



Training course package for bean Farmers and Consumers

BEANS FOR NUTRITION AND HEALTH

Website	foodland-africa.eu
Twitter	@FoodLANDafrica
Facebook	FoodLANDafrica
LinkedIn	foodland-africa



Table of Contents

1. FoodLAND technical innovation for local food supply chains: concepts and approaches	3
2. FoodLAND practical training: aims and scope	5
3. Second training packages on the adoption and management of the tested innovations: an overview	6
4. Training package on practical information on the adoption and management of the tested innovations	7
5.1.1 New improved legume lines	7
Principles of good beans farming	7
Beans for nutrition	28



1. FoodLAND technical innovation for local food supply chains: concepts and approaches

The FoodLAND project has the ambition to impact on a large number of supply chains and communities, hence the process of food operators' capacity development has to be tailored and as much participative as possible. Accordingly, one of the assumptions of FoodLAND is that sustainable and nutrition-responsive farming systems can be achieved basically by strengthening the capacity development, and specifically by **a)** empowering farmers and processors through the implementation of capacity building processes and concrete opportunities; **b)** creating or consolidating cooperation and shared knowledge to overcome the lack of coordination among food operators; **c)** addressing the inefficient use of resources; **d)** trying to address and build resiliency to the high vulnerability of food systems to climate change; **e)** enhancing the integration of supply chains by creating commercial and stakeholders' networks; **f)** improving the responsiveness of the production sector to the market demand.

To implement these elements of capacity development, FoodLAND proposed the adoption of specific innovations, among which the organizational ones, to create strong and responsive links between producers and encompassing all the intermediate actors along the food value chain, such as researchers, SMEs, NGOs, local and national authorities. In order to ease the creation of those links and guarantee the sustainability over time of the results, 14 Food Hubs will be created in 6 countries as part of the organizational innovations. Food Hubs are conceived as multi-actors centers of innovation where to develop or enhance the organizational and operational conditions enabling local food supply chains (D3.6).

Functional to the implementation of the Food Hubs and of the innovations, the training courses were designed – in form of capacity development activities – as a two-phase process. Firstly, a training session focused on general, preparatory



topics was provided to farmers as described and reported in D3.5 (“Group Introductory Training”, GIT). According to the project GA, GIT broad set of goals were: to enhance the knowledge of consumers’ nutritional needs and market opportunities, and to boost the notions about climate change, sustainability, resilience, and food culture. Secondly, a specific training session were organized to provide food operators with practical information on the adoption and management of the innovations tested at lab / small scale level and to contribute to validating them at appropriate scale.

However, as the whole approach has been designed by FoodLAND to ensure the inclusion of the local actors from the first moment, both the training sessions were set up accordingly. Indeed, yet in the inception phase of the project, an assessment on participatory methods has been run and Participatory Learning and Action (PLA) approach has been eventually assessed as the best one to ensure the inclusion of multiple perspectives. The main purpose of PLA is to support people within communities to analyze their own situation, rather than have it analyzed by outsiders, and to ensure that any learning is then translated into action (Gosling and Edwards 2003). In addition, a gender-sensitive approach has been applied to the trainings that have been designed considering gender roles and power relations; they have provided equal opportunities to participate in the process by caring to times, venues and use of local languages.

The GITs have been conceived as the first step towards the innovation validation and aim at involving the producers, yet from the inception phase. They are just the first step in a sequence of 6, summed up in **Table 1**. After the GITs, where farmers and processors meet and share their vision and goals for the Food Hubs and exchange information about specific topics, the Food Hubs were created and the innovation tested (first in pre-test, then in pilot phase). The constant iteration between researchers and local actors is a key feature of the project: specifically, the practical trainings focused the single innovations (step 5) are aimed at validating the innovations at adequate scale and planned to trigger feedback loops of control and improvement involving developers and adopters.



Table 1. Activities with farmers and food processors (SMEs) and participatory approach

Step	1	2	3	4	5	6
Task	T3.3	T3.3	T3.4	T4.1, T4.5	T5.1, T5.5	T5.1, T5.5
Activity	Group introductory training	Food Hubs creation	Innovation undertaking	Innovation tests	Individual and group practical training	Innovation pilot and validation

2. FoodLAND practical training: aims and scope

According to the project bottom-up and participatory approaches, following the courses on introductory topics GIT organized in the early project phase (T3.3), and as component creating / strengthening the Food Hubs as local innovation centres, FoodLAND has organized a second set of training activities with food operators based on active learning methods and gender equality principle (Task 5.1-5.9). In this regard, specific mechanisms (being aware of the gender roles and power relations; providing equal opportunities to participate in the process by putting attention to the times, venues, use of local languages, etc.) will be lifted to ensure women’s participation. These training packages are aimed at providing the local farmers and food processors with operational instructions on the adoption and management of the validated innovations.

This second set of training activities has been organised – triggering PLA approach – as individual and group practical (demonstration/capacity building) activities to be conducted in parallel to the implementation of the technological research (where relevant) and of the innovation pilots and validation. These technology-centred trainings aim at strengthening the participants’ understanding of novel production and post-harvest techniques, innovative tools and systems (e.g., climate smart/precision agriculture, hydroponics, and integrated aquaculture), new technologies for primary and secondary processing, and supply chain management. Thus they aim at fostering knowledge and operational



capacity to deploy, manage, and maintain the validated technological innovations – documented by the released guidelines D4.1 ÷ D4.11 (e.g., training pamphlets, user manuals, flow diagrams, and operational recommendations) and practice abstracts D6.5 – validated jointly at appropriate scale.

3. Second training packages on the adoption and management of the tested innovations: an overview

The second training course aimed at consolidating the food operators' knowledge and practical skills to adopt, manage and validate the project innovations and complement the related guidelines. Specifically, the realized training materials provide local farmers and food operators with a set of notions and concrete information on a series of innovative tools and systems as per the following **Table 2**. It is clear that both the contents and formats of the learning packages widely differ across technologies as well as Food Hubs (when the same type of innovation must be validated in different contexts). The diversity that emerges from the proposed solutions reflects the different needs highlighted by farmers and stakeholders as well as the conditions and opportunities characterizing the local communities. Nevertheless, in order to take into due account the existing heterogeneity inside the local communities, the developed learning materials have been let available on the project intranet so as to be used for further training initiatives across the network of Food Hubs.



4. Second training packages on practical information on the adoption and management of the tested innovations

5.1.1 New improved legume lines

Principles of good beans farming



1. INTRODUCTION

Beans, like other crops, are cultivated in various parts of the world, including Latin America, Africa, the Middle East, China, Europe, the United States and Canada. In these areas, beans are cultivated in various environments and systems. In Tanzania, beans are cultivated almost everywhere but they perform well in the areas with altitude 800-2000 m.a.s.l.

1.1 Types of Common beans

Beans are divided into two main groups as follows

(a) Dry beans or green beans (French or haricot beans) – Beans that can be grown and harvested as dry grains are called dry beans. While green beans are grown and harvested for use when the pods and seeds are still green and not



matured. These are usually eaten the whole pods, they are also known as snap beans.

(b) Climbing beans and non-climbing (bush) beans - usually climbing/creeping beans need to be supported by poles, ropes or other crops if the farmer has them mixed with another crop such as maize so that they can creep more. Its height and reproduction depend more on the length of the material used to help the plant crawl. These beans can grow more than three meters high. Non-climbing beans do not exceed sixty centimeters in height.

Regardless of the type of beans one needs to grow, the principles of good bean cultivation must be followed. These principles will enable the farmer to use resources efficiently in production so as to obtain high yields while reducing production costs as much as possible. These principles are observed at all stages of the beans value chain. Some of the measures include:

- (a) The choice of the right area to grow beans,
- (b) Preparation of the beans field,
- (c) Preparation of the area for planting beans,
- (d) Selection of good seeds, planting,
- (e) Controlling weeds,
- (f) Maintaining soil fertility,
- (g) Controlling insects and diseases,
- (h) Proper harvesting
- (i) Appropriate storage of beans.

1.2 Importance of growing Common beans

Common bean is one of the legume crops cultivated all over the world. Other legumes include crops such as, peas, peanuts, soybeans, chickpeas and pigeon pea just to mention a few. All these legumes are grown in Tanzania but common bean is the one that is mostly grown (75% of the legume crops produced). Beans, along with other crops of its category, have one main feature; they have nodules on their roots. Those nodules store special bacteria (nitrogen fixing bacteria) that make nitrogen. This is the reason why this group of plants is known for their importance of improving the soil fertility. A farmer can grow beans for food consumption only at home or for selling. The simplicity of growing beans and its advantages attract many people to grow it, but without following professional guidance, it will be a dream for the farmers to get the harvest they expect.

1.3 Importance and benefits of bean cultivation

(a) It takes a short time to mature a farmer can grow it two to three times in a year,



- (b) The cost of its production is relatively lower compared to other crops such as maize
- (c) Food security and nutrition- beans contain protein, nutrients such as zinc, iron and vitamins. In addition to dry beans, leaves and premature pods are also edible. On average a Tanzanian eats up to 20kg of dry bean per year.
- (d) Provide livestock feeds Beans residues after threshing (plant stalks and pods) are good feed for livestock
- (e) Source of income- There are already bean markets in Tanzania and in the neighboring countries such as Congo, South Sudan, Zambia, South Africa, Malawi, Zimbabwe, and Kenya. Most of the times it fetches a very good price in the market,
- (f) Fertilizing the soil: Beans are a good source of nitrogen in the soil because of their ability to take up nitrogen from the air. When roots are left in the soil after harvesting, it leads to more than 20-60 kilograms of nitrogen remaining in one hectare of land that can be used to fertilize the upcoming crops. This is equivalent to $\frac{3}{4}$ -2 of a salt fertilizer, and can produce good results. When beans leaves and its roots are left in the ground after harvesting, it increases the nitrogen in the ground.
- (g) Used as a cover crop, they can help prevent soil erosion.

1.4 Environment and climate for bean production

Beans thrives well in areas with an altitude of 800 to 2000 meters from sea level. The ideal temperature for the growth of beans is an average temperature of 20 to 29 degrees Celsius, although in some areas it starts at 15 degrees Celsius. The most suitable rainfall for bean cultivation is between 350-500mm during bean cultivation accompanied by a small drought to reduce the possibility of an outbreak of diseases caused by bacteria or fungi. Beans grow well in loamy soil with a mixture of fertile and well-drained loam. Soil pH should be between 5.5 - 7.0, although beans can tolerate even a pH of 4.5. In Tanzania, beans are grown in abundance in the regions of Mbeya, Iringa, Kigoma, Arusha, Morogoro, Kagera, Kilimanjaro, Tanga, Ruvuma and Rukwa.

2. GOOD AGRICULTURAL PRACTICES FOR BEAN PRODUCTION

2.1 Beans field preparation

Field preparation includes clearing bushes, removing tree stumps, tunnels and weeding. Beans need a balanced area with soft soil that enables the roots to absorb the nutrients in the soil. If the planting area is well prepared, it enables the beans to germinate well and reduces the number of weeding that would be needed because it reduces the invasion of weeds.



Generally, the preparation of the field should begin at the end of the harvest season or at least **twenty-one days** or **three weeks** before planting. This time allows various things to decompose in the soil. The field should be plowed at least twice and sometimes followed by loosening the soil to get a smooth planting area. If the farm has a history of having beans pests, then loosen the soil more because this helps to kill the eggs and insects.

It's usually advised to choose an area that is **fertile enough, allows water penetration and with less acidic soil**. To control pests, beans can be planted in rotation with other crops for example if previous year the field was planted by maize then the following year one can plant beans and next year or after two seasons another type of crop is planted. The beans can be planted randomly in the field or in lines or in ridges. Using ridges help to prevent stagnant water which damages crops and causes little or no harvest.

2.2 Time to plant beans

Bean planting should be done at the right time for the respective area depending on the availability of sufficient water (rain). In Tanzania in the Eastern regions planting should be done in **March/April**, in the Lake regions **August/September** and **January/February** while in the Southern highlands in **November/December, February/March**. To all regions, if irrigation is used, beans can also be planted in any other months depending on water availability. Beans should be planted when there not a lot of rains. This is because too much stagnant water is not good for the beans and causes plant diseases and rot. In the same way drought is also not good because it can make the plants wilt or die and cause losses. So before planting a farmer must be certain of a reliable source of water.

2.3 Seed preparation

There are many types of bean varieties to be used as seeds. There are good improved varieties that have been researched and approved for use. Regarding the source of seeds for planting, there are seeds that are produced by the seed companies and have been certified by Tanzania Seed Certification Institute (TOSCI) and there are also those produced by farmers under Community based seed production system and certified by TOSCI. The seed grade that is produced under this community-based system is known as the Quality Declared Seed (QDS). QDS is distributed within a restricted area. But a farmer can also use seed saved from last crop (last season's seeds saved for the next season) provided that the farmer stores well the seed to maintain quality. It is up to the farmers to make decisions about the seeds they want, but it is good and advisable



to use the good quality seeds that has been certified, because they lead to good yield since they can also be resistant to various diseases. The best bean seeds are available at the Agricultural Seed Agency (ASA), its headquarters is Morogoro but also at its branches in Arusha, Mwanza and Njombe. For the farmer who saves own seeds, the seeds must be kept in a good place without extreme heat, humidity and insects so that they can still be of good quality when planting.



2.4 Bean varieties Bean varieties

The best bean varieties are those that have been researched by legally recognized institutions and approved by the National Seed Committee for use. Among the best bean varieties developed at different times and now used by farmers in Tanzania include Uyole, Lyamungu 85 and 90, Rojo, Mshindi, Pesa, SUA 90, SUA Kalima, Sakila 20, Bilfa and Canadian wonder. In addition to these, there are also landraces maintained by the farmers and have traits preferred by the farmers and consumers, these can also be grown.



Figure 1 a: Some of the improved bean varieties in Tanzania





Figure 1 b: Some of the improved bean varieties

2.5 Seed rate (amount of seed for planting) and Plant spacing

To plant one acre **30 to 40 Kgs** of beans is needed. This is equivalent to **80 to 90 Kg** of beans per hectare, however the exact amount depends on the size of the seed.

It is recommended to plant beans at a distance of **(50×20) 50 cm (row to row) and 20 cm (plant to plant)**, plant **two bean seeds in one hole**, the seeds can be planted at a distance of **3-6 cm** down. One seed in each hole use a space of **50 cm by 10 cm**. This will give between **150,000 and 200,000** plants in one hectare (short beans); creeping beans are half the number of short beans per hectare. (1 hectare = 2.471 acres.). Climbing beans are planted in a space of **60cm×10cm**; this is because these plants are big and need a lot of space between plants.





Figure 2: Farmers are being trained on Good Agricultural Practices for preparing the field and planting beans

2.6 Weed control

When weeds are present in the field, they compete with beans in using water, nutrients and light, which are very important in the growth of beans. Therefore, a farmer should control weeds so as to reduce competition in using water, nutrients, light and space. There are several ways of controlling weeds and they include:

(a) Weeding the field.-Weeding has to be done early as soon as the beans germinate and soon after the field is weeded. Normally, a bean farm needs two weeding with a hand plow, especially for small and medium farmers. In the first weeding, the weeds should be removed from the field as soon as they appear, but this should be done at least the **second week** after the beans germinate (8-12 days after the plant germinates). Weeding can also be done **before the beans bloom (20-30 days after the first weeding)**. Weeding at flowering or fruiting causes wilting of flowers and/or fruit.

(b) Use of herbicides before planting, pre-emergence or after germination- There are different types of herbicides and one will choose what to use depending on the major types of weeds present in the field, time of application, availability and the cost of the herbicide.

2.7 Fertilizer Requirements

Plants need nutrients from the soil to grow and produce healthy fruits. Beans need the following minerals:

- (a) Nitrogen
- (b) Phosphorous'
- (c) Potassium



- (d) Others are needed in small amounts such as zinc, calcium, sulfur etc.

Sources of nutrients:

- (a) Organic fertilizers-which are obtained from organic fertilizers such as manure, compost, ash, animal urine and plant residues.
- (b) Inorganic/industrial fertilizers-Which are manufactured in the factories

It is important to be aware of the levels of nutrients in the soil in which one hopes to plant the beans so assess the levels of minerals and know those which have decreased in order to make efforts to increase them.

Fertilizers from both sources are good, however, it is important to use them according to the recommendations given by the extension workers based on the soils fertility levels. Organic fertilizers of which living organisms to grow and continue to enrich the soil, for example bean roots that help with living organisms (nitrogen fixing bacteria) in the soil to produce nitrogen can also be employed.



Figure 3: Some of the nutrients from soil needed by the plant

There are several industrial fertilizers, the choice of what to use will depend on time of application, soil type and status in terms of fertility and pH levels. Fertilizer most used are:

- (a) DAP- Di-Ammonium Phosphate
- (b) TSP-Triple Superphosphate
- (c) CAN-Calcium Ammonium Nitrate



- (d) NPK-Nitrogen, Phosphorus, Potassium
- (e) SA-Ammonium Sulfate
- (f) Urea
- (g) Rock Phosphate

DAP is applied at sowing or **one week** after the beans have germinated. Other fertilizers in the list are applied **later** during plant growth just before flowering or at flowering time.

Caution if these fertilizers are in excess, the beans can have more leaves than flowers and cause the yield to be low. Therefore, one should apply amount based of the soil fertility level of the field. These days, there are some soil testing tools that can be used to test the soil quickly in the field to estimate mineral levels. These test results can allow a farmer to determine the amount of fertilizer that will be needed to be applied in the field.

Usually, beans might not need nitrogen in abundance especially if planted in the field previously planted by beans that have ability to develop root nodules because the roots of beans help with living organisms (nitrogen fixing bacteria) living in the soil to make nitrogen. However, beans need phosphorus to improve the roots and potassium to prepare the plant to produce more flowers and produce better fruits.





Figure 4: Bean root nodules are the habitat of bacteria that produce nitrogen, which is a very important nutrient for beans and other crops.

It is recommended that if the field was applied with fertilizers such as Urea or CAN for the previous season, then there is no need to re-apply nitrogen fertilizers, instead one can apply TSP or DAP 60 Kg per hectare during planting. But if possible, it is important to test the soil first to know the real condition of the minerals content present in the soil. Or Minjingu fertilizer (Minjingu Rock Phosphate) **250 Kg per hectare** can be during planting.

Since the nutrients must be in the soil, then if the field is very exhausted or nitrogen fertilizers were not applied in previous season, then NPK can be used in a ratio of **5:10:10** amounting to 30 Kg per hectare should be applied during planting. All fertilizers should be placed five to **10 centimeters** from the stem/hole of the plant and **3 to 5 centimeters** deep.





Figure 5: A measure of fertilizer per hole or plant used by farmers. It is easy to have equivalent measures that the farmers can use easily e.g. a cap of a soda bottle shown here

If manure is used then **two to four tons per acre** or **five to ten tons per hectare** or green manure (**5 tons per hectare**) should be used. Manure should be poured/scattered all over the field and then mixed/spread well with the soil by plowing (with tractor or cow plough). In order to use manure economically and if the manure is dry, then two or three soda caps of manure powder should be applied in each hole before planting.

With regard to green manure, this is available after cleaning the field and leaving it until when the weeds grow and then plowed with a tractor or cattle (with weeds in it) but before the weeds have produced seeds, and then the bean seed are sown as described above. Minjingu rock phosphate fertilizer can be used together with manure and green manure.

2.8 Irrigation

Beans need sufficient moisture before flowering and during podding. But need a little humidity during flowering and dryness during pod maturation and drying of pods. If any other irrigation method is used other than rain, then one need to check at what stage of plant growth the beans have reached before planning irrigation schedule. The irrigation methods that can be used include:

- (i) Farrow
- (ii) Drip
- (iii) Sprinkler



The choice of the method to be used will depend on the availability of the facilities, the stage of plant growth, the amount of water available for irrigation



Figure 6: A Healthy bean plant with pods

2.9 Intercropping

It is very common in Tanzania and other East African countries to grow bean together in the same field with other crops (intercropping). This is practiced by farmers mainly as assurance for food security. With scarcity of land in some areas intercropping is also practiced so as to use the available land efficiently such that the same field produces two crops at the same time.

Studies have shown that the yield of beans when grown alone is higher than the yield of beans intercropped with maize or another crop. This is due to the fact that unlike beans mixed with other crops, beans grown alone do not compete for food, light and space, thus making them self-sufficient throughout the growth period and thus bringing a high yield. However, intercropping is a good practice and it is recommended to plant beans together with plants of other species such as maize because it helps in distributing nitrogen minerals and for climbing beans, they find a place to hold or crawl. Beans can be planted between rows of corn. Potatoes can also be planted with beans.



It is recommended not to plant beans together with other leguminous plants as it causes the plants to not grow well as they are not getting enough nutrients and can cause problems such as insects (bean whitefly) and diseases since some legume crops share the same pest problems.



Figure 7: A field with a mixture of maize and beans

2.10 Dealing with insects and diseases in the field

Beans are attacked by insects and various diseases. So it is important to be fully prepared to be ready to fight those insects and diseases

Insects

There several ways of managing insects in the bean field, the choice of a way to manage will depend on the type of the insect, resources available, growth stage of the insect and the facilities available for the control method. Among the ways of preventing, protecting and repelling insects are to:

(a) Ensure that the plants are in good condition (weeded, enough space and not damaged).



(b) Change the type of plants planted (crop rotation) in the same field it helps to reduce the possibility of insects multiplying.

(c) Use of pesticides- There are several pesticides in the market that can be used. A farmer will need to ask the Extension Service worker in her/his location for a suitable pesticide to use.

(d) Use of botanicals-For some insects such as caterpillars (African Bollworms, they can be expelled using neem seed/plant extract or garlic.

Neem extract is a very good medicine to repel insects and has no harm to humans. Industrial pesticides can be used and are available at agricultural input stores.

Bean stem maggots are pests that attack young bean plants. These bean maggots can cause up to 100 percent damage depending on weather conditions that is low humidity, low fertility, presence of beans weed and diseases in the soil, repeated planting of beans crop every season and beans variety.



Figure 8: Bean stem maggot

(e) Early planting

(f) Seed fertilizing with drugs such as Endosufan, Acephate, Murtano before planting the seeds in the ground. Doing this will help prevent bean stem maggot and root rot causes.



Diseases

Popular diseases that are enemies in the growth of beans include those which are caused by, caused by bacteria, fungi and viruses. Infected seed, soil and bean litter are major sources of transmission for all diseases.

The main ways to control beans diseases are as follows:

- (a) Using varieties of beans that are resistant to diseases is the main solution and this is inexpensive compared to any other method.
- (b) Diseases caused by fungi as well as diseases caused by bacteria survive in the seeds or in the remains of plants. Thus, using fresh seeds, changing the type of crops grown in the same field every season, proper weeding and weeding the field after harvesting help to control diseases. Avoid using seeds that came from infected beans because their seeds are also infected and cannot be seen with naked eyes.
- (c) Diseases caused by fungi can survive in the soil as well. Planting jujube seeds, weeding the land, using ridges and crop rotation helps to prevent the disease from spreading through the soil infected by the fungal disease.
- (d) If fungal spores appear regularly on the field, then the seed can be protected by using fungicides before planting the seeds. There are different types of fungicides in the market one will choose what to use based on the type of the problem, efficacy, availability and the cost. A farmer will need to seek advice from the extension officer in his/her area to get the type of fungicide to be used based on the factors stated above.

Safe use of pesticides

- Only pesticides that are recommended for use on beans should be used, and this helps to avoid harm to the plants
- Pesticides can cause harm, so one should make sure the instructions as written on the packaging or the advice of the input dealer or agricultural expert are followed so that they can be used safely. It is also good to consider the instructions for the appropriate time to use beans after spraying pesticides, especially for those who use premature beans.
- Avoid keeping pesticides in the same place or with food
- If you are going to use a spoon to mix pesticides then avoid using that spoon to eat food.



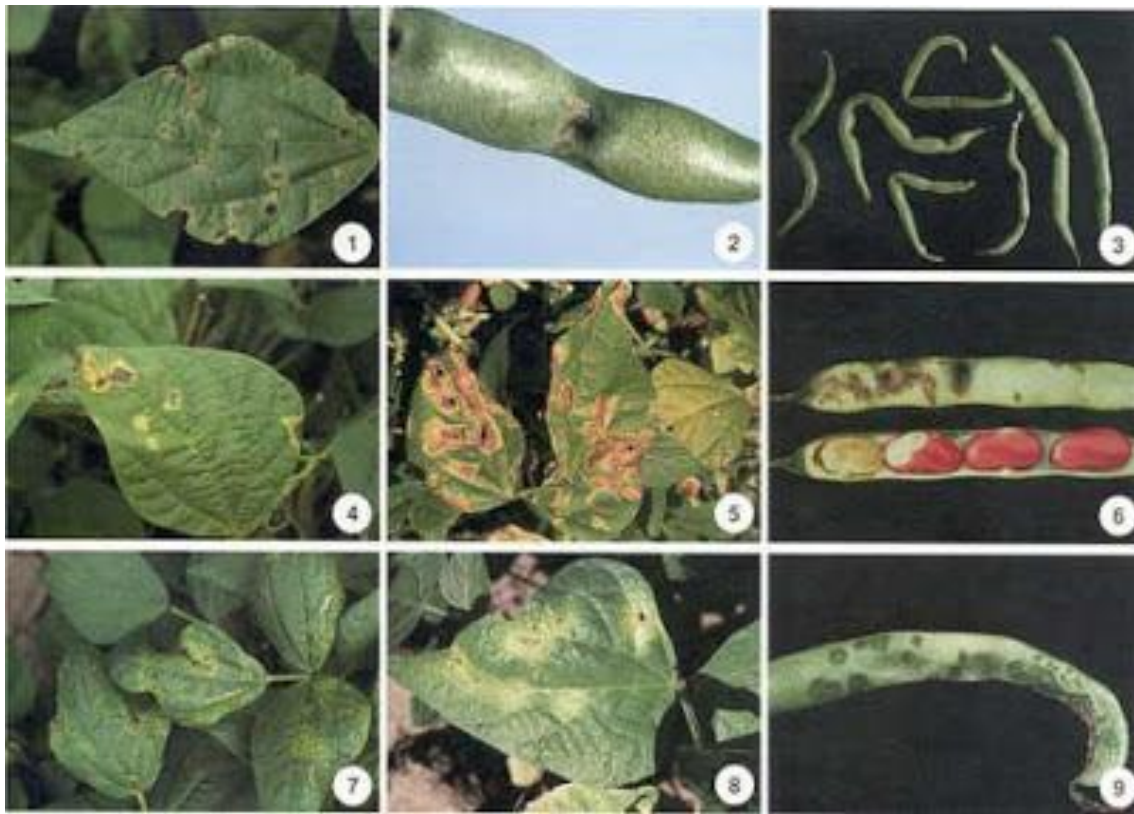


Figure 9: Some symptoms of bean diseases affect different parts of the plant (Courtesy: Compendium for Common Bean diseases)



Figure 10: The owner of the farm and the farmers examining the infected plant together



2.11 Ripening and harvesting of beans

Green beans should be harvested before the beans are completely matured. This is between 7-8 weeks after planting. Dry beans are harvested once a satisfactory amount of maturity and drying has been achieved. When 80% of the beans are mature and start to change color (dry) or otherwise shrink, they are ready for harvest. Usually the whole plant is plucked and placed in the sun to continue drying, then the beans are removed from the plant and continued to be dried to reduce loss during storage. After drying to at least 12 percent moisture, the beans should be stored in a container with a cover such as a plastic bucket or barrel and to have a regular check so that to make sure that insects have not entered and then cover them again.

Harvesting

Beans should be harvested as soon as they are dry and before the pods burst. At the time of harvesting, it is recommended to remove the bean stalks and collect them, then threshing them to remove the grains from their pods.

Some of the signs of ripe beans include leaves turning yellow and others drying up, and bean pods starting from ripe green to pale green to yellow and finally crusty. One can also confirm by opening the pods and be satisfied with the appearance of the beans inside. Dry beans take 75 days (two and a half months) to 100 days to be ready for harvest depending on the type of bean. However, some types of beans are early the can reach maturity in less days than those specified above. If in every 10 plants seven or more beans are mature then beans in that field are ready to harvest





Figure 11: Harvested beans ready for being threshed

During normal harvesting, the entire bean plant is uprooted and collected in heaps and later all the heaps are gathered in one place in the sun so that the beans dry before peeling. Two days after the beans are picked; they are dry enough that can be and threshed and be winnowed/sifted to separate the clean seeds from the trash.





Figure 12: Sifting beans over a canvas sheet to control the soil from mixing with the beans

How to store Beans

After sifting beans can be dried under the sun for several days to make sure they are dry and free of moisture that can cause them to get fungus. Beans should be stored in sacks and if they need to be stored for a long time without being sold/eaten then one should make sure that they are applied with appropriate pesticides to control storage pests (such as Shumba, Actellic Dust or Malathion). Special grain storage bags or a container with a lid such as a plastic bucket or barrel can be used to store beans and one need to keep checking them regularly to make sure insects have not entered. It is important to make sure that the warehouse or containers that are used to store the beans are clean.





Figure 13: Beans being sold in the market



CONCLUSION

It is very important that the farmers follow Good Agricultural Practices (GAP) for beans so as to get benefits from bean farming. Adopting GAP will ensure the farmers get good yields per unit area and the crops are of good quality to be consumed in the household and be marketed for wider use by other consumers. Farmers should always seek advices from Agricultural Extension Services Providers located in their areas so as to solve challenges occurring during bean and cultivation. Agricultural Extension Services Providers through the Local Government Authorities should organize frequent trainings to farmers so as to educate /update farmers of good agricultural practices for growing beans and other crops. Where possible demonstration plots should be set in the villages where farmers can see how plots managed using GAP look like and copy the practices in their own fields.

Prepared by:

Susan Nchimbi-Msolla- nchimbi@sua.ac.tz

Joshua Kidudu- kidudu@sua.ac.tz

Adriano Mvile- mvileadriano@gmail.com

Sokoine University of Agriculture, FoodLAND Project, Morogoro, TANZANIA



Beans for nutrition

1. INTRODUCTION

1.1 Nutrition as a priority issue

- Nutrition is an important part of health and development. Good nutrition involves improving the health of infants starting from the womb to enable them to grow physically and mentally, build stronger immunity, reduce the risk of diseases and have a long life.
- Healthy children learn faster and do better in school. When they are adults, they have the strength and ability to create an opportunity for themselves to break the cycle of poverty and hunger in the household and society in general.
- Good nutrition is also important for adults at different age stages. It is important for production and reproduction

1.2 Types of food

- Foods consumed by human being can be categorized in six major groups, namely, cereals, roots and tubers; fruits; vegetable; animal source foods; legumes & pulses and oil and fats. Each type of food group has a role in human nutrition as indicated in Table 1 and therefore for good nutrition people are required to eat all groups at determine amount depending on age, activity pattern and physiological status (type of work, sick or normal).
- Different types of foods can provide what is needed in each food groups, therefore people should eat what is available in their own localities.
- Where possible, it is recommended in each meal to have foods from all food groups and have what is known as balanced diets
- People using balanced diets are always healthy and are capable of improving their livelihoods and contributing to the national economy



Table 1: Food Groups and their roles in human body

Food group	Key nutrients	Examples of food items
Cereals, roots, tubers and plantain	Carbohydrates, fibre, protein, fat and micronutrient (when eaten unprocessed Cereals or in bio-fortified or fortified form)	Maize, wheat, rice, potatoes, sweet potatoes, green banana, plantain, cassava, yams,
Animal and animal source foods	Protein, fats, iron, vitamin A, B-vitamins, calcium, zinc, magnesium, phosphorous, selenium	Beef, mutton, chicken, milk, fish, sardines, eggs, edible insects (kumbikumbi, senene)
Legumes and pulses	Carbohydrates, protein, fibre, iron, folate, B group vitamins, minerals	Kidney beans, soy beans, cowpeas, green gram, pigeon peas (mbaazi), chick peas (dengu), Bambara (njugumawe), peas (njegere)
Vegetables	Fibre, pro-vitamin A, vitamin C, Folic Acid, vitamin K, potassium, phytochemicals	Sweet potatoes leaves (matembele), cowpeas leaves, cassava leaves, amaranth leaves (mchicha), okra, African eggplant (nyanyachungu), eggplant, nightshade (mnavu), spider plant (mgagani), pumpkin leaves, kale
Fruits	Sugar, fibre, Vitamin C, Potassium, phytochemicals	Mango, papaya, pineapple, water melon, guava, orange, soursop, avocado, passion fruit, tamarind (ukwaju), baobab (ubuyu), banana, jackfruit
Fats and oils	Essential fatty acids, fat soluble vitamins	plant oils from seeds (palm, sunflower, simsim), oils from fish, fatty meat, cheese, butter



2. BEAN CONSUMPTION AND IMPROVEMENT OF NUTRITION

Prioritizing beans in nutrition

Beans are given priority because they are the cheap source of protein and have many benefits in our bodies including:

- a) Affordable sources of proteins and iron
Beans are key to preventing iron deficiency anaemia especially in low-income countries.
- b) Good absorption of minerals
Iron from beans is best absorbed by the body when taken with foods that contain vitamin C, like green leafy vegetables and citrus fruits or when eaten with meat, fish and other sea foods. Vitamin C helps to change the iron in beans to a most absorbable form. Plant based proteins, unlike proteins from animal sources; do not contain all amino acids that make up complete protein. However, when foods are eaten in combination, such as maize and beans, or beans and rice, the amino acids from two food groups will make the protein be complete.
- c) Reduces cholesterol
One of the foods that reduce fat in the body is beans. The fiber found in beans clings to the fat in the stomach and prevents more fat from being absorbed into the body.
- d) Reduces risk of cancer
Beans are rich in manganese and vitamin K, which together prevent cell damage that causes cancer.
- e) Improves brain health
Chemical thiamine and vitamin K found in beans help in improving brain health.
- f) Controls the level of sugar in the body
Beans contain fiber that reduces the metabolic rate of carbohydrates in the body. By doing this, it helps to control the increase in sugar level, especially after eating. Beans also contain protein that helps reduce the level of sugar in the body.
- g) Improves heart health
Some beans contain vitamin B9 (folate or folic acid) which is important for heart muscle health. Beans contain fibre, folate and phytochemicals that are beneficial to the functioning of the heart. The fibres in pulses help to lower blood cholesterol even without weight changes and may prevent sharp rises in blood sugar, both of which are risk factors for cardiovascular diseases
- h) Improves memory capacity



Beans improve brain health. Memory capacity is also improved through the consumption of beans. Vitamin B1 found in various types of beans fights memory loss (Alzheimer's and dementia).

i) Fight high blood pressure

Minerals such as potassium, magnesium and protein help a lot to deal with high blood pressure. Beans help to reduce high blood pressure as they are a good source of potassium, magnesium and protein.

j) Reduces weight

Foods like beans contain fiber that helps not to feel hungry early, thus avoiding eating too often and reduce body weight. It should also be remembered that beans are type of food that have a small amount of fat, so it does not cause a lot of body weight.

k) Reduce constipation problem

Beans are very rich in fiber; it should be remembered that fiber-rich foods are the best remedy for the problem of constipation.

2.1 Reasons for Biofortification of minerals iron (Fe) and Zinc (Zn) in beans

Anemia is a major health problem in the world that mainly affects children under the age of five years as well as pregnant women. In Tanzania, about 44% of women of reproductive age (18 to 49 years) and 57% of children below five years are anemic. This deficiency is caused by inadequacy of iron and zinc in intake. It should be noted that these minerals are not produced by the human body, so they must be ingested through various foods, including beans. These minerals are found in beans and they are cultivated by many farmers in the world, especially small holder farmers in developing countries like Tanzania. However, the types of beans cultivated in Tanzania have a small amount of iron and zinc, so increasing the level of these nutrients in beans by plant breeding will help fight this problem of anemia for many people in the country and in the world. Under the FoodLAND project, Sokoine University of Agriculture researchers have selected bean lines with increased levels of iron and zinc which are also high yielding. These lines are currently being tested in farmers' fields for them to know their performance and suitability in their (farmers) localities.

2.2 Iron

2.2.1 Why is iron important?

Our bodies need iron. Iron is used to make hemoglobin, the component of red blood cells that carries oxygen around the body. It is also important for muscle strength, energy and mental functioning. If iron levels are low, a person may feel tired and unable to perform normal daily activities.



In general, iron have a unique importance in the human body as follows:

- It is an essential element necessary for the formation of haemoglobin, the red pigment present in the red cells of blood. Haemoglobin plays an important role in the transportation of oxygen to the tissues.
- Reduction in haemoglobin in blood leads to anaemia; a condition characterized by paleness and easy fatigue and increased susceptibility to infections.
- Iron deficiency is common especially among women of reproductive age and children.
- During pregnancy, iron deficiency increases the risk of low birth weight and maternal mortality
- In children, it impairs learning ability; reduces concentration and increases vulnerability to infection.
- Iron that is easy for the body to absorb is obtained from meat, eggs, liver and poultry. Fortified cereals and beans also supply iron.

2.2.2 What are the effects of lack of iron in the body?

a) If iron minerals are insufficient in the body, a person can experience low level of blood, technically called Anemia, which leads to fatigue, dizziness, headache and lack of immunity in the body, so you can get opportunistic diseases.

b) If iron minerals are missing in the body, a person can get a disease of inflammation of the glands which is called goiter, which means inflammation in the neck where this disease causes serious harm to many people, so we should eat foods rich in iron because it helps a lot in activities various in the body.

2.3 Zinc

2.3.1 Why give priority to zinc

The World Health Organization estimates that Zinc deficiency affects 31 percent of the world's population, where different countries in the world vary in the level of this deficiency, where the deficiency ranges from four to 73 percent. For developing countries, Zinc deficiency is among the ten main causes of disease burden.

Zinc is a necessary nutrient in the body and the body is not able to make or maintain it. For that reason, the body always needs to get zinc mineral from the food we eat. Zinc is found in abundance in food derived from plants and animals. Some of the zinc rich foods are pulses including beans, ginger, garlic, carrots, liver, eggs and some of sea foods



2.3.2 Functions and benefits of Zinc in human body

In general, zinc minerals perform various functions and benefits in the body as follows:

- a) Wounds heal early
Zinc deficiency is associated with delayed wound healing. Studies since the 1970s confirm this argument. Zinc minerals are involved in every step of wound healing, from repairing damaged skin, removing inflammation, to preventing infection. This is suitable for all types of wounds, be it accidents, burns or surgery.
- b) Reduce the possibility of getting chronic diseases
Cell stress is a major cause of chronic diseases in the body, especially cancer, high blood pressure and diabetes. It increases the body's ability to control a large increase in sugar, as well as increasing the stimulation of insulin enzymes to protect the normal level of sugar in the body. In addition, it improves the health of blood vessels, increases the amount of Sodium released from the body through urine and reduces blood pressure. Currently, these diseases are dangerous for human health.
- c) To treat the problem of diarrhea
According to the World Health Organization, diarrhea is the second leading cause of death in children under the age of 5. An average of 525,000 children in the World die each year from this disease. Zinc supplements help treat this problem quickly. Reduces deaths from diarrhea by 23 percent. It is important if children get enough of these minerals because they are very beneficial for them. Zinc minerals are also suitable for adults.
- d) Body immunity
Zinc minerals have a great contribution in the functioning of the natural immune system that a person is born with as well as the one they get from vaccinations or suffering from various diseases during their life. Increases the ability of various types of white blood cells to fight pathogens, inflammation and lead the genetic system to make new copies, inherit information and divide body cells. These supplements are very useful for the elderly whose ability to fight diseases decreases with age. Regardless of your age, make an effort to use these supplements to boost your immune system as they are needed by everyone. Deficiency of these minerals reduces the body's ability to fight disease, it also invites frequent infections.
- e) Reproduction
Zinc helps improve reproductive health for women and men, especially when used together with Folate. It has a great role in achieving the



maturation of male sperm, the production of male stimulants as well as improving the menstrual cycle of women. Zinc also helps to improve reproductive system.

2.3.3 What are the effects of lack of zinc in the body?

The clinical features of severe zinc deficiency in humans are growth retardation, delayed sexual and bone maturation, skin lesions, diarrhoea, impaired appetite, increased susceptibility to infections mediated via defects in the immune system, and the appearance of behavioural changes.

CONCLUSION

In general, apart from being a relatively cheap source of protein, bean contributes very well to human nutritional status and health. It is important that people include beans in their diets. Beans need to be eaten along with other types of foods to be more beneficial i.e. other groups of food, such cereals, roots and tubers, vegetables and fruits and animal source foods. There are already so many food recipes that include beans, people should use them to prepare their food and also design other recipes that will be more appealing to people of different age groups. The longer time it takes for some bean to cook, can be reduced by soaking for at least 6 hours before cooking. However, there are some bean varieties that naturally/genetically take shorter time to be cooked, consumers should be encouraged to use those types of beans.

Training Material for Bean farmers and consumers

Prepared by:

Susan Nchimbi-Msolla- nchimbi@sua.ac.tz

Akwilina Mwanri – akwmwanri@sua.ac.tz

Joshua Kidudu- kidudu@sua.ac.tz

Sokoine University of Agriculture, FoodLAND Project, Morogoro, TANZANIA

