A SIMPLIFIED PRODUCTION MANNUAL FOR COMMON BEANS IN UGANDAN REFUGEE SETTLEMENTAND HOST COMMUNITIES USING Mak -BIO-FIXER

A FIELD STUDY CONDUCTED IN RWAMWANJA REFUGEE SETTLEMENT IN WESTERN UGANDA

BY

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FSL-RW: Food Systems Lab Rwamwanja

ZARDI: Zonal Agricultural Reserch and Development Institute

NARO: National Agriculture Research Organization

MAK: Makerere University

OPM: Office of the Prime Minister

UNHCR: United Nations High Commission for Refugees

CAES: College of Agriculture and Environmenta Sciences

ADRA: Adventist Development Relief Agrncy

LWF: Luthreran World Federation

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1.0 Background.

Common bean (Phaseolus vulgaris L.) is a dominant legume crop in the Rwamwanja refugee settlement. It doubles as the staple legume for the host community translating to a national consumption of 58 Kg per capita.

In Rwamwanja refugee settlement, the common beans yield potential stands at 300 Kgs per acre compared to the National expected yield of 1300 Kgs. Like in the host community, Beans production system in Rwamwanja refugee settlement is predominantly small-scale accounting between 95% of the farmers on less than 0.5 acre with average production of 0.15 metric tons (150kg) despite the national potential yield of 350 to 650 Kg (per 0.5 acres) depending on the variety. The cropping system is characterized by low input use especially seed and pesticides with most of the refugees using seed from previous season harvest. Beans are famous source of protein and micronutrients mostly Vitamins B, Iron, Calcium and Zinc. The crop offers a good source of balanced nutrition for both the refugees and host community with limited potential to accessing animal proteins.

1:1: Importance of Beans to refugees.

1.1.1. Nutritional benefits: In Rwamwanja, the refugees consume the crop at different growth stages including fresh tender leaves, immature green pods, mature undried fresh seeds and dried seeds.

1.1.2. Economic benefits**:** Beans is the second leading income earner crop after maize in Rwamwanja settlement and host communities with some seasons rising to position one especially in the first season of the year when the rains are scanty and short. Due to the fact that beans have a short gestation period of around 60-76 days (depending on the variety), they tend to perform better than maize that goes to around 115 days (depending on the variety). The refugees supply maize to both the National market and even export a reasonable proportion to the regional East African market especially Rwanda and Burundi.

1.1.3. Environmental benefits:

Due to their short anatomic characteristics, the beans act as a living cover to the soils preventing both wind and rain erosion which are notorious agents of soil loss and exhaustion in the Rwamwanja refugee settlement and host communities. These characteristics have also encouraged refugees to intercrop beans with maize so that the costs of weeding are reduced since beans tend

to shade off the weeds limiting their growth potential. The intercrops increase soil productivity as the result of nitrogen fixation which boosts yield performance.

1.20: Challenges and Opportunities of beans cultivation In Rwamwanja Refugee settlement and the host communities.

1.2.1. Challenges

Small holder farmers in Rwamwanja refugee settlement and host community experience several bottlenecks at different stages of the value chain. The most notorious issues are encountered at the production node where farmers fail to realize the expected yields at harvesting due to the low soil fertility levels. Rwamwanja refugee settlement covers an area of about 40 square miles and currently accommodates more than 95,000 refugees. The refugees till the land growing almost the same crop season after season. Continuous practice of poor methods of growing crops coupled with soil erosion have greatly contributed to loss of soil nutrients leading to low productivity levels within and around the settlement. Other beans production issues include low-income levels limiting affordability to quality and certified inputs such as seeds, fertilizers and pesticides. In addition, the low extension levels among the smallholder bean farmers has resulted into practice of poor agronomic practices such as poor timing, poor weed management, pest and disease management, post-harvest handling and management and lack of effective storage capacity.

1.2.2 Opportunities to beans cultivation in Rwamwanja refugee settlement

Rwamwanja refugee settlement has around 21,737 households (Office of Prime Minister data June 2023) with at least every household cooking beans on daily basis averagely. In addition, the domestic demand of beans around the host communities exceeds the available demand from the settlement. This increasing demand both locally and at the regional markets have resulted into interest by stakeholders such as The National Agriculture Research Organization (NARO), Makerere university and the local government under the department of production to invest in beans production at different nodes of the value chain. For instance, Makerere university has embarked on production of Rhizobia inoculant for common bean production focusing on increasing the yield performance. The NARO under the Rwebitaba ZARDI in Fortportal around 78 Kilometers away from Rwamwanja is focusing on breeding different bean varieties to match with the regional context but also cope up with the consequences of climate change including

drought. These parameters are relevant to establishing a favorable bean value chain for all the actors at different value chain nodes.

1.3 Relevant beans value chain actors around Rwamwanja refugee settlement

There exist a number of potential beans value chain actors around Rwamwanja refugee settlement. These include National Agriculture Research Organization-Rwebitaba-Zonal Agricultural Research Development Institute Fortportal / NARO Rwebitaba ZARDI. This is a government research institute charged with agricultural research including breeding of new bean varieties and multiplication. In addition, Makerere university under the College of Agricultural and Environmental Sciences/CAES, produces the rhizobia inoculant focused at promoting bean yields. Other relevant key stakeholders include: the Kamwenge district local government-department of production comprising of extension workers who offer advisories to the bean farmers. Developmental partners including Finn Church Aid/FCA, AVSI, LW, ADRA, Feed The Future, UNHCR, OPM among others have contributed towards promotion of extension services to the farming community. The private sector such as OKEBA, YIELD HARVEST and other input dealers in the Rwamwanja surrounding trading Centers offer convenient market support system for the bean value chain. In addition, emerging farmers' cooperatives such as the Rwamwanja Rural Farmers' Cooperative (RRFC) that comprises of 36 producer associations offers a stable network and linkages between small holder farmers and financial institutions for increased access to financial services.

2:0 Some of the observable good practices learnt and recommended on common beans production within Rwamwanja Refugee settlement.

2.1 Planning: Cognizant of the fact that there is limited land in the refugee settlements coupled with competing production priorities at individual household level, it is a prerequisite that family members convene to jointly agree on the crop enterprise, acreage, source of seeds and other production requirements before engaging in the season. This is important in preventing production risks and economic violence among refuge households that would negatively impact the yields. For instance, in Rwamwanja, men rarely participate in common bean production but dominantly dominate the selling of common beans produced by women in the market. This has been identified a key bottleneck that demoralizes women investing appropriately in the production. In households

where women and men have been seen to jointly participate in production decisions, high yields have been realized. It is relevant that participatory planning at household level be embraced during the pre-planting activities for a successful common bean yield performance at harvest.

2.2 Land preparation. It has been noted a common practice for refugees to plant maize and introduce beans when the maize has already established (3-5) Weeks old. Maize pits are always established on unprepared fields. In host communities and a few refugee farmers that prepare fine seedbeds before planting, notable yields have been realized. It has been observed and recommended a good practice to prepare fine seed bed for uniform and proper growth of roots to absorb the available soil nutrients and moisture. Planting beans in already prepared fields have been seen as appropriate method of destroying weeds at planting reducing weeds intensity and thus minimizing frequencies of weeding. In addition, the farmers who avoid land preparation tend to remove the plant remains of the previous season from the garden creating a nutrient transfer and loss. On the other hand, the farmers who clear land before planting create an opportunity for the remains of the previous season to be incorporated in the soil which improves carbon sequestration and organic matter content of the soil creating a stable soil structure that improves the health and performance of the crop.

2.3 Season Timing: Field observations have indicated that early and late planting are risks to the beans production. The farmers who plant early after the first rains risk re-planting exercise as beans germinate and immediately get shocked by the sunshine. Those that plant much later after several Weeks of consistent rain downpour also face challenges during the flowering and podding as pods tend to rot. In addition, the beans do not benefit from the nitrogen flush available at the beginning of the first rains. It is relevant and advisable that farmers follow the weather and climate forecast as provided by the responsible authorities. Planting activities should match with the Weather conditions if potential crop yields are to be realized. Much rains at harvesting period has been identified to cause a significant loss in terms of quantity and quality as the beans tend to rot. This has been noted a biggest a challenge to refugee farmers who have limited storage facilities. The farmers who plant timely face limited challenges at all levels of the production node.

2.4: **Timely Field weed management**: It was observed that farmers who maintained clean bean fields all the time had better yields compared to those whose fields that were either delayed being weeded or were wedded only once. Weeds were seen more fatal at flowering and podding stages

where the decomposing weed leaves in contact with bean plants were seen to cause flower and pod abortion especially when the rains were frequent. The weeds assisted to maintain consistent wet environment, a condition that is not so desirable by pods even at maturity phase. In addition, the weeds are competitors for soil nutrients and water with the bean crops and therefore may result to reduced yield performance. The weeds were observed as the main cause of differences in performance for the rhizobia inoculant pilot farmers. Those whose fields were free of weeds especially in the early stages and at flowering phase registered slightly high yields than those who delayed the weeding exercise.

2.5 Post harvest handling and appropriate storage.

Appropriate post harvesting handling and management practices are key in preventing bean loss immediately after harvesting and during storage. Proper drying of beans while still intact in their pods is key in preserving the quality of bean seeds. Removing beans from their pods before complete drying risks seed damages and may result to germination failure, high risk of storage pest entry and rotting. After drying, the bean seeds are removed from the pods and re-exposed to sun light to ensure the right moisture content is achieved before storage. Any clean material such as tarpaulin, sacks, mats (depending on the quantity) may be ideal for the traditional farmers. Separation of organic matter content from the seeds is crucial before storage for quality assurance. Simple materials and processes such as winnowing is suitable for this practice. The grading of the seeds based on variety/color/size is key. Different varieties have different cooking points, tastes and are thus preferred and marketed differently. To ensure effective pricing and marketing, the seeds should be appropriately graded. Once the bean seeds have attained the right moisture content, they should preferably be put in airtight bags/silos and stored to manage storage pests.

Figure 1: Ordinary but effective post-harvest handling and management of common beans in Rwamwanja refugee settlement

3.0 Rhizobia inoculant -A Nature-Based Approach to Soil Nutrition in common beans

In response to soil exhaustion caused by over-cultivation and limited access to nutrients due to affordability challenges, the Food System Lab in Rwamwanja Refugee Settlement, Uganda, promoted environmentally friendly and affordable bio-fertilizers for refugees and host community farmers. The project promoted the use of rhizobia inoculant, an agricultural practice that enhances the release of Nitrogen, a nutrient required to improving plant growth.

Figure 2: Podding bean plant in one of the FSL-RW piloted fields

Rhizobia is a type of soil bacteria forming symbiotic relationships with legume roots, play a vital role in fixing atmospheric nitrogen and solubilizing soil nutrients. The inoculant serves as a bio-fertilizer with no adverse effects on soil or farmers during application. This method of application is farmer-friendly and does not incur additional costs (simply mixed with seeds). For example, farmers require only 2 packs (100 grams) of inoculant to fertilize one acre of common beans at a cost of one dollar, compared to spending $60 on a 50-kilogram bag of chemical NPK fertilizer for the same yield. Moreover, the bio-fertilizer remains in the soil for multiple seasons, benefiting

subsequent crops, while also aiding in reducing the overutilization of chemical fertilizers, which are polluting soils and water resources.

3.1 Recommended Steps in using the Bio fixer inoculant

3.1.1 Requirements

- The right inoculant
- Selected bean seeds
- Supporting materials (basin, tablespoons, water, sugar).

3.1.2 Procedure

1. Weigh 16Kgs of beans (this is adequate to plant 1/2 an acre).
2. Get 2 tablespoons of sugar and mix it in a -bottle of water (500Mls)-5% sugar solution.
3. Mix the solution (in 2 above) with a standard pack of Mak-Bio N Fixer
4. Mix the solution (in 3 above) with 16 Kgs of beans
5. Ensure that all the seeds are evenly coated
6. The coated seeds can be left for 15 minutes to ensure effective absorption
7. Plant all the coated seeds same day

NB:

a. Farmers are advised to mix the quantity of seeds that can be planted and finished that very day and no coated seeds should be left for the next day's planting.

b. Mak-Bio N Fixer is not poisonous when used in high amounts but may not be effective if used in less amounts.

   For instance, farmers with small gardens like ¼ an acre which require only 7 Kgs can use a full pack of Mak-Bio N Fixer (which ideally is enough for ½ an ace). However, one pack of Mak-Bio N Fixer may not be of effective use if used to mix 30 Kgs. In summary, there is under doze but no overdose with the Mak-Bio N Fixer.

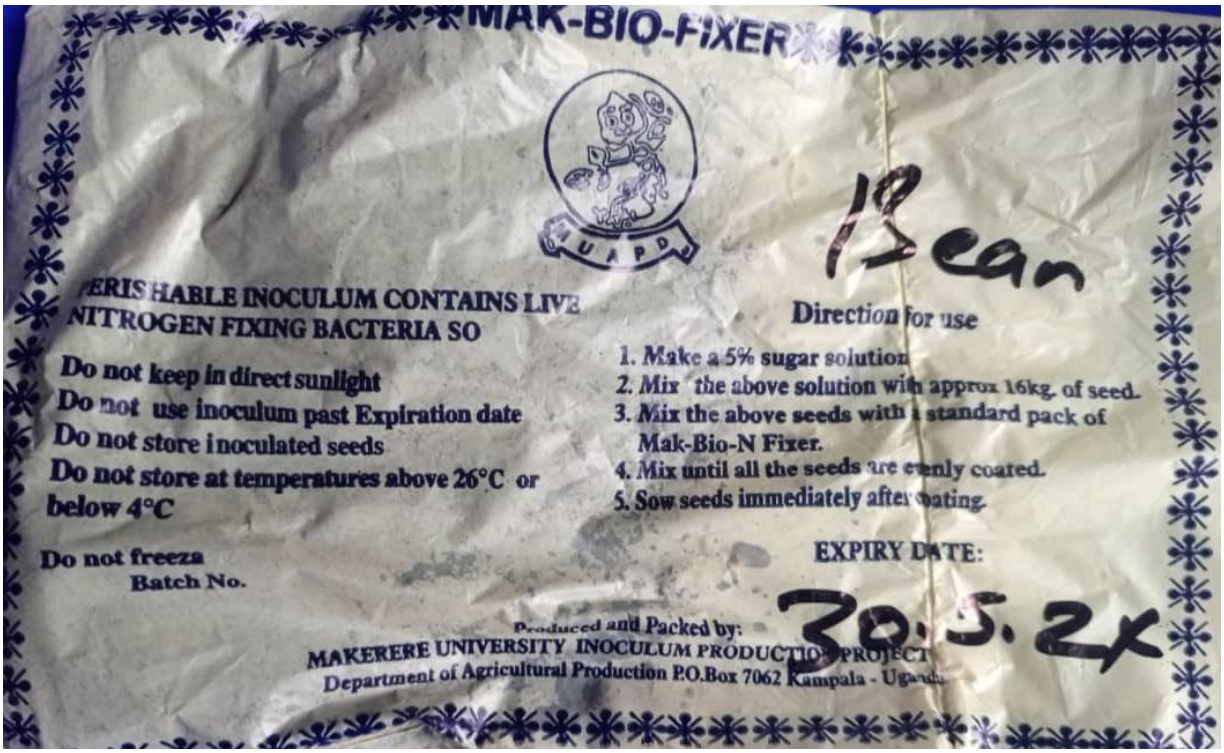

Figure 2: **Mak-Bio N Fixer pack**

Figure 3: ***Makerere University-Prof John Baptist Tumuhairwe (in white jumper) trains FSL-RW farmers on the use and application of the Mak-Bio N Fixer.***

3.0 Mak- Bio-Fixer Yield potential

FSL-RW used conducted an assessment on the performance of Mak-Bio-Fixer on common beans using two approaches. The first approach was diseeminating it to 50 pilot farmers to use in their own fields. The farmers managed their fields independently. The second approach was using the innoculant at the farmers cooperative facility demonsytration block. This was more of experiment

where the FSL-Technical team and farmers were responsible for the plot management and most of the agronomic practices such as timely planting, timely and frequent weeding were consistently observed.

3.1 Rhizobia Inoculant performance at the farmers' cooperative facility demonstration unit

The FSL-RW established a farmers cooperative named as Rwamwanja Rural Farmers Cooperative (RRFC) that was provided with a milling facility for value addition activities. The facility is seated on one acre of arable land which additionally is used for carrying out and demonstrating on good and climate smart agricultural activities and innovations to accelerate their adoption. The FSL-RW conducted a study at the RRFC to determine the yield potantial of Mak-Bio-Fixer in relation to the production results from the 50 pilot farmers that were also studying the performance from their own home fields.

3.1.2 Methods used

The FSL-RW established three seperate compartments with with an idependate treatments. In each compartment, 5 Kilograms of beans were planted. In the compartment one, common beans coated with Mak-Bio-Fixer were planted. In the second compartment, common beans coated with Mak-Bio-Fixer were planted using SSP. In the third compartment, common beans were planted without any treatment.

3.1.3 Yield performance per treatment at the farmers demo unit

After harvesting, the beans from different compartments were dried, threshed and seperately winnowed. The seeds were weighed and the yield determined in kilograms. The 69, 70 and 47 kilograms were harvested in the compartments of Mak-Bio-Fixer, Combination of SSP + Mak-Bio-Fixer and control field respectivley. This translated to an increment of 22 and 23 Kilograms when Mak-Bio-Fixer and a combination of SSP and Mak-Bio-Fixer were used respectively. The results are summarised in the table 1 bellow.

Table 3.1:Yield Performance per treatment at the farmers demonstration unit

Sn	Treatment	Yield (Kgs)	Yield increment	Percentage increment

			(Kgs)	
1	Mak-Bio-Fixer	69	22	47
	Combination of Mak-Bio-Fixer			
2	and SSP	70	23	49
3	Control	47	0	

3.2 The rhizobia inoculant performance at the selected Pilot farmers gardens

The FSL worked wth 50 selected pilot farmers where 40 were females and 10 were males. The farmers grow the common beans using different approaches at different plot sizes. On average, no single farmer exceeded 0.5 acres of land. Cognizant to the fact that the overdoze of the Mak Bio Fixer has no fatal consequences on yield performace yet the underdoze has no significant performance improvement, all farmers were asked to use a full Mak Bio Fixer. However, some of the farmers intercropped beans with maize while others considered a mono crop. On comparasion, 65% was under mono- crop since even those who intercroped had scattered the maize crop whose growth was greatly hindered by the long dry spell. Unlike at the farmers cooperative facility where performace yield determination followed a sytemised approach (harvesting, winnowing, weighing with standard materials/weighing scale), the farmers used rodumentary equipment and materials. Some farmers determined weight by use of cups, bags, basins and buckets. When asked about the yield performace on comparasion with the previous season (considering the same size of the plot) 43 farmers reported a yied increment and 7 reported total garden failure due to late planting, animals damages and drought. When asked to define in percentage increment from 0 to 100%, four categories came into existance with the 45% as the highest and 30% as the lowest as illustarted by table 3.2 bellow:

Table 3.2: Mak-Bio Fixer percentage Yield increment

Sn	Category	Number of farmers	Percentage increment
	Category 1	5	45

Category 2	25	40
Category 3	8	35
Category 4	3	30

As observed in the above table, 37.5% is the median, 40% is the mode and 37.5 is the avearge. Approximately, 38% was reported as the average yield performance. Carefully yield determination (weighing using standard measurements) and observing proper field management practices such as timely weeding was anticipated responisble for a rise in yield. Forinstance, the 48% obtained from the cooperative demo where all the agronomic practices were observed. It was also observed that the inovation was conducted in the first season of the year where yields are always less by more than 30% from the main second season. The probability that the inoculant would increase the yield performance to >60% in a good season is interpreted possible. This is in line with the Mak-Bio Fixer expected yield potantial of increasing yields between 50-120%.

3.3The DONTS while using the Rhizobia Inoculants

- Never transfer already coated seeds (mixed with the inoculant) for the next planting day. Ensure that whatever quantity is mixed with the inoculant is planted and finished the same planting day.
- Never use an inoculant for beans with another type of a legume. For instance, inoculants for beans may not work in ground nuts or peas. Mak-Bio- Fixer is crop specific.

4.0 Conclusion

The use of Rhizobia inoculant was learnt to be a good innovation for improving soil productivity and common bean yield potential due to its affordability, easy to use and environmentally safe benefits especially in the refugee settlement where the farmers are limited with access to financial services.