

CHALLENGES OF WEEDING OPERATION IN INTERCROPPING AND MIXED CROPPING SYSTEMS IN NIGERIA

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Abstract:

A literature study was undertaken on the challenges of weeding operation in intercropping and mixed cropping systems in Nigeria. Nigeria intercrops required 29% more labour input during the peak weeding period than did sole crops. Suppression of weeds in intercropping may have a beneficial effect on crop yield and are useful in improved farming systems. The practice of growing several crops on the same piece of land is an ancient strategy for crop production among farmers in the tropics. Mixed cropping is to meet the desire of the farmer to minimize risk. This system offers the farmers insurance against total crop failure, It helps to control soil erosion and weeds, and it brings about a more even distribution of farm labour than in sole cropping. It has also been shown that diverse plant communities are more resistant to environmental stresses such as drought. Weeding is the most taxing job, both in energy and time, and traditionally, it involves bending down and working carefully not to damage the crop and at the same time, the operation must finished before weeds outgrow the crops. Weeding is conducted by pulling out the weeds and shaking them off. The paper highlights the challenges of application of a rotary mechanical weeding device in control of weed in intercropping farming systems and sparsely application of herbicide in traditional mixed cropping systems. The merit of mixed cropping system was identified to indicate that the diverse crop species grown together to complement one another by using resources in different ways, scarce labour is efficiently utilized, weeds and insects are suppressed, erosion is controlled and there is sequential harvesting and the risk of total crop loss is averted.

Keywords: Weeding, Intercropping, Mechanical weeder, Herbicide, Farming systems

1. Introduction

Nigeria intercrops required 29% more labour input during the peak weeding period than did sole crops. Suppression of weeds in intercropping may have a beneficial effect on crop yield and are useful in improved farming systems. Weed infestation is a constraint in crop production, and the control is currently the cornerstone of increased production in Nigeria. Weed control is by far the most labour-demanding field operation in an intercropping and mixed cropping systems production in Nigeria. Crop in intercropping and mixed cropping systems is generally susceptible to weed infestation because of its initial slow growth after planting and subsequent spacing and staggering of crops to be planted in mixed cropping farm condition. Weed competition reduces canopy

development. In cereal crops, stem formation, tasselling, podding and grain formation are retarded while in tuber crop, tuberization, tuber number and weight are adversely affected. Weeds generally predispose the crop to pest and disease infestation. Reduction in tuber yield as a result of weed competition varies from 40% in the early branching varieties to nearly 70% in the late or non-branching varieties (IITA, 1990). Absence of weed control in crop farm resulted to crop losses of up to 100% (Nyam, 2005).

Weeds are only a problem if they reduce crop yields or cause harvesting problems. The organic farmer does not expect entirely clean fields but sees the farm as an ecological system that has a diversity of plants, where the crop is the dominant species. The techniques used to control weeds focus on giving the crop a head start rather than eliminating all species of weeds.

A cropping system is an aspect of farming system or agricultural production system which consists of one or more enterprises, or business activities in which sets of resources and inputs are uniquely managed by the farmer in the production of one or more commodities to satisfy human needs for food, fibre, various products, monetary income and other objectives (Okigbo, 1982). Intercropping as a cropping system, involves the growing of two or more crops in proximity to promote interaction between them (Ibeawuchi, 2007).

Intercropping is a common feature of agriculture in the tropical Africa as well as in the Asian and American tropics (Okigbo, 1978; Kurt, 1984; Papendick et al., 1976). According to Agahiu et al. (2011) specific intercropping systems have developed over the centuries in the different regions and they are closely adapted to the prevailing ecological and socio-economic conditions. Cassava may be grown in pure stand but is commonly grown in mixture with other crops, especially maize (*Zea mays*), yam (*Dioscorea* spp), melon (*Colocynthis citrullus*) and vegetables (Okigbo and Greenland, 1976).

Marais (1987) has shown that yield reduction in maize due to competition from weeds is almost linearly related to the biomass of weeds growing in association with the maize. It was shown that under conditions of severe weed infestation the total biomass of crops plus weeds tends to be constant. This indicates that where weeds cannot be controlled by conventional methods, attempts could be made to replace the weeds with a companion crop. The ideal is for the intercrop to have an economic value, and for it not only to replace the weeds completely, but also to compete less with the main crop than the weeds (Olaoye and Adekeye, 2011).

Marais (1983) found that maize was most sensitive to weed competition during the second month after planting. When weeds were controlled for the first two months after planting only, the yields obtained amounted to approximately 90% of those of weed-free maize crops. This suggests that in applying Marais' findings to intercropping, the intercrop should be established between the maize rows one month after planting, because the tillage required establishing the interplanted crops to act as a weed control measure.

Joubert (2000) asserted that the type of intercrop selected should be one that will act as a smother crop. Two crops, which might be considered, are the traditional African watermelon, *Citrullis vulgaris* and sweet potato. Both these crops are relatively drought resistant and will often produce well even when the maize has succumbed to drought. Intercropping is fairly widely practiced in Nigeria. Cropping maize with beans, pumpkins and melons are the most common intercropping practices at present.

2. Practice of Mixed Cropping as Insurance against Total Crop Failure

The practice of growing several crops on the same piece of land is an ancient strategy for crop production among farmers in the tropics. Mixed cropping is to meet the desire of the farmer to minimize risk. This system offers the farmers insurance against total crop failure, mixed cropping helps to control soil erosion and weeds, and it brings about a more even distribution of farm labour than in sole cropping. It has also been shown that diverse plant communities are more resistant to environmental stresses such as drought.

Cropping systems across the zone are characterized by tremendous diversity. By combining crops of different growing periods, farmers develop highly diversified cropping patterns involving as many as 5 to 6 but more commonly 2 to 3 crops in a mixture (Okigbo and Greenland, 1976). The choice of mixed cropping generally provided opportunity for growing wide variety of crop in a given area. Mixed cropping increases the period of fallow. The frequency of cropping is increasing and fallowing is decreasing. Powell (1998) indicated that in the mixed cropping systems the cultivation factor, R is evaluated as shown in equation 1. The value of R is 30 to 40, with loss of soil fertility being a particular problem. In areas of high population density where land is the limiting factor, the length of fallow periods is greatly reduced or the practice abandoned altogether.

$$R = (\text{Crop Years} \times 100 \text{Crop Years} + \text{Fallow Years}) \quad (1)$$

Fallowing is commonly practiced as a means of maintaining land at a steady productive level without its undergoing severe or progressive degradation. When the

fallow period is long enough in relation to the cropping period on the given soil type, natural vegetation restores soil organic matter, nutrient status and structure, and suppresses weeds, pests, and/or diseases that may have been a problem during cropping years (Powell and Williams, 1993). The optimum length of the fallow period can be reduced by the application of organic manure, if this is available in sufficient quantities.

3. Energy Demand for Weeding Operation and the merit of a mixed Cropping Farm

Weeding is the most taxing job, both in energy and time, and traditionally, it involves bending down and working carefully not to damage the crop and at the same time, the operation must finished before weeds outgrow the crops. Weeding is conducted by pulling out the weeds and shaking them off.

The merit of mixed cropping was identified to indicate that the diverse crop species grown together to complement one another by using resources in different ways, scarce labour is efficiently utilized, weeds and insects are suppressed, erosion is controlled and there is sequential harvesting and the risk of total crop loss is averted. Because cropping operations are almost exclusively done manually, labour is the major input. The amount of land cultivated annually per household is a function of family and/or hired labour availability during periods of peak demand, namely during land preparation and weeding.

The main advantages mentioned by farmers relate to maximizing returns from limited resources and stabilizing income over time (Abalu, 1976). The range of local climatic and soil conditions, resource availability, and markets or farmers' tastes and preferences allows a wide variety of cereal, pulse and tuber crops to be grown.

Olaoye and Adekanye (2011) noted that weeds waste excessive proportions of farmers' time, thereby acting as major barrier on agricultural development. The use of mechanical weeder will reduce drudgery and ensure a comfortable posture of the farmer or operator during weeding operation. Hand hoes are common futures in farms in Nigeria for the purpose on weeding. Manual weeding is labour-intensive, accounting for about 80% of the total labour required for producing food in Nigeria (Odigboh and Ahmed, 1979).

4. Factors Affecting the Choice of Tillage Practices

Tillage is a labour-intensive activity in low-resource agriculture practised by small land-holders, and a capital and energy-intensive activity in large-scale mechanized farming (Lal 1991). For any given location, the choice of a tillage practice will depend on one or more of the factors presented in Table 1.

Table 1: Factors Influencing the Choice of a Tillage Practices

Influencing Factors	Soil factors	Climatic factors	Crop factors	Other Government policies	Socio-economic factors
Specific Details	Relief (slope) Erodibility Erosivity Rooting depth Texture and structure Organic-matter content Mineralogy	Rainfall amount and distribution Water balance Length of growing season Temperature (ambient and soil) Length of rainless period	Growing duration Rooting characteristics Water requirements Seed	Objectives and priorities	Farm size Availability of a power source Family structure and composition Labour situation Access to cash and credit facilities

(Source: Lal 1980; Unger 1984)

According to Unger *et al.* (1988) conservation tillage systems to protect the soil and water reserves often have limited appeal to producers unless they offer economic advantages. Economic factors contributing to interest in conservation tillage include:

high costs of fuel, labour, tractors, and other equipment; high equipment inventories and maintenance costs; ability to use land at risk of erosion for more intensive crop production (rather than for pastures or in long-term rotations); the opportunities offered for more intensive cropping, avoiding long fallow periods, because of greater water conservation; and in many instances, higher crop yields

4.1. Types of Technology Influencing Tillage Practices

Pingali *et al.* (1987) defined technology as a method to overcome a problem in mixed cropping farming. Any intervention can be considered a technology - whether it is technical, management or policy related - but there is one condition. The cost of the technology should be paid by a combination of the extra return and the saved effort, a "calculation" that tends to be done differently among farmers themselves, scientists and/or policy-makers. Several different technologies exist in relation to mixed farming and the distinct categories are versus management-based technology, accelerating versus defusing technology, exogenous versus indigenous technologies, technologies for national and local problems, technologies for individual farmers and for society and exploitative and regenerative technologies.

Gianessi (2009) reported that weeds compete with crops for nutrients, space, light and water thus reducing crop yields. Numerous studies have documented the negative effects on yield of season-long weed competition in Africa. Under unweeded conditions, crop losses have been measured for: maize (55-90%), common bean (50%), sorghum (40-80%), cowpea (40-60%), rice (50-100%), cotton (80%), wheat (50-80%), groundnut (80%), and cassava (90%) (Ishaya *et al.*, 2007a; Ishaya *et al.*, 2007b; Johnson, 1995). One kilogram of weeds reduced the yield of rice by 500-900 grams in a Nigerian experiment (Adeosun, 2008). Weeds need to be cleared from a field prior to planting a crop and weeds need to be removed from the field during the growing season for optimal yields to be achieved. Weed competition is

most serious when the crop is young. The critical period of crop-weed competition is approximately equal to the first one-third to one-half of the life cycle of the crop. In weed-crop competition studies, the "critical period" is the stage after which weed growth does not affect crop yields. Keeping the crop free of weeds for the first third of its life cycle usually assures near maximum productivity (Adegroye *et al.*, 1989).

5. The Challenges Mechanical and Hand Weeding and Prevalence of Herbicide Application

Hand weeding is the predominant weed control practice on smallholder farms. Hand weeding is the oldest method of weed control and consists of hand-pulling, hand slashing and hoeing of weeds. Smallholder farmers spend 50-70% of their total labor time hand weeding (Johnson and Adesina, 1983). Women contribute more than 90% of the hand weeding labor for most crops (Kent *et al.*, 2001). 69% of farm children between the ages of 5-14 are forced to leave school and are used in the agricultural sector especially at peak period of weeding (Ishaya *et al.*, 2007b).

The various possible benefits of herbicide use include (Parker and Vernon, 1982):

1. improved yields due to more effective weed control especially early in the crop's life, when the critical period of weed competition occurs and when wet conditions may preclude effective removal by manual weeding.
2. an increased area of crops within the scope of a single family
3. an indirect increase in yields achieved by releasing labor from one crop, in which herbicides have been used, for the more timely planting or improved care of another crop, such as cotton
4. improved yields achieved by permitting a larger area to be planted at the optimum time, instead of having to spread out planting to avoid having too large an area requiring weeding at any one time.

5.1. Weeding and Impact on Family Labour

Family labour is seriously stretched on farms and has to be deployed continuously for weeding, as the first weeded plots are re-infested by the time the last plots are cleaned. One effect of the large demand for

hand weeding labour is that a considerable portion of a farmer's fields may be left fallow and not planted to a crop. The area cultivated is often reduced by 50% because of the farmer's assessment that not enough labor would be available to weed the additional fields (Ibeawuchi, 2007). The principal limiting factor to the size of farms in Africa is the number of necessary weeding during the period following planting (Kent *et al.*, 2001). 80% of farmers said that if weeds were less of a problem, they would increase the area of land under cultivation (Johnson, 1995). African farmers tend to plant as much as they think they will be able to weed. As a result, weeds can be considered as the main constraint on agricultural production.

Gianessi (2009) revealed that in sub-Saharan Africa, the once readily available and reliable cheap labor force has disappeared in the face of rapid urbanization, improved living standards, and increased educational opportunities. Landless young people have shifted from agricultural activities to off-farm activities. Labor for hand weeding is therefore very scarce and, when available, too expensive for the average farmer to afford (Akobundu, 1979). As a result, it is often impossible to carry out timely weeding by hand. In many instances, labor constraints force farmers to plant their crops after weeds have begun to grow. Such crops are easily smothered by weeds and give an extremely poor yield; in such cases, these fields are abandoned (Gianessi, 2009).

The scarcity of labor and the concurrent rise in the cost of hand weeding make timely removal of weeds by direct labor difficult and expensive. There is an acute shortage of labor at the beginning of the wet season for land preparation, planting and adequate first weeding. No pool of landless rural laborers can be called upon during periods of peak labor demands. African women point out that crop management can be neglected during pregnancy, with tasks requiring hard physical work (such as weeding) particularly affected (Webb and Conroy, 1995). In addition to farming responsibilities, African women farmers have considerable family responsibilities—typically caring for children, elderly parents and sick family members. As a result of these conflicting time demands, weeding is not always carried out in a timely fashion or in the right amounts. Malaria is also a common problem on farms, reducing the availability of productive labor. The scarcity of labor coupled with early season

rains often impede timely removal of weeds. According to Gianessi (2009) the sowing time of some crops coincides with or just precedes periods of heavy rain, and wet soil conditions do not permit efficient hand weeding or hoeing. For those farmers with heavy soils, excessively wet conditions do not permit efficient hand weeding to be done resulting in long periods of crop-weed competition and yield reduction.

5.2. Effect of Poor Weed Management on Crop Performance:

Poor weed management in mixed cropping farm caused an average yield gap of 6.5 t/ha and restricted production in farmers fields in Nigeria and this report is similar to Fermont *et al.*, (2009) of 11.6 t/ha. Several constraints limit the effective use of hand weeding, including limited cash for hiring labor and labor not being available for hire during peak periods (Johnson, 1995). The supply of labor in rural areas has been significantly reduced in many African countries due to AIDS and migration to urban areas which has led to less weeding of crops. AIDS is causing the loss of at least 10% of the agricultural workforce in most countries and, in at least five countries, more than 20% (Bishop-Sambrook, 2003).

In Africa, 80% of the cultivated land is currently prepared by hand; on 16% of the land animal draught power is used and only 4% is prepared with mechanical power (Pingali *et al.*, 1987). Family sizes have, in many traditional African societies, been increased to cope with weeding activities (Adegrooye *et al.*, 1989). The contrast between research recommendations and farmers' practices is particularly stark in the case of weed management. Researchers have produced clear-cut recommendations for optimal time of weeding. Research on experimental plots has indicated that to produce maximum yields, a large number of hours of hand weeding must be undertaken: groundnuts (378 hours/ha), maize (276 hours/ha), and sorghum (150 hours/ha) (Reddix *et al.*, 2001). 200-400 hours per hectare are required to weed cotton and 200-418 hours/hectare to weed rice (Ishaya *et al.*, 2007a). A total of 324 and 309 hours of labor are required to hand weed one hectare of sorghum and maize fields respectively in northern Nigeria (Ishaya *et al.*, 2007b).

Research has demonstrated the impacts on yield of performing fewer than the optimal number of hand

weeding. Opara-Nadi (2000) reported that with three properly spaced hand weeding, the highest cotton yields (549 kg/Ha) were obtained; with two hand weeding, the yield was reduced by 27% (401 kg/Ha); one hand weeding resulted in a loss of 55% (249 kg/Ha); and zero hand weeding resulted in yields that were 87% lower (73 kg/Ha) than the optimal yields. 30-90 hours per hectare are required to remove weeds before planting. A lot of energy is expended in removing weeds by hand, crop yields are generally very low due to weed competition, as a result of untimely and ineffective weed control (Nyam, 2005). Weeding usually competes with other farm activities and is postponed to a later date. Farmers will not weed crops that are sown first until they complete the seedbed preparation and sowing of all other fields.

An econometric analysis of labor decisions by small scale farmers concluded that farmers are unable to allocate sufficient weeding labor for optimal yields in years when rains are abundant because weed growth is rapid and prolific and labor shortages preclude the availability of sufficient weeding (Fafchamps, 1993). As a consequence of less than optimal weeding, yields do not achieve their full potential- even in years of considerable rainfall. Farmers do not undertake overly ambitious production plans since they are likely to lead to weeding manpower constraints.

6. Conclusion

The practice of growing several crops on the same piece of land is an ancient strategy for crop production among farmers in the tropics. Mixed cropping is to meet the desire of the farmer to minimize risk and to serve as insurance against total crop failure.

Energy demand for weeding operation and the merit of a mixed cropping farm revealed that weeding is the most taxing job, both in energy and time, and traditionally. The merit of mixed cropping was identified to indicate that the diverse crop species grown together to complement one another by using resources in different ways, scarce labour is efficiently utilized, weeds and insects are suppressed, erosion is controlled and there is sequential harvesting and the risk of total crop loss is averted.

Several different technologies exist in relation to mixed farming. Weeds need to be cleared from a field prior to

planting a crop and weeds need to be removed from the field during the growing season for optimal yields to be achieved. Weed competition is most serious when the crop is young.

Some of the major challenges of weeding operation in intercropping and mixed cropping farms indicated that smallholder farmers spend 50-70% of their total labor time hand weeding. Women contribute more than 90% of the hand weeding labor for most crops. Farm children between the ages of 5-14 are forced to leave school and are used in the agricultural sector especially at peak period of weeding.

Family labour is seriously stretched on farms and has to be deployed continuously for weeding, as the first weeded plots are re-infested by the time the last plots are cleaned. Poor weed management in mixed cropping farm caused an average yield gap of 6.5 t/ha and restricted production in farmers fields in Nigeria

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