

**Increasing plant population of soybean and groundnut as a way of intensifying and diversifying production for smallholder farmers in Lilongwe district - Malawi**



## **1. Rationale for promoting the double row technology**

Soybean and groundnut are the most common leguminous crop in Malawi. In Lilongwe, where Inter Aide is working with smallholder farmers to increase yields and diversify incomes, soybean and groundnut represent respectively 10% and 22% of the smallholder farmers' cultivated land during rainy season and they were cultivated respectively by 59% and 81% of farmers who started collaboration with Inter Aide in 2016. Soybean and groundnut productivity are relatively low as farmers obtain 800 Kg/ha on average against a potential yield of above 2500 Kg/ha. The national demand for those leguminous crops have increased the past years, especially due to the rapid growth in the poultry sector and oil mill processors in Malawi.

There are 8 main commonly accepted factors that can improve soybean yields in Malawi:

- use of quality seed of improved variety
- land preparation (including 75cm ridges and early planting)
- double row planting
- use of inoculants (only for soybean)
- use of chemical fertilizer
- use of compost
- weed control
- spraying for disease and pest management

Although it is not yet included in the latest version of the agriculture extension worker's guidelines of the MoAIWD<sup>1</sup>, **International and National Research Centers in Malawi recommend to plant soybean and groundnut in two rows instead of single row, possibly with ridges spaced 75cm apart instead of 90cm**, in order to increase yield up to 50% and the economic benefit over 60% (ICRISAT, 2019).

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<sup>1</sup> Ministry of Agriculture, Irrigation and Water Development

**The current single-row system, where seeds are planted in only one row on the middle of each ridge that are usually 90cm apart, has many disadvantages:** it induces more labour-intensive weeding regimes, it does not make an optimal use of the available land (reduced yields) and it leaves the crops prone to aphids' attacks due to the open spaces (ICRISAT, 2019).

Inter Aide had previously promoted most of the crucial aspects allowing to improve soybean and groundnut production (use of productive varieties such as CG-7 for groundnut and the self-inoculated Tikolore for soybean, early planting, weed control and use of compost). For soybean, access to inoculant is difficult and farmers reported during different trials in 2016 and 2017 that the process of inoculation was cumbersome and did not give positive results. Inter Aide decided not to work anymore with varieties that require inoculant and continued therefore to promote the Tikolore<sup>2</sup> variety that does not require inoculation. As Inter Aide approach is focusing on low-cost technologies for economically-constrained rural households, **testing the planting in double-row system and the reduction of ridges to 90cm to 75cm were logically the only main remaining factors that could make an additional difference** when it comes to soybean and groundnuts production. As a reminder, shifting ridges from 90cm to 75cm apart increase by 18% the agricultural productive surface (as 10 meters of land can contain 11 ridges at 90cm and 13 ridges at 75cm). As yields reported on research stations are often higher than on farm due to better soil fertility and crop management (Van Vugt, 2018) and because the relevance of technologies varies according to different local contexts and factors, Inter Aide conducted some on-farm trials and surveys to assess the relevance of promoting this technology.



An extension worker showing the huge loss of cultivable surface induced by the single row planting system with 90cm ridges for groundnut cultivation (ICRISAT) 2019).

## 2. Short guidelines to increase the plant population of soybean and groundnut

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### *Planting ridges spaced 75cm apart*

To maximize the use of the arable surface and efficiently increase the plant population, cultivation using ridges spaced at 75cm apart, instead of the usual way with ridges spaced 90cm apart, **increases automatically the plant population by 18%** while reducing the labour for weeding and the risks of aphids' attack<sup>3</sup>. Using ridges spaced 75cm apart allows intensification of the cultivation for all major crops in Malawi, except tobacco. Note that ridges in research station are often flattened on the top to maximise de water infiltration and to leave an optimal space for roots development, but that is usually hardly seen in farmers' conditions as it involves more labour. According to surveys conducted by Inter Aide, shifting ridges from 90cm to 75cm requires about 50% more labour during the first year (former ridges have to be flattened and adjusted at 75cm). Once ridges have been adjusted at 75cm, it will require every subsequent year about 20% of additional labour work compared to ridges spaced at 90cm. If a household has to pay more labour force to change the ridges from 90cm to 75cm, this investment is equivalent to about an additional 7 euros per acre the first year and 2 euros the following year, compared to the 90cm system.

### *Plant spacing using double row*

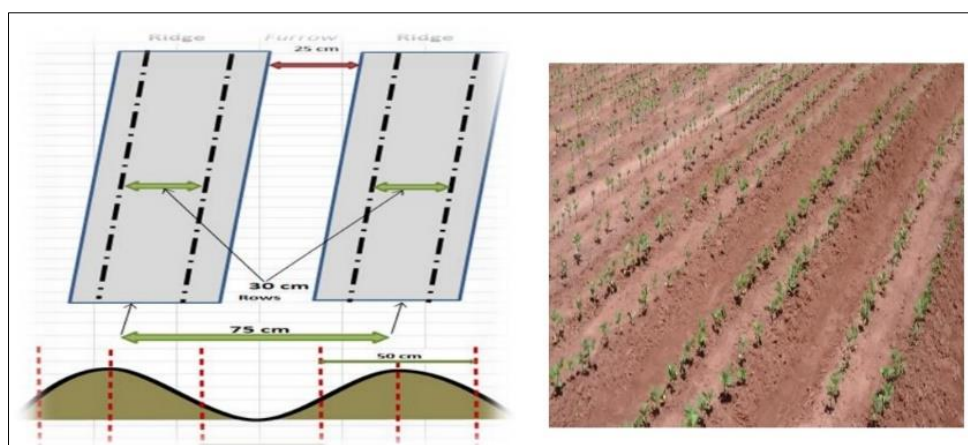
On the ridge, planting should be done in two rows spaced at 30cm apart on each edge of the ridge as shown in the picture here below.

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<sup>2</sup> Potential yields according to research institutions are 2500 kg/ha for Tikolore versus 3000 kg/ha for most of the other certified varieties (Nasoko, Makwacha, Soprano, Serenade) after inoculation and if when all favourable factors are met.

<sup>3</sup> Dense planting provides a barrier to aphids penetrating in from field edges and discourages population build-up of aphids and reduces incident of rosette disease (ICRISAT, 2019).





A sketch and picture of how soybean should be planted using double row system and ridges 75cm apart (IIAT, 2019).

**For soybean, planting stations are normally spaced at 5cm apart on each row.** The seed itself is buried not more than 2.5cm deep. If the self-inoculated Tikolore variety is used, the planting will require 60 kg of seeds per hectare for a population of around 530,000<sup>4</sup> plants when using ridges at 75cm. For farmers who are using ridges spaced at 90cm apart, they will use about 50 kg of seeds for a population of around 445,000 plants per hectare. Planting at 75cm apart requires therefore around 20% more seeds.

**For most of the groundnut varieties, planting stations are normally spaced at 15cm apart on each row.** The seed itself is buried at a depth range of 5 to 6cm. With ridges spaced 75cm apart, 120 kg of seeds are required for a population of 179,000 plants per hectare, while with 90cm ridges only 100 kg of seeds will be needed for a population of 148,000 plants per hectare. Here also, there will be the need of 20% more seeds.



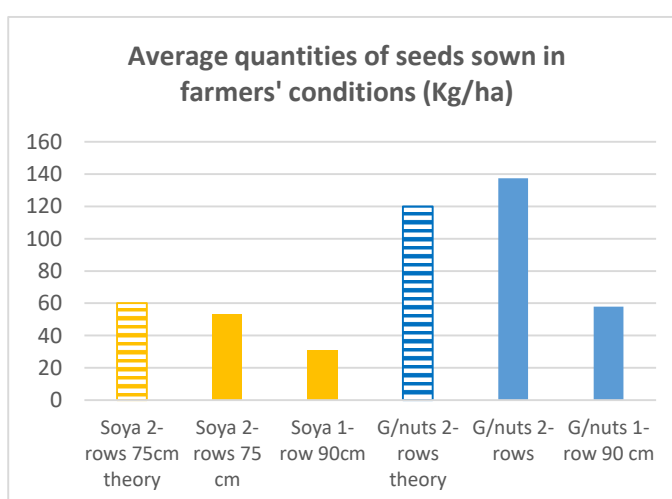
Soybean cultivated in double row system (Inter Aide 2019)

### 3. Trials done by Inter Aide trials and results

During the 2018-2019 season, tests conducted with 4 farmers showed a **31% of yield increase** when **soybean is cultivated in double row and with reduced distance of 75cm between ridges**, compared to single row and 90cm distance between ridges. **For groundnut, the same experienced showed that the yield increased by 67%.** As most of farmers interviewed acknowledged that the technology requires more seeds than the traditional method, another test was conducted in 2019 and confirmed that **using double row system and ridges spaced at 75cm requires a significant higher quantity of seeds for planting.** To implement this test, farmers were trained in soybean and groundnut double-

row planting and were told to do their best to respect the standards. They were also told to plant a control

plot in single row using their traditional system. **For soybean, farmers used on average 31 kg of seeds per hectare with the traditional method (one row and 90cm ridges) while they needed 53 kg when using**



<sup>4</sup> This the plant population at the time of sowing. If one aims at a 75% germination and survival rate, there will be about 400,000 plants reaching the productive stage if one doesn't count that other factor such as climate, pests and diseases may decrease this number. This is valid for all plant population figures given in this document.

**double-row on ridges spaces at 75cm (+71%). For groundnut, they used on average 58 kg per hectare with the traditional system and 137 kg on double-row system (+136%).** Compared to the recommendations in the literature, we can notice that farmers implementing the double-row technology tend to use less seeds than recommended for soybean (-12%, 53kg compared to 60kg), but more seeds than recommended for ground nut (+14%, 137kg compared to 120 kg).

For farmers who already crop with ridges spaced 75cm apart, but using single row planting, the double-row planting still requires to increase the quantities of seeds by 45% for soybean and 100% for groundnut<sup>5</sup>.

#### 4. Other research results in Malawi used to validate the technology

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For soybean production, among the 8 practices tested using on-farm trials in D. Van Vugt thesis and involving 120 farmers in 3 districts in the Central Region, it was found out that **planting two lines per ridge spaced at 75cm apart using double row is the option with the second best value cost ratio**, after the use of inoculant. **When it comes to farmers' perception, "increasing the plant population received the highest ranking after early planting"**<sup>6</sup>. In this study, the use of double row technology (although not optimal<sup>7</sup>) in smallholder farmers conditions allowed, by using an additional 26% of seeds, to **increase the yield by 28% with a value cost ratio of 2.1**<sup>8</sup> (meaning an additional income of 2.1 kwacha for each kwacha invested).

For groundnut, ICRISAT concluded that "the advantage of using twin rows (some refers to it as 'double row planting') is that **it increases groundnut yield by over 50% compared to single row planting pattern. Economically, twin rows increase economic benefits by over 60% compared to single row planting pattern**".

#### 5. Limitation and disadvantage of the technology

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A survey on technologies' adoption conducted by Inter Aide in Lilongwe district between December 2018 and April 2019 shows that 60% of the farmers working with Inter Aide have engaged a process of reducing the ridges spacing<sup>9</sup> and 30% of farmers cultivating soybean or groundnuts have already adopted the double row system. In order to diffuse the technology to more families and remove the barriers to adoption for some families, it is important to understand which factors may limit the adoption of the technology.

According to farmers working with Inter Aide, the **main limitation to adopt the legumes double row technology is that it requires much more seeds for the same surface** even if the same ridge spacing is maintained. This difficulty is mostly experienced by farmers **because they tend to use much less seeds than recommended when using the single row method** (31 kg/ha instead of 60 kg/ha for soybean and 58 kg/ha instead of 100 kg/ha for groundnut). Despite additional investment in seeds, high increase in yields produces a very good return on investment for this technology. The most challenging aspect for farmers is in term of planning, as planting the same land surface will require to save or to buy more seeds than they used to.

Technically speaking, planting the recommended rate with the recommended spacing remains challenging for farmers, especially for soybean. Indeed, soybean seeds are quite small and the planting distance quite narrow as well (1 seed every 5 cm on two rows), making the respect of the planting pattern quite difficult to achieve, or else time consuming. Some simple techniques, like using an empty "soda-type" glass bottle, can be used by farmers to speed-up the process of sowing.

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<sup>5</sup> Planting on 75cm spaced as compared to 90cm requires 18% more seeds for single row (see page 2). It corresponds to 1,18 x 31kg = 36,6kg of seeds for 75cm space with single row. For the same spacing with double row, measurement showed that farmers use 53kg of seeds on average, this is to say + 45%. The same logic is applied for groundnut.

<sup>6</sup> By descending order of preference as (1) Early planting (2) Plant population (3) Variety choice (4) Compost manure (5) Weeding (6) Inoculant (7) Fertilizer and (8) Spraying pesticides. Note the ridges spaced at 75cm and double row system were both a requirement for the plant population trial, while in the control plots farmers were free to decide on their preferred ridge spacing, plant population and planting methods.

<sup>7</sup> Due to poor germination, the number of planting stations increased only by 26% instead of 60% as planned.

<sup>8</sup> The incremental value to cost ratio (VCR) was calculated for each technology by dividing the marginal revenue by the marginal production costs. A VCR > 2 is often considered to be a sufficient economic incentive for adoption by smallholder farmers (Kelly 2006, in Van Vugt 2018 ).

<sup>9</sup> Not only for soybean and groundnuts but for all other major crops used in the farm crop rotations (maize, common bean, sorghum, pigeon pea) except tobacco that requires ridges spaced at 120cm.

**Labour is of course an additional constraint** for farmers who would like to plant those legumes in double row, but **respondents do not mention it as a major limiting factor**. This is probably explained by the fact that most farmers are witnessing an impressive increase in production thanks to the double rows system and therefore tend to ignore this factor as it is difficult to measure.

In the table here below, Van Vugt reports the number of times the advantage or disadvantage is mentioned during interview with farmers who have compared single row and double row cultivation for soybean. Interestingly, the need for additional seeds is not even reported (probably because farmers received seeds' support for the experiment). **The additional work does not seem to be an issue for a vast majority of them (less than 10% of the respondents), while the advantage of getting higher yields is clearly mentioned.**

Technology	Rank	Advantages	<i>n</i> <sup>1</sup>	Disadvantages	<i>n</i>
Planting 2 lines per ridge	1	High yields from a small area	99	Plants don't grow well	17
	2	Higher plant population	5	Wind and sun light competition	15
	3	Good pod setting	2	Low yields	10
	4	Diseases don't enter easily	1	The plants are too close together	9
	5	Easy fertilizer application	1	More work during planting	7
	6			Weeding is more difficult	4
	7			Nutrient competition	4

<sup>1</sup>n= number of times the advantage or disadvantage is mentioned (Extracted from Van Vugt, 2018)

## 6. Conclusion

Increasing plant population is a relatively cheap and effective way to increase yields (Van Vugt, 2018). For most farmers, increasing plant population for soybean and groundnut involves 2 major changes in their cropping system: ridges spaced at 75cm apart and the use of double row. Despite this important change for farmers and the lack of available data on the separate effects between those 2 variables, **both aspects of the technology seem to be interesting for farmers, even if implemented separately. While reducing the distances between ridges allows to increase the agricultural productive surface by 18%, planting in double row, even without shifting the ridges to 75cm, seems to be an effective way of convincing farmers to plant more seeds per unit of land compared to the single row system which is usually implemented too extensively and therefore not at the recommended rate.** Even though most of farmers cannot manage to reach the recommended plant population when using the double row system (mainly because of the technicity, the time constraint, but also sometimes the perception that they lack seeds), **the simple fact that they are shifting to double row cultivation induces an improvement in their planting method that leads to a higher plant population compare to their "traditional" single row system.** For those reasons, both components of the intensification should be recommended. If they cannot be combined for some reason, implementing either ridge re-alignment at 75cm or the double row system will anyway help farmers to produce more on the same surface of land, and this at a minimum cost.

Following the tests implemented by Inter Aide, the perception by farmers that the new planting pattern requires more seeds has proven to be correct. Therefore, **projects promoting this technology should not only inform farmers about the additional quantity of seeds needed but also support them in establishing strategies to sustainably access enough seeds in order to increase soybean and groundnut plant population in their fields.**

## 7. References

- IAAT, CGIAR (2019). Growing Soybean in Malawi.
- ICRISAT (2019). Guide for groundnut production in Malawi.
- Inter Aide, study done by Benjamin Grelier (2019). Study of agricultural practices adoption.
- Van Vugt (2018). Participatory research to close the soybean yield gap on Smallholder farms in Malawi, in *Participatory approaches to diversification and intensification of crop production on smallholder farms in Malawi* (PhD thesis).