

# Mixed Cropping: Food Security Solution for Developing Countries

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**Abstract:** The agricultural food system in Nigeria is facing unprecedented shocks and stresses in recent times largely due to several adversities. This creates threats to food security and may cause food crises. It has serious implication on smallholder farmers' livelihood, which largely depend on agriculture. Another issue is the need for sustainable agricultural intensification. Simultaneous cultivation of two or more crops on the same piece of land has been found to promote Conservation agriculture as well as sustainable agricultural intensification. This paper highlights the studies conducted on mixed cropping in Nigeria within two decades (between 2000 and 2020). Over ten publications were made in this regard. The findings of the studies on the level of adopting the mixed cropping agricultural practice in the country, pest suppressive effects of the practice, and other advantages of the practice have been underscored. These include; improving food production and income for small farmers; promoting diversification of agricultural productions; securing the regularity of returns throughout the season as well as safety net against climatic uncertainties. Not only has intercropping demonstrated to improve crop productivity, but also develop balanced bio-diverse richer ecosystem. Since small-scale farmers based on traditional techniques, mixed cropping, mostly carry out crop cultivation in Nigeria is best suited for farming at this level.

**Keywords:** Mixed Cropping; Sole Cropping; Conservation Agriculture, Small-scale, Yield

## I. INTRODUCTION

The agricultural food system in Nigeria is facing unprecedented shocks and stresses in recent times largely due to several adversities. These include insecurity and climate change that usually results in uncertainty in yield and production. Low and inconsistent rainfall pattern at midseason can cause harm to crop like maize at various growing stages, resulting in yield loss or even complete harvest failure (Daryanto et al. 2016). This creates threats to food security and may cause food crises. It has serious implication on smallholder farmers' livelihood, which largely depend on agriculture.

Another issue is the need for conservation agriculture. This is being advocated to enhance soil health and sustain long term crop productivity rather than profitability alone. It is in line with the concept of sustainable agricultural intensification. Simultaneous cultivation of two or more crops on the same piece of land has been found to promote conservation agriculture. It leads to improvement in soil fertility (Nwosu et al 2014).

The practice of cultivation of two or more crops simultaneously is referred to as intercropping or mixed cropping (Alamu, 2002; Yusuf et al 2008; Nwosu et al 2014). Mixed cropping is a farming practice that is common among farmers of the tropics (Maiangwa, 2007; Yusuf et al 2008). The practice is common in Nigeria. A wide variety of cereal and tuber crops being grown is determined by the range of resource availability, climatic and soil conditions, demand and farmers' preferences. This is similar to the practice in most parts of Nigeria as observed by a number of studies, such as Fawole and Oladele (2007), Nnadi and Nnadi (2009), Ekunwe and Ajayi (2010), Obasi, et al. (2013), etc.

This paper highlights the studies conducted on mixed cropping in Nigeria within two decades (between 2000 and 2020). Over ten publications were made in this regard. The findings of the studies on the level of adopting the mixed cropping agricultural practice in the country are presented in this review. Pest suppressive effects of the practice, discussed in the report of the studies, have been exposed. Comparison between sole and mixed cropping made in the studies was revealed. The advantages of the practice have been underscored as opined by the researchers. Mixed cropping and intercropping have been used interchangeably in this study, while sole cropping has also been interchanged with mono cropping.

## II. MIXED CROPPING AS WIDER PRACTICE

Bamire et al (2002) evaluated the determinants of farmers' fertilizer adoption decisions and the intensity of use of the technology with 180 respondents, complemented with focus group discussions, in the agro-ecological zones of Osun State. The dominant farming practice at a small scale was found to be mixed cropping system. Adedipe et al. (2004) conducted a study in the south western Nigeria and found that 88% of his respondents practiced mixed cropping with a diverse number of crop combinations.

Maiangwa (2007), investigated the rate of awareness and adoption of mixed cropping and the factors conditioning the adoption of the mixed cropping in four settlements in the north-west zone of Nigeria, namely; Funtua and Ajiwa in Katsina State and Rano and Danbatta in Kano State. He found that mixed cropping was widely practice in Ajiwa, Danbatta and Rano with adoption rates of 93%, 80% and 75% respectively. It was only in Funtua zone the he found slightly more than half of the farmers adopted sole cropping system. Maiangwa (2007) observed that adoption of mixed cropping

had been influenced by farmers' age, membership of association; amount of credit received and land security. Fawole and Oladele (2007) examined the combination of food crops among farmers and found that Yam/maize crop mixture was the most prominent.

Nnadi and Nnadi (2009) investigated the rate and reasons of sustained adoption of cassava/maize multi cropping with 115 randomly selected farmers in Orlu zone of Imo State. It was obtained that 89% of the farmers sustained the adoption, while 80.40% indicated sustaining the adoption for more than 5 years. Ekunwe and Ajayi (2010) examined the cropping pattern, profitability and constraints to plantain production in Edo State. They found majority of the farmers (84 percent) practicing mixed cropping. Furthermore, they found that cropping pattern was affected by farm size, farmers' age and experiences. Obasi, et al. (2013) examined the factors affecting agricultural productivity with 99 farmers in Imo State. They found a mixed cropping system of combining Yam, cassava, maize, vegetable and melon as the main crop combination practiced by the farmers in the state.

### III. MIXED CROPPING PERFORMANCE

Olojede et al (2002) screened twenty-one cassava genotypes for their intercrop performance at Umudike, to determine the performance of the new cassava genotypes under intercrop and to identify suitable cassava genotypes for maize or maize/melon intercrops, as well as other combination. Cassava genotypes were found compatible with maize and melon. Most genotypes were identified as being compatible for intercropping except in few cases. Adedipe (2004), whose study was in the south western Nigeria found that mixed cropping led to 26% rise in total crop output and 32% rise in profit for cowpea farmers.

Amos et al (2004) examined the productivity and technical efficiency of small-scale farmers using multi-stage sampling techniques, from some villages in Niger State. They found that the technical efficiency of the sole maize farmers was lower (0.5266) compared to that of the mixture of Yam and Maize cropping system (0.7172). Oguru et al. (2008) assessed the relative profitability of sole and mixed cropping practice using 100 farmers from 3 local government areas in Bayelsa State. The results indicate that average returns per hectare of mixed cropping (88,500.16) was relatively higher than that of sole cropping (50,532.81). Fawole and Oladele (2007) also found mixed cropping as appropriate mean for assurance of food security.

Oguoma and Nwosu (2009) analyzed the resource-use efficiency of cassava-based mixed crop farmers in Imo State. It estimated the resource-use efficiency of their operations, their relative profitability among others. The findings revealed inefficiency in the farmers' use of resources but their relative margin of profit is high. Nnadi and Nnadi (2009) had also reported that 69.91% of their respondents said they adopted mixed cropping because it was cheap, 98.04% indicated profitability while 82.35% attributed it to simplicity.

Okunlola and Ofuya (2013) found that mixed cropping has better growth and yield parameters than mono cropping. They opined that this cropping system enhance yield. Using 480 respondents, Ajayi (2014) estimated the economics comparative of mixed and sole cassava cropping systems in the six major cassava-producing states namely; Benue, Cross Rivers, Enugu, Kogi, Ondo, and Oyo. He found that mixed cropping system provides opportunities of all-year-round farm incomes, serving as a better poverty alleviating mechanism. He observed that it lessens the likelihood of total crop failure because even if one crop fails, others in the field might still produce. Obayelu et al (2014) analyzed the profitability of cassava crop farming using 265 cassava-based farmers in Ogun and Oyo States. Their findings revealed that mixed cropping of cassava and cowpea farming system had the highest net margins.

### IV. PEST SUPPRESSIVE EFFECTS OF MIXED CROPPING

Pests attack is a major issue in smallholder farming. Mixed cropping has been found to have suppressive effects on a number of pests. This has been supported by some studies in Nigeria. For instance, Okunlola and Ofuya (2013) argued that mixed cropping system controls insect pests in addition to enhancing yield. They opined that the presence of non-crop areas in the landscape and the diversification of agroecosystems might be a worthwhile approach for managing pests with limited reliance of chemical insecticides especially by smallholder farmers in Nigeria.

Using 805 respondents in 12 states of Nigeria, Zhang, et al. (2018) assessed farmers' perceptions of pest severity to landscape, agronomic, biophysical, and socio-economic background. Their findings implied that pest severity was not associated with the proportions of unused land and forest, indicating the existence of pest suppressive effects of a diverse landscape. They stressed that pest severity was lower in mixed-cropping systems under Nigerian smallholder agricultural system.

### V. MIXED CROPPING AS ADAPTATION STRATEGIES FOR CLIMATE CHANGE

Ayanwuyi, et al (2010) assessed farmer's perception of impact of climate change on food crop production in Ogbomoso Agricultural zone of Oyo State. 360 respondents were used in the study. 74.7% of the farmers mentioned planting of different crops as adaptation strategies for the negative impact of climate change. Onyeneke and Madukwe (2010) studied adaptation measures by crop farmers in the southeast rainforest zone with sixty respondents from Orlu, Owerri, and Okigwe agricultural zones for Imo State and Bende, Aba, and Umuahia agricultural zones for Abia State. 20% of their respondents mentioned intercropping as the adaptation strategy they employed.

Valbuena et al. (2012) assessed the potential trade-offs of leaving more residues as mulch in contrasting high, medium and low densities settings with mixed crop livestock systems.

Their studies covered villages in 12 sites in 9 different countries across Sub-Sahara Africa and South Asia. The result revealed availability of livestock feed due to high biomass production, allowing part of the residues to be used as mulch, in high-density sites. Scarce biomass, high feed demand, pressure on crop residues and mulch as trade-off were found in medium-density sites. Availability of communal feed and fuel resources was found in low-density areas, with less pressure on residues. However, biomass production is low and farmers mostly rely on crop residues as livestock feed in dry season, instead of using it as mulch.

Although Valbuena et al. (2012) study was on promoting conservation agriculture based on mulching practices, it revealed the advantage of mixed cropping with livestock, to increase biomass production, so as to fulfil demands for feed and fuel and then retaining a proportion of crop residues on the field as mulch. This they opined as good method of maintaining soil cover.

Tasie and Kalio (2015) assessed the effects of climate change and adaptation methods used by Telfairia farmers in Ahoada, East L.G.A of Rivers State with 60 respondents. They found that mixed cropping were among the most widely used adaptation strategies by farmers. Usmana et al. (2020) examined the factors influencing the adoption of multiple Sustainable Agricultural Practices. The dataset used were obtained from the Nigeria General Household Survey, conducted in 2015. This was part of the World Bank Living Standard Measurement Survey and Integrated Surveys on Agriculture project. The result revealed mixed-cropping techniques among the Sustainable Agricultural Practices.

#### VI. SOLE CROPPING VERSUS MIXED CROPPING

Most of the research works conducted within the time scope of this review, promoted mixed cropping system. However, there are studies that encourage sole cropping system. They include Ibeawuchi et al. (2007) whom evaluated the effects of landrace legumes, Lima bean (*Phaseolus lunatus* L.) velvet bean (*Mucuna pruriens* Var. *utilis*) and African yam bean (*Stenostylis sternocarpa*) with yam, cassava based crop mixtures. Several combinations were made in the research. The research was carried out in Owerri, a humid rainforest zone of southeastern Nigeria. They found that the legume crops performed well in mono cropping system than in mixed cropping due to competition for the required growth resources.

Yusuf et al. (2008) studied the profitability of 'egusi' melon (*Citrullus lanatus* Thunb. *Mansf*) based on sole and mixed cropping enterprise in Okehi Local Government Area of Kogi State, using 240 purposively sampled and 120 randomly selected farmers. Their findings promoted sole cropping. In the same vein, Ajayi (2014) opined that sole cassava cropping system is more economically profitable than mixed cassava cropping system. Amos et al (2014) also found sole cassava cropping system to be more economically profitable than mixed cassava cropping system. Meanwhile he had observed

that mixed cropping serve as a better poverty alleviating mechanism because it provides opportunities of all-year-round farm incomes.

Nonetheless the observations of Ibeawuchi et al. (2007), Yusuf et al. (2008), Ajayi (2014) and Amos et al (2014), whom are in favor of mono-cropping, generally, the studies conducted within the last two decades favored mixed cropping system in terms of advantages. Some, like Hirst (2020) had argued that less inputs in terms of fertilizers, pesticides, etc., are required in mixed cropping system than in monoculture farming.

#### VII. MIXED CROPPING; *THE PANACEA*

From the discussion so far, several advantages of mixed cropping practice have been expatiated. They are as enumerated by some studies like Gurr et al. (2003), Poggio (2005), Latati, et al (2014), Sanaa et al (2016), and Streit et al. (2019). These include sustaining biomass production and decreasing risk of crop failure, enhance grain yield, recovering distressed ecosystem like water and nutrient cycling, as well as decreasing risks of pests' attack. The practice promotes conservation agriculture by maintaining soil cover through retaining proportion of crop residues on the field as mulch (Valbuena et al., 2012). Diverse species of weed are low in the intercropping as observed by Poggio (2005).

Mixed cropping has the advantages of maximizing returns from limited resources and stabilizing income over time. Combining legume and cereals cultivation might be an appropriate approach for producing both crops, due to symbiotic relationship of nitrogen-fixing bacteria (Sanaa et al., 2016). Due to complementary resource use, combining legume and cereal are characterized by higher grain yields and biomass (Streit et al. 2019). Less inputs in terms of fertilizers, pesticides, etc., are required in mixed cropping (Hirst, 2020). Mixed-cropping has been in practice since the primordial time. However, Hirst (2020) observed that the main purpose of mixed-cropping of the primordial time was likely due to the needs of the farmer's family, rather than it being a good idea. Some plants likely adapted multi-cropping over time due to domestication process, he opined.

Mixed cropping has been fruitfully adopted to improve food production as well as income for small farmers as observed by Hirst (2020). It promotes diversification of agricultural productions, securing the regularity of returns throughout the season as well as safety net against climatic uncertainties. An all-year-round farm income is guaranteed by the practice because it lessens the likelihood of total crop failure. If one crop fails, others in the field might still produce. This is a worthy poverty-alleviating alternative.

#### VIII. CONCLUSION

This review had revealed that mixed cropping practice has many prospective benefits in terms of enhancing crop productivity, reducing pest and diseases. It is a viable strategy



for enhancing ecological services, promoting conservation agriculture and sustainable agricultural intensification, particularly for farmers in developing countries whom are mostly small-holder farmers. Since crop cultivation in Nigeria is mostly carried out by small-scale farmers that cultivate less than 3 hectares of land based on traditional techniques, mixed cropping is best suited for farming at this level. Although it is being practice by many farmers in the country, there is the need to further promote it so that almost all smallholder farmers embrace it. This is important because the smallholder farmers are easily devastated when their farms suffered any misfortune. The is need for experimenting which combination will yield best output in every region since the combination that works in one region might fail in another. Not only has intercropping demonstrated to improve crop productivity, but also develop balanced bio-diverse richer ecosystem.

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