Training course packages targeting food operators on the adoption and management of the technological innovations

MILLING

Training material on composite flour preparation

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FOODLAND

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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

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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.

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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

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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.

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

Milling

Training material on composite flour preparation

INTRODUCTION

Milling is defined as the process of grinding cereal grains or legumes into flour or meal. It is an important and intermediate step in the post-production of cereals. The primary objective of the milling process is to remove the outer layer (husks) and produce an edible portion that is free of impurities and in the form of a powder with different particle sizes (Oghbaei and Prakash, 2016). The milling process can be of two kinds: first, wherein the whole grain is converted into flour without abstracting any parts; and second, it could undergo differential milling to separate the grain into different parts (Oghbaei and Prakash, 2016). Cereal grains are the major source of energy for the majority of the population in developing countries. However, cereal-based foods are a poor source of dietary protein and subsequently have poor nutritional quality (Abdel-Gawad et al., 2016). Thus, supplementing cereal-based foods with legumes such as pulses and oil seeds provide high-quality foods because legumes are an excellent source of proteins, complex carbohydrates, low saturated fat, dietary fiber, a variety of micronutrients, and phytochemicals (Chiweshe et al., 2012). The purpose of this training manual is to guide the small-scale millers on preparation of composite flours.

Types of Milling Machine

Mechanically, milling operation is carried out by either of the following methods: grist mills, burr stone mills, roller crushers or hammer mills.

Hammer mills

The hammer mills are very common type of milling machine in developing countries like Tanzania. It is designed for processing, grinding, and sieving all

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kinds of cereal grains, such as maize, wheat, millet, sorghum and wheat. As well as noncereal products like dry cassava, dry sweet potatoes, beans, yam and many others (Nasir, 2005). The hammers in the mill grind grains through impact. A hammer mill is essentially a steel drum containing a vertical/horizontal rotating shaft or drum on which hammers are free to swing on the ends of the cross, or fixed to the central rotor (Figure 1). The hammer revolves at high speed and grinds the materials fed into pieces by beating. The hammer mill is very simple to operate and constructed from locally available materials (Figure 2).

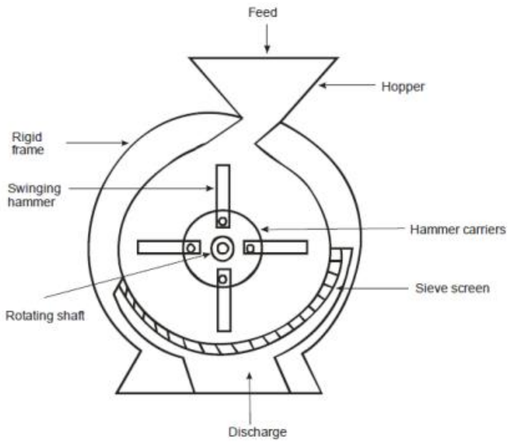

Figure 1: Diagrammatic representation of hammer mill

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PREPARATION OF COMPOSITE FLOUR CEREAL-LEGUMES BASED (MAIZE FLOUR)

Locally grown cereals (maize and millet), legumes (bio-fortified common beans and soya beans), and oil seeds (sesame seeds) will be used as the main ingredients for the formulation of composite flour (Figure 3). Soybean and sesame seeds will be used to increase the protein and fat contents, respectively. Maize, millet, soybeans, and sesame seeds will be purchased at the local market, while bio-fortified common beans will be obtained from one of the FoodLand bean projects at Mvomero Food Hubs.

Figure 2. Assembling of hammer mill

Figure 3. Preparation of composite flour

These materials will provide optimum proportions of ingredients according to the desired amino acid profile requirements. Proportions of food ingredients were obtained through a computer program by blending essential amino acid compositions similar to those recommended by FAO, WHO, and UNICEF for children. The goal is to produce composite flour with 360 kcal of energy, a 65 amino acid score (AAS), 15 g of protein, and 10-20% protein energy. Different formulation of composite flour based on Expert Design software will be used. Figure 4 show process outline of composite flour production.

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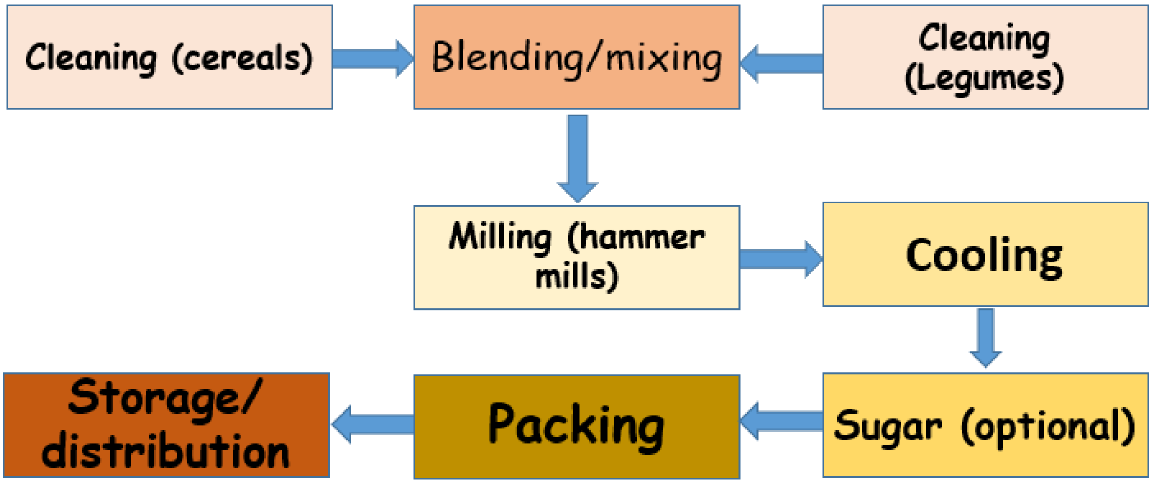

Figure 4. Outline of composite flour production

PRODUCTS ANALYSIS

Analysis of Composite flours based on cereals-legumes

The raw materials and the developed composite flours will be analyzed for proximate analysis (moisture, crude protein, crude fibers, ash, and carbohydrate), total phenol. As well as for physical properties such as bulk density (BD), water absorption index (WAI), water solubility index (WSI), oil absorption, and angle of repose.

Methods of analysis

The following methods will be used to analyses composite flour for physico-chemical properties.

Determination of Bulk density

Bulk density will be measured according to Hasmadi (2021) with slight modification.

The flour sample was filled to a known volume in a measuring cylinder. The volume will be then read directly from the cylinder and corresponding mass was recorded from analytical balance. The bulk density will be calculated according to the relationship; Bulk density = Mass/volume (g/cm^3).

Angle of Repose

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Angle of Repose will be determined by Fixed Funnel Method as explained by Brian Baer (2018). Flour material was poured through a funnel to form a cone. The tip of the funnel should be held close to the growing cone and slowly raised as the pile grows, to minimize the impact of falling particles. Stop pouring the material when the pile reaches a predetermined height or the base a predetermined width. Then Angle of Repose is given by the equation **tan-1(2h/r),** where **h** is height of the pile from the base to the tip and **r** is radius of pile.

Water Absorption and Water Solubility Indices

Water Absorption and Water Solubility indices will be determined by method outlined by Nargis Yousf et al. (2017). Water absorption index (WAI) measures the volume occupied by the granule or starch polymer after swelling in excess of water. The flour samples (0.2gm) will be suspended in distilled water (5ml) at room temperature for 30 minutes, gently stirred during this period and then centrifuged at 3000 rpm for 15 minutes. The supernatant liquid will be poured carefully in to tared evoporating dish. The remaining gel was weighed and WAI will be calculated as grams of gel obtained per gram of solid; **WAI =M_g/M_S.**

Where M_g is the weight of the hydrated gel (g) and M_S is the weight of sample (g)

Water solubility index (WSI) determines the amount of polysaccharides release from the granule on the addition of excess of water. WSI was the weight of dry solids in the supernatant from the water absorption index test above expressed as percentage of the original weight of the sample.

Water solubility index (WSI) was determined from the amount of dry solids recovered by evaporating the supernatant from the water absorption test as;

WSI (%) = Weight of dissolved solid in supernatant / Weight of dry solids *100

Oil Absorption Index

Oil Absorption Index, (OAI) will be determined according to the method of Liadakis et al. (1993), refined sunflower oil (6ml) was added to sample (1.0 gm) in a graduated centrifuge tube.The tube was agitated for 1min, left for 30 min and centrifuge for 20 min at 3000 rpm; the volume of the free oil will be read. OAI was

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calculated as: OAI = Voil/M. Where Voil is the volume of oil absorbed (ml) and M is the weight of the sample (g).

Determination of moisture content (AOAC, 1990)

Moisture content will be determined by oven drying method. 5g of well-mixed sample will be accurately weighed in clean, dry Petri-dish. The Petri-dish will be dried in an oven at 105^0C for 24 hours until a constant weight was obtained. Then, the Petri-dish was placed in the desiccator for 30 minutes to cool. After cooling, it will be weighed again. The percent moisture (%) will be calculated by the following formula

$$\%\text{Moisture content} = \frac{\text{Moisture Weight}}{\text{Weight of sample (g)}} \times 100$$

Determination of ash content (AOAC, 1990)

For the determination of ash, a clean empty crucible and lid will be placed in a muffle furnace at 550^0C for an hours to ensure that all possible impurities on the surface of crucible were burned off. They will be then cooled in desiccator for 30 minutes and then weight of empty crucible and their lids will be noted W1. 5g of sample was taken in crucible (W2). The sample was heated over Bunsen flame with lid half covered. When fumes will be no longer produced, the crucible and lid will be placed in furnace. The crucibles with their content were heated overnight. After complete heating, the lid covered the crucible to prevent loss of fluffy ash. The sample in crucible will be cooled down in the desiccator. The weight of the ash with crucible and the lid was determined.

$$\%\text{ Ash content} = \frac{\text{Weight of Ash(g)}}{\text{weight of sample(g)}} \times 100$$

Determination of crude protein (AOAC, 2000)

Protein sample will be determined by the Kjeldahl method, as described in AOAC (2000). According to this method, samples will be digested by heating with concentrated sulphuric acid (H2SO4) in the presence of Kjeldahl catalyst. The mixture will be then made alkaline and distilled into a boric acid solution. The

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borate ions formed was titrated against standard sulphuric acid 0.05N, which is converted to total nitrogen in the sample, then multiplied by 6.25 conversion factor to crude protein.

Determination of fat content (AOAC, 2000)

Total fat will be determined by using Soxhlet ether extraction official method 922.06 (AOAC, 2000). 5.g of flour sample were placed into the extraction thimble and assembled to the Soxhlet apparatus. The petroleum ether 70 ml will be used for continuous reflux for 55 min in three phases, the boiling phase for 15 min, the rinsing phase for 30 min and petroleum ether recovery phase for 10 min. The remaining Petroleum ether will be then evaporated. Pre-weighed cups containing fat will be dried in an oven at 105^{o}C for 1 hr to evaporate any remaining petroleum ether, cooled in a desiccator for 30 min and weighed. Percentage fat will be calculated by using the formula:

$$\%\ \mathbf{Fat\ Content} = \frac{\boldsymbol{Weight\ of\ crude\ fat(g)}}{\boldsymbol{Weight\ of\ samples(g)}}$$

PRACTICAL ACTIVITIES CONDUCTED

Identification of raw materials (ingredients)
Processing of raw materials
Preparation and mixing of different formulation
Production of composite flour
Laboratory analysis of composite flour
Testing and storage of composite flour

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