
A "2:4:2" Maize/Legume Intercropping Pattern

Tim Motis, PhD

Introduction

While doing legume intercropping research in South Africa (2010-2015), ECHO staff members learned about a system of cereal/cowpea production developed in Nigeria through research by IITA (International Institute of Tropical Agriculture) and national partners (Ajeigbe *et al.* 2010a, Ajeigbe *et al.* 2010b). This strip cropping approach involves a repeating sequence of two rows of a cereal crop, such as sorghum or maize, and 4 rows of cowpea (Figure 3).

A survey of cropping systems, conducted from 1992-1993, showed that farmers in the northern Guinea Savanna zone of Nigeria were already intercropping cowpea with cereals (mostly sorghum and millet but some maize) (Henriet *et al.* 1997). Cowpea was relied upon as a source of food for both human and animal consumption, and as a means to maintain soil fertility. In these traditional systems, however, cowpea was only producing 0 to 132 kg/ha of grain (Van Elk *et al.* 1997). Noted yield constraints included wide cowpea spacing, lack of fertility inputs, and shading of cowpea by the cereal crops.

The effort by IITA to improve upon traditional intercropping systems in Nigeria involved trials on experiment stations as well as on-farm trials. The 2:4 (referred to in this doc as 2:4:2) system shown in Figure 3 was validated in on-farm trials with participation by over 1600 farmers. As explained in an online IITA publication titled Improved Cowpea-Cereal Cropping Systems: Cereal-Double Cowpea System for the Northern Guinea Savanna Zone (http://www.iita.org/c/document_library/get_file?uuid=b6c32286-d127-4851-a569-cfed750aaf94&groupId=25357), total grain (cowpea + cereal grain) production in large-scale farmer field trials increased from less than 1.5 t/ha with traditional practices to over 3 t/ha with the 2:4:2 approach (Ajeigbe *et al.* 2010b).

In the planting pattern shown in Figure 3, maize and cowpea rows are spaced 75 cm apart. In-row spacing is 20-25 cm for maize and 20 cm for cowpea. Livestock are integrated into the system; residues are fed to farm animals and the resulting manure is returned to the field. Judicious use of inorganic fertilizers and insecticide are also used. The IITA publication mentioned in the preceding paragraph has more detailed technical information.

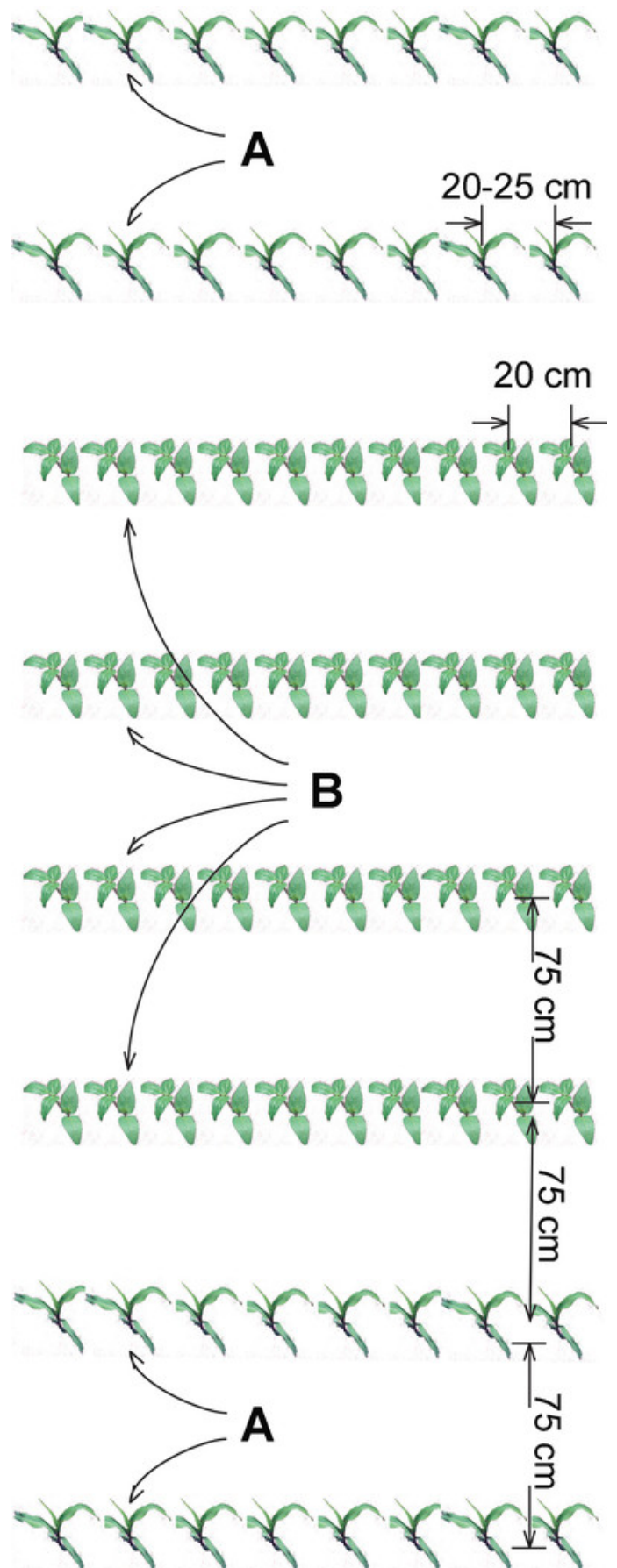


Figure 3. Illustration of the IITA 2:4:2 maize/cowpea strip cropping pattern. Two rows of maize (A) are alternated with 4 rows of cowpea (B). *Source: Tim Motis.*

Advantages of 2:4:2 include:

- Dense planting of a cereal crop and cowpea, with minimal competition for light between crops.
- The planting of crops in rows makes the system easy to scale up. Ox-drawn implements, for example, can easily be used to establish planting bands/furrows for seeding.
- Simultaneous seeding of the cereal and cowpea, which simplifies planting strategy. Also, in comparison to relay cropping, planting both crops at the same time reduces the amount of time that the cowpea is shaded and that rainfall is needed.

Potential disadvantages are:

- The significant amount of land devoted to cowpea as opposed to maize could be unattractive for some farmers. This is largely an issue of economics. In northern Nigeria, where IITA saw widespread acceptance of this system by farmers, the price of cowpea grain in markets was high enough to justify the amount of land devoted to the legume. Ajeigbe *et al.* (2010a) pointed out that, with less land devoted to maize, fertilizer requirements are lower (because maize requires more nutrients than cowpea).
- With the cereal and legume crop planted at the same time, there is greater risk of both crops failing if the rains stop before the plants are established. Seeding when the soil is moist is important.
- The unequal number of cowpea and maize rows does not allow for full crop rotation from one season to the next. Partial crop rotation can be done each season by planting maize into two of the rows previously occupied by cowpea.

Summary of an ECHO 2:4:2 Trial

To gain first-hand experience with this system, we decided to set up a trial at our demonstration farm in southwest Florida. We also wanted to see how well other commonly-grown legumes perform in a 2:4:2 pattern with maize. Below is a brief summary of our first year (April 2015-Jan 2016) of experience with 2:4:2.

Methods

Treatments were three different legume crops: cowpea (*Vigna unguiculata* 'Thai Long'), jack bean (*Canavalia ensiformis*), and velvet bean (*Mucuna pruriens*) (Figure 4). The 'Thai Long' cowpea variety used in this trial is early-yielding and is capable of significant vine growth. Lablab (*Lablab purpureus*) would have been a good choice, but it does not always grow well during our hot, humid rainy seasons. Jack bean, however, tolerates Florida's summer rain and heat and produces a canopy that is

about the same height as lablab. Thus, jack bean was selected, even though the beans are not typically eaten (see an ILEIA document, Edible cover crops (<http://www.agriculturesnetwork.org/magazines/global/more-than-rice/edible-cover-crops>), for an exception to the general rule—some interesting content on food uses of jack bean in parts of Ghana).



Figure 4. Cowpea (left) and jack bean (right) in a 2:4:2 ECHO trial conducted in 2015. *Source: Tim Motis*

Our third treatment was initially rice bean (*Vigna umbellata*), but the seedlings were eaten by rabbits. Velvet bean seedlings, from seeds left on the ground after a 2014 planting, were allowed to grow and replace the rice bean. CAUTION: we do not advise eating velvet bean seeds, as the L-dopa they contain can be harmful to humans and non-ruminant animals. As a cover crop, velvet bean is an excellent

option for weed suppression and restoration of soil fertility. A Feedipedia datasheet (<http://www.feedipedia.org/node/270>) by Heuzé *et al.* (2015) describes its use as animal feed and forage.

Treatments were replicated three times, with each replication consisting of a block of space divided into three plots (each plot was 10.9 m long by 7.0 m wide). Each legume was randomly assigned to one of the three plots within each block/replication, resulting in a randomized complete block design.

Soil amendments were as follows:

- 23 kg/ha of nitrogen from 8:2:8 (8% nitrogen: 2% phosphorus: 8% potassium) inorganic fertilizer applied to the maize; this amount was split into three applications.
- 2 t/ha of compost applied to the maize
- 1 t/ha of compost applied to the legume plots

Maize and the legumes were planted between the 8th and 10th of April. Maturation time, from seed to harvest, is quite short (8 weeks for 'Thai Long') for cowpea. Therefore, in keeping with what was done in Nigeria by IITA, a second cowpea crop was sown (during the first week of November). Measurements included above-ground plant biomass and grain yield.

Lessons learned

Based on the results shown in Table 1, and recognizing that this only reflects one growing season, some key points are:

Table 1. Above-ground biomass and grain yields, as influenced by the legume grown in each plot. Each value is the average of three weight measurements (one in each three plots).

	Above-ground dry matter (kg/ha)	
Legume treatment	Legume plants	Maize plants
Cowpea	2996 b	2950
Jack bean	4311 a	2984
Velvet bean	2800 b	3033
P value*	0.0050	0.9762
	Grain yield (kg/ha)	
Legume treatment	Maize alone	Maize + legume
Cowpea	1267	2287 a
Jack bean	1433	1539 b
Velvet bean	1385	1678 b
P value*	0.5874	0.0231

*Within columns, at least two values differ statistically if the corresponding P value is ≤ 0.05 . Where $P \leq 0.05$, means were separated via Duncan's multiple range test; any two values are statistically different unless followed by the same letter.

1) The three legumes grew well in sandy soil, with jack bean contributing the most above-ground biomass.

The same legumes also grew well in a dry sandy soil, with no fertility inputs, in ECHO research plots in South Africa, a project undertaken from 2010 to 2015. Legumes are often able to thrive in poor soils because of their ability, in association with rhizobial bacteria, to utilize nitrogen from the atmosphere. This is what makes them a good option for building soil organic matter. In this trial, they added 3 to 4 t/ha of dry matter to the soil, in addition to the 3 t/ha from maize. For these residues to favorably impact the soil, it is important to leave as much of it as possible on the ground. If biomass is removed from the field for animal feed, return some of the resulting manure to the field. Collecting manure to put back on a field is easier with controlled grazing than with free-roaming livestock.

2) Within the 2:4:2 system, other legumes besides cowpea grew well with maize-without reducing maize growth and yield below that with maize + cowpea.

In this strip cropping pattern, a maize row is only bordered by a legume on one side, the other side being the adjacent maize row (Figure 3). By comparison, in an alternate-row system, with every other row being planted to a legume, every maize row is bordered by a legume row on both sides. Strip cropping, therefore, gives

farmers a way to integrate vining legumes with large leaf canopies that contribute high amounts of organic matter. Delaying the planting of the legume is also a good strategy but, as mentioned earlier, a longer rainy season is required.

3) The maize/cowpea combination produced the most grain.

This underscores the trade-offs to consider in selecting legumes to try with this system. Cowpea may not produce as much plant biomass as jack bean or velvet bean, but it provides an early-season bean crop (ready before the maize harvest) and can usually be planted twice in a single growing season.



Figure 5. A strip cropping approach being tried at ECHO (Florida), with 2 rows of maize (A) alternated with 4 rows of legume (B; in this case, jack bean), and cassava (C) grown in the middle of the legume strips.

Next steps

A follow-up trial is underway in which we are incorporating a no-legume control and growing cassava within the legume interspaces (Figure 5). Cassava could improve the resilience of maize-legume intercropping systems under marginal growing conditions. Future trials could also be done to evaluate other legume options such as lablab or pigeon pea (*Cajanus cajan*).

Closing Thoughts

Consult the first two references listed in the next section to learn more about IITA's experience with the 2:4:2 system. Their approach has been rigorously tested and replicated in many farmers' fields. Our evaluation of 2:4:2 with other legumes besides cowpea is very preliminary, but hopefully it inspires ideas for creative adaptation beneficial to farmers.

If you are interested in exploring the potential of 2:4:2 intercropping for your project area, find out if farmers are already growing legumes with their cereal crops. If they are, ask what row arrangement they are using and why. If what they are

already doing makes good use of the land, in terms of crop yields and economic returns, there may not be any reason to switch to a different row pattern. Look for ways to improve on existing intercropping systems, such as planting a higher- or earlier-yielding cowpea variety, that do not require farmers to make major changes. If the 2:4:2 pattern looks promising, try it out on small test plots. Let us know of your experience and insights.

References

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