025.0 6 990.0	1 056 312.50
Pure Cassava	7 637.5		228 937.50
Pure Plantain	10 500.0		1 045 153.00
Cassava + Plantain		5 475.5 6 750.0	1 064 750.00

* EMV= Equivalent monetary value

Table 6: Yield fluctuations with intercropping

Crop	Coefficient of variation (for three years replicates)	
	Average for crops grown singly	Crop associations
Cassava/beans	33.04	27.54
Cassava/sweet potatoes	23.87	13.42
Cassava/maize/sweet potatoes	31.05	21.44
Cassava/maize/bean	25.04	14.95

Intercropping also protects the soil from water and wind erosion since the land is always occupied by crops (Norman, 1974). There is better control of pests, weeds and diseases. The land is in constant cultivation. Competition from quick growing minor crops may keep weeds down in the early part of the season to the benefit of a slower growing main crop. It ensures effective use of labour because all crops are weeded in one operation. According to Richards (1985), a single intercropped plot is much easier to protect against birds, rodents and human thieves than several sole-cropped plots. Research has shown intercropping to be less vulnerable to pests, weeds and diseases because of its greater ecological diversity (Kayumbo, 1976).

It helps to maintain soil fertility (Ruthenberg, 1971). Inclusion of legumes provides nitrogen. It maximises labour absorption, and uses labour more efficiently (Bains, 1960; Finlay, 1975; Norman,1967). Diehl (1981) in Nigeria shows that traditional intercropping strategies even out labour input profiles.

Intercropping also leads to more efficient use of environmental resources. Different crops have different feeding depths, nutritional requirements and growth cycles. Some beneficial effects are achieved through its impact on soil temperatures and the micro-climate. Some crops benefit from conditions of increased humidity and reduction of soil temperature and transpiration adjacent to earlier established, leafy plants. Others benefit from the windbreak effect provided by tree crops or by a boundary "hedge" of tall grain such as sorghum (Richards, 1985).

6. FUTURE RESEARCH

Research needs mainly exist in the following fields.

- ***Crop compatibility***

Maximum yield advantage can be obtained only if there is an element of complementarily between crops. For instance, planting a high-nutrient demanding plant with a low-nutrient demanding plant, eg., cassava and groundnuts, or a short stature crop in advance and a tall crop, eg cowpea and maize or slow growing crops like plantain and fast maturing crops like maize.

- ***Plant population and spatial arrangement***

- The total plant population has a determinant role on the yielding ability of crops, Any population above or below optimum population will result in competition and under utilization of resources respectively. Appropriate planting geometry is also required to alleviate competition as well as to permit some forms of mechanization.

- ***Appropriate planting times***

Devising appropriate planting times for the various crop combinations will help to prevent the peak periods of growth and maturity of the crops from coinciding. This may help avoid competition, and help to realize the yield potential of both crops.

- ***Fertilization management practices***

Agronomists should come out with conducive fertilization practice that will help to maintain the productivity of the land since two or more crops occupies the same land at the same time.

7. CONCLUSION

The following conclusions are made:

- Intercropping has a higher total productivity per unit land area than monocropping and this suggests that there is efficiency in production and maximisation of resources.

- There is a greater stability and revenue in the intercropping systems because if one crop fails or grows poorly, another component compensates.

A breakthrough in intercropping technology will certainly benefit less-endowed farmers. It may also help to improve household food security and fill the gap created by the problem of scarcity of land. The intercropping system can therefore be looked upon as an efficient and sound method of growing crops.

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