CASSAVA–WHEAT COMPOSITE FLOUR PROCESSING AND BREAD-MAKING

A TRAINER'S MANUAL

Adebayo Abass, Abdul-Rasaq Adebowale, Gregory Nwaoliwe,
Adeniyi Ogunkoya, and Simon Lukombo

IITA
Transforming African Agriculture
CGIAR
SCIENCE FOR A FOOD-SECURE FUTURE
AFRICAN DEVELOPMENT BANK GROUP
GROUPE DE LA BANQUE AFRICAINE DE DÉVELOPPEMENT
TAAT
Technologies for African Agricultural Transformation
ATA-RDC
Agenda de la Transformation Agricole
CVCD PROJECT

Published by the International Institute of Tropical Agriculture (IITA)

The International Institute of Tropical Agriculture (IITA) is a not-for-profit institution that generates agricultural innovations to meet Africa's most pressing challenges of hunger, malnutrition, poverty, and natural resource degradation. Working with various partners across sub-Saharan Africa, we improve livelihoods, enhance food and nutrition security, increase employment, and preserve natural resource integrity. IITA is a member of CGIAR, a global agriculture research partnership for a food secure future.

International mailing address:
IITA Ltd, Suite 32,
5th Floor, AMP House,
Dingwall Road
Croydon
CR0 2LX, UK

Headquarters:
PMB 5320, Oyo Road
Ibadan, Oyo State
Nigeria

ISBN 978-978-131-435-3

Correct citation: Abass, A., Adebowale, A., Nwaoliwe, G., Ogunkoya, A., and Lukombo, S. 2026. Cassava–wheat composite flour processing and bread-making: A trainer's manual. IITA, Ibadan, Nigeria. 120 pp.

Printed on demand

Scoping, background research, planning, rewriting, editing, revisions, design, layout, and proofreading: Green Ink (www.greenink.co.uk).

The illustrations in this manual were created using AI-assisted image processing. AI tools were also used to support the drafting of text content. All material has been reviewed and approved by the authors.

CASSAVA–WHEAT COMPOSITE FLOUR PROCESSING AND BREAD-MAKING

A TRAINER'S MANUAL

Adebayo Abass, Abdul-Rasaq Adebowale, Gregory Nwaoliwe, Adeniyi Ogunkoya, and Simon Lukombo

2026

IITA Transforming African Agriculture
CGIAR SCIENCE FOR A FOOD-SECURE FUTURE
AFRICAN DEVELOPMENT BANK GROUP
GROUPE DE LA BANQUE AFRICAINE DE DÉVELOPPEMENT
TAAT Technologies for African Agricultural Transformation
ATA-RDC Agenda de la Transformation Agricole
CVCD PROJECT

About IITA. The International Institute of Tropical Agriculture (IITA) is a non-profit institution that generates agricultural innovations to meet Africa's most pressing challenges of hunger, malnutrition, poverty, and natural resource degradation. Since 1967, IITA has worked with international and national partners to improve livelihoods, enhance food and nutrition security, increase employment, and preserve natural resource integrity. As one of 15 research centers in CGIAR, a global partnership for a food secure future, IITA is engaged in several CGIAR Research Programs (CRPs). IITA has delivered more than 70% of the CGIAR's impact in sub-Saharan Africa and remains committed to the science-driven improvement of agriculture and related food value chains. To help address poverty and the high number of unemployed young men and women in sub-Saharan Africa, IITA has initiated a Youth Agripreneurs program to create jobs by making agriculture and agribusiness appealing to the youth. The program is integrated into the Business Incubation Platform (BIP), the technology delivery arm of IITA, which serves as a model to stimulate product development and to provide opportunities for market expansion.

About TAAT. The Technologies for African Agricultural Transformation (TAAT) Program is the African Development Bank (AfDB) flagship program and a major component of the Feed Africa Strategy. The program is being implemented by a consortium of international agricultural research and development institutions led by the International Institute of Tropical Agriculture (IITA). TAAT is deploying proven agricultural technologies and innovations to African farmers in more than 35 countries with a focus on African priority commodities: cassava, maize, rice, fish, high-iron bean, wheat, orange-fleshed sweet potato, sorghum and millet, soybean, aquaculture, and small livestock. These value chains have high potential for helping Africa achieve food security and participate in global agricultural trade while reducing food importation. The consortium of national and international organizations is organized as a Compact around each commodity, design interventions, and national strategies to introduce the technologies and innovations to help nations transform their agriculture. The TAAT ecosystem of experts assists countries in designing, planning, and executing their agricultural loan projects as a vital element of the approach to attaining the desired agricultural transformation.

About the DR Congo Agricultural Transformation Agenda. ATA-RDC is a program of the Government of the Democratic Republic of the Congo designed to modernize the agricultural sector as part of the government's agenda to develop the 145 territories of the country. It focuses on the key value chains of cassava, rice, maize, soybeans, banana, beans, and aquaculture. IITA provides technical assistance to the nationwide program. It aims to double agricultural yields using improved crop varieties, fish breeds, and production inputs. Its goal is to create wealth and jobs through modernized agriculture by consolidating and building on several ongoing agricultural projects financed by development partners and banks. The program works closely with and provides technical assistance to a range of private sector entities, chiefly the Bio AgroBusiness (BAB) that operates on behalf of the Ministry of Agriculture. An essential priority of ATA-RDC is to develop the infrastructure and human competencies for the production of bread-making cassava flour (BCF) or high-quality cassava flour (HQCF) and its use in the bakery industry to reduce dependency on imported wheat.

About the CVCD Project. Cassava Value Chain Development to Support Food Security and the Bread Industry in DRC (CVCD) is an American government–funded project. It builds on American government bilateral interventions in deploying improved cassava production technologies to enhance the economic potential of the crop. The project aims to improve the livelihoods of small-scale producers and women while creating jobs for youth. The value chain approach seeks to strengthen cassava processing activities to produce high-quality food products, which can replace imported food items such as wheat flour. This will boost cassava agro-industrial and agribusiness activities, thereby attracting private sector participation. The goal of the project is to assist DRC in ameliorating food shortages resulting from the impact of Russian Federation's war on Ukraine. The project collaborates with other ongoing projects with similar objectives, such as the TAAT Program and ATA-DRC, to contribute to the cassava value chain development efforts of the DRC Government aimed at reducing the importation of wheat by at least 10% through substitution with bread-making cassava flour.

ACKNOWLEDGEMENTS

The manual combines the science and art of bread-making with the experience of using high-quality cassava flour in bakeries in Nigeria and the Democratic Republic of the Congo. The Nigerian experiences were contributed by Adekola Adegoke, Idris Ayinde, Bashirat Bello, and Dola Adeboye. Josana Sanginga, Guelord Nsuanda, Doline Matempa Tanda, Nazareth Ambua, Bobo Kasampu, Hervé Bondonga, and Cynthia Kamunga of IITA-DRC contributed the DRC experiences. Dapo Arowona, Sunday Akinola, and Olaitan Alade provided wheat milling industry insights.

Green Ink (www.greenink.co.uk) provided editorial service: customizing for the four target audiences; writing and editing the modules; production of the visual aids; design, layout, and proofreading.

Prof. Taofik Akinyemi Shittu contributed to the technical review of the document.

.

CONTENTS

Module 6: Implementation planning

PREFACE

Across Africa, efforts to reduce reliance on imported wheat and boost local agricultural value chains are gaining momentum. One major opportunity lies in incorporating high-quality cassava flour (HQCF) into baking and confectionery production. This *Trainer's manual* aims to provide structured, practical, and policy-aligned guidance on the use of cassava–wheat composite flour in bread and pastry production. Derived from both field practice and practical training experience, it serves as a comprehensive reference for trainers tasked with building the capacity of local bakers and agro-processors.

The manual uses clear, instructional language that combines technical content, practical skills, and teaching methodology. It is designed for training delivery in workshops, vocational settings, and national extension programs, but is equally useful for self-directed learning or as a curriculum support tool.

The manual is organized into six structured modules, each with clear objectives and key takeaways. The content is delivered in straightforward, trainer-friendly language, and incorporates principles of adult learning, participatory facilitation, and contextual adaptation. Each section integrates technical rigor with practical relevance, ensuring trainers can confidently communicate concepts to diverse audiences.

Module 1 explores the policy rationale, definitions, and benefits of adopting cassava flour in bread-making. Module 2 provides a detailed foundation in processing techniques, national and international standards, quality control measures, and hazard analysis for bread-making cassava flour and composite flour. Module 3 equips trainers with practical instruction on ingredient quality assessment, recipe adaptation, equipment use, hygiene practices, and production methods for cassava-based baked goods, while the economic viability of composite flour adoption, including cost–benefit analysis, market readiness, record-keeping, and quality assurance from a business perspective are covered in Module 4. Teaching methodology (Module 5) outlines strategies for adult education, demonstration-based instruction, learner adaptation, and participatory assessment to ensure effective knowledge transfer. And finally, Module 6 (Implementation planning) guides trainers through planning, resource mobilization, session setup, local adaptation, and post-training support—including monitoring and evaluation strategies.

This manual is designed primarily for: technical trainers and facilitators in bakery and agro-processing programs; vocational instructors and extension agents in agricultural or food technology fields; training organizations, NGOs, and government programs implementing bread-making cassava flour utilization initiatives; and educators in food systems and enterprise development. This manual is more than a teaching resource—it is a tool for empowerment, sustainability, and economic transformation. By strengthening technical training on the use of bread-making cassava flour, we take a step toward more inclusive, resilient food systems in Africa.

This publication is part of a wider toolkit—including a *Learner's handbook*, *Entrepreneur's guide*, and *Practitioner's workbook*—designed to support a complete ecosystem for cassava-based bakery development.

MODULE 1:
INTRODUCTION TO CASSAVA–WHEAT COMPOSITE FLOUR

MODULE 1 OBJECTIVES

By the end of this module, trainers will be able to:

- Explain the policy rationale and benefits of incorporating cassava flour in bread-making
- Define and describe key technical terms related to bread-making cassava flour
- Compare national, regional, and international standards for bread-making cassava flour and composite flour
- Outline the key responsibilities of a technical trainer in bread-making cassava–wheat composite flour training.

1.1 POLICY CONTEXT AND RATIONALE

This section would need to be adapted to the trainees' countries of work. This could either be specific (as here) for in-country courses or more generic for regional courses that draw participants from several countries.

The Democratic Republic of the Congo (DRC) faces significant challenges related to wheat imports and food security.

DRC depends heavily on wheat imports, with an average of 97.5% of its wheat supply coming from foreign sources between 2014 and 2023 (FAOSTAT, 2025). This reliance creates economic vulnerabilities, as wheat imports cost the country between US$78 million and US$184 million annually. The global wheat supply chain has been further disrupted by geopolitical conflicts, such as the war in Ukraine, leading to higher prices and supply shortages. As a response, the DRC government has initiated policy changes to promote the use of bread-making cassava flour (BCF) as a substitute for a portion of wheat flour in bread and pastry production.

In December 2020, national food industry standards were amended to mandate the inclusion of at least 5% high-quality cassava flour (HQCF) in wheat for bread-making and a minimum of 10% in pastry products. More recently, the DRC government has actively supported and promoted the adoption of BCF in the baking industry. These policies align with the National Agricultural Transformation Agenda (ATA-RDC), which aims to reduce dependence on wheat imports, create new market opportunities for cassava farmers and processors, enhance food security, and strengthen local agro-processing industries. By encouraging investment in BCF production, these measures also support job creation in both the agriculture and baking industries, fostering economic sustainability.

1.2 BENEFITS OF BREAD-MAKING CASSAVA–WHEAT COMPOSITE FLOUR ADOPTION

The integration of BCF into wheat-based baking products offers advantages across various segments of the value chain.

In **technical terms**, it is possible to produce bread with 10% BCF that is of similar quality to 100% wheat flour. Moreover, some pastry and confectionary products can be made from 100% BCF.

For **flour millers**, incorporating composite flour reduces dependence on imported wheat, thereby lowering foreign exchange expenditure and enabling reinvestment in other business areas. It also presents an opportunity for backward integration, where millers can invest in cassava farming to secure a stable supply of raw material. Adopting composite flour also contributes to corporate social responsibility efforts

by aligning with national policies, supporting economic development, and responding to evolving consumer demands. Millers will also develop new skills in flour blending.

Bakers stand to benefit from lower production costs as a result of cheaper flour (due to reduced reliance on imported wheat); thus, composite flour adoption can enhance competitiveness by decreasing input costs while maintaining product quality. Moreover, bakers can expand their skills by learning new techniques for working with cassava–wheat blends, positioning themselves advantageously in the evolving market landscape. Whether or not it is a concern for individual bakers, they have the same corporate social responsibility to adopt composite flour as millers.

Consumers may also experience benefits, including potentially lower bread prices. Nutritionally, cassava flour enhances dietary fiber content, serving as a prebiotic that supports digestive health. Studies suggest that cassava-based bread produces a lower glycemic response compared with 100% wheat bread, making it a viable option for individuals managing blood sugar levels. Cassava flour also has a lower fat content, contributing to healthier dietary choices. However, the nutritional impact depends on the cassava variety and processing methods.

1.3 KEY TERMINOLOGY AND DEFINITIONS

Bread-making cassava flour (BCF) / High-quality cassava flour (HQCF): A fine, unfermented flour derived from fresh cassava roots. The processing sequence includes peeling, washing, grating, dewatering, drying, and milling. Due to the high perishability of cassava roots, processing must occur within 24 hours of harvest. A well-processed batch typically yields a recovery rate of around 25%, though varieties with higher dry matter content can increase efficiency.

Quality characteristics of BCF: High-quality cassava flour should be white (or cream/yellow if from biofortified varieties), odorless, tasteless, finely textured, and free from foreign matter and fungal contamination. It should have low bacterial content, a moisture content of no more than 12%, and pH in the range 5.8–7.0. The flour must also meet hygiene and safety standards to ensure it is suitable for human consumption.

1.4 STANDARDS FRAMEWORK

Bread-making cassava flour must comply with standards at multiple levels, each adding specific requirements while building upon international foundations. At the international level, the Codex Alimentarius Commission establishes baseline requirements for food safety, including maximum limits for pesticide residues and contaminants, while also setting expectations for good manufacturing practices (GMP) and good hygiene practices (GHP).

The African Standards for cassava flour intended for human consumption (CD-ARS 838) build on these foundations by specifying quality characteristics particular to HQCF, such as particle-size requirements and limits on extraneous matter. When the DRC joined the East African Community in March 2022, it became subject to additional regional standards that set specific technical parameters, including pH ranges, minimum starch content, and stricter controls on cyanide content. The harmonization of standards across levels is intended to facilitate trade while ensuring product safety and quality.

Quality assurance procedures must be established through the Hazard Analysis Critical Control Point (HACCP) system, which is used to:

- Identify where hazards might occur in the production process
- Implement safeguards to ensure BCF is of high quality and safe for human consumption
- Support effective sanitation of buildings, pest control, waste disposal, and adequate ventilation in processing environments.

1.5 THE ROLE AND RESPONSIBILITIES OF A TECHNICAL TRAINER

As a technical trainer, your role extends beyond simply delivering information—you are a guide, a facilitator, and an enabler of skill development. Your ability to communicate clearly, adapt to your audience, and foster an engaging learning environment will determine the success of your trainees. Here are some of the things you need to focus on.

- **Knowledge transfer and facilitation:** To be an effective trainer, you must know your material inside and out. Your ability to explain technical information in a clear and accessible way is crucial. Remember that your audience may have diverse levels of expertise, so adjust your language accordingly—simplify without oversimplifying. Practical demonstrations and real-world examples will help reinforce key concepts and make learning more engaging.
- **Adapting to your audience:** Each group of trainees will have different educational backgrounds, literacy levels, and learning styles. Your job is to recognize these differences and modify your approach accordingly. Use locally relevant examples and case studies to keep the training relatable and practical. The more your trainees can see the relevance of the material, the better they will engage with, retain, and apply it.

- **Embracing flexibility:** Training is not a one-way process: it should be interactive. Be open to interruptions and allow time for questions and discussion throughout the session. However, to maintain structure, schedule a dedicated question-and-answer (Q&A) period at the end of each session. Additionally, be prepared to adapt to resource constraints, different training environments, and diverse infrastructure levels.
- **Promoting best practices and standards:** Your trainees must understand and apply industry best practices. Reinforce the importance of GMP, GHP, HACCP, and food safety principles. Ensure trainees are aware of relevant national, regional, and international standards governing HQCF/BCF and bread-making.
- **Building capacity and ensuring sustainability:** Training should not stop with you. Your role includes empowering trainees with the confidence and skills to pass on their knowledge. Encourage a cascade training model where your trainees can train others in turn. Cultivating a mindset of continuous learning and professional development ensures that knowledge is not only transferred but also sustained and expanded.
- **Upholding professionalism and ethical standards:** A great trainer fosters an inclusive and participatory learning environment where all trainees feel valued. Maintain professionalism by treating trainees with respect and ensuring clear, structured communication. Promote ethical practices in production and business, ensuring that trainees understand the importance of integrity in their work.
- **Evaluating and refining training approaches:** Regular assessment is key to ensuring that trainees truly understand and can apply what they have learned. Use practical evaluations, feedback sessions, and observation to gauge progress. Adapt your training strategies to your trainees' needs. Where possible, provide follow-up support and mentorship to help them implement their knowledge effectively.

By fulfilling these responsibilities, you contribute not only to the adoption of high-quality cassava flour in bread-making but also to the growth of a more knowledgeable and capable industry. Your work as a trainer can shape livelihoods, improve food security, and promote economic sustainability.

MODULE 1 KEY TAKEAWAYS

Policy and economic context

- The DRC's high dependence on wheat imports (97.5%) creates economic vulnerability
- National policy mandates minimum inclusion levels: 5% BCF for bread, 10% for pastries
- Adoption of composite flour supports economic sustainability and food security.

Technical foundations

- BCF quality requirements combine physical characteristics (color, texture) with measurable parameters (moisture ≤12%, pH 5.8–7.0)
- Processing must occur within 24 hours of harvest to maintain quality
- Standards compliance spans international, continental, regional, and national requirements.

Multi-level benefits

- Millers: Reduced import dependence, opportunities for vertical integration
- Bakers: Lower production costs while maintaining product quality
- Consumers: Potential price benefits and enhanced nutritional profile.

Training responsibilities

- Knowledge transfer must adapt to diverse audience backgrounds and learning styles
- Place emphasis on practical demonstrations and locally relevant examples
- Quality assurance and best practices are central to successful implementation
- A cascade training model ensures sustainable knowledge transfer.

MODULE 2:
TECHNICAL KNOWLEDGE BASE

MODULE 2 OBJECTIVES

After completing this module, technical trainers will be able to:

1. Outline the technical requirements and processing steps for producing bread-making cassava flour that meets national, regional, and international quality standards
2. Compare and contrast the key requirements of international, African, East African, and DRC standards for:
   - Bread-making cassava flour
   - Wheat flour
   - Bread-making cassava–wheat composite flour
   - Bread and pastry products
3. Identify critical quality control points and compliance requirements that must be emphasized when training producers and bakers
4. Understand the importance of practical implementation of standards to manufacturers, including:
   - Raw material selection and quality assessment
   - Processing controls and testing
   - Documentation and traceability
   - Meeting requirements for both domestic and export markets
5. Explain how standards facilitate trade while supporting national development goals through local cassava utilization.

These objectives prepare trainers to effectively communicate technical standards in ways that are practical and actionable for their trainees.

2.1 BREAD-MAKING CASSAVA FLOUR PROCESSING

SESSION 2.1 OBJECTIVE

To understand the fundamentals of processing cassava root into high-quality/bread-making cassava flour.

2.1.1 Introduction

Bread-making cassava flour (BCF), also known as high-quality cassava flour (HQCF), is a specialized unfermented flour produced from freshly harvested cassava roots. It differs from traditional cassava flour in that it is subject to a controlled processing timeline and strict quality measures to ensure it meets the requirements for bread-making. When properly processed, BCF can serve as a cost-effective, locally available alternative to wheat flour, supporting food security, industrialization, and economic growth.

2.1.2 Processing timeline and scale

Processing BCF requires an efficient timeline. The entire process, from harvesting cassava roots to completing the drying stage, must be done within 24 hours. This strict timeline is crucial to prevent fermentation and ensure the flour maintains its desirable qualities for bread-making.

BCF can be produced at various scales, from small-scale local processing to industrial-scale production. Regardless of the scale, the fundamental principles and quality requirements remain consistent.

2.1.3 Selection of cassava roots

The quality of BCF depends largely on the cassava roots used. Best practices for selecting cassava roots include the following.

- Choosing high dry-matter content varieties for better flour recovery rates.
- Using only wholesome, freshly harvested cassava roots.
- Ensuring mature roots are selected to optimize starch content. It is recommended that cassava roots be harvested 12 to 18 months after planting.

2.1.4 Processing steps

The roots must be processed as soon as possible after harvest, and certainly within 24 hours after harvesting, to prevent fermentation and discoloration. The production of BCF follows several key steps.

1. **Peeling:** Remove the outer skin to eliminate unwanted fiber, dirt, and contaminants.
   - Peel manually using a sharp stainless-steel knife or use a mechanical peeling machine.
   - Completely remove peel to reveal cassava flesh (this will help prevent product discoloration) and remove the stalk/peduncle to prevent damage to the grating machine.
   - Place clean, peeled roots in a clean container or on a clean surface in readiness for washing.
   - Wear gloves to prevent injury from knife use.
2. **Washing:** Thoroughly wash the peeled roots to remove soil and debris and thus avoid product contamination and maximize the whiteness of the product.
   - This can be done manually or semi-automatically.
   - Place peeled roots in clean water and wash roots until all soil and adhering dirt are removed. A scrubbing brush or sponge may be used where the roots are deeply soiled.
   - Do not leave cassava roots in water for more than an hour to avoid fermentation.
   - Washing roots soon after peeling avoids discoloration and maximizes the whiteness of the processed product.
3. **Grating:** Mechanically or manually grate the fresh roots to aid cyanide removal and increase surface area for drying.
   - Turn on the grater or wet hammer mill and run water through it to clear any surface dirt and provide lubrication to the abrasive drum.
   - Ensure there is a clean collector to discharge the pulp into.
   - Place washed roots into the grater or wet hammer mill until the batch is complete.
   - Ensure abrasive grinding drum is sharp.
   - Clean the machine after each use and store it in hygienic conditions.
   - Ensure equipment is maintained and regularly serviced.
   - Wet milling produces a finer pulp and may improve recovery rates.
4. **Dewatering:** Press or drain excess moisture from the grated cassava to reduce drying time.
   - Place standard amounts of grated pulp into clean propylene (or other porous) bags.
   - Place each bag in turn into the press. Place a wood or metal plate underneath the jack (where used) before the jacking and pressing operation.
   - For optimum dewatering for HQCF production, load bags equally with a maximum of 10–15 kg of mash.
   - Flatten bags across the press cage and stack.
   - Load the corners with wood as the cage is filled.
   - Ensure the pressing jack is operated by trained staff.
   - Clean the press and jack after each use and place them in a clean store.
5. **Granulation:** Break down lumps for uniform drying and improved texture.
   - Break the pressed cake and pour it into a motorized grater.
   - Collect the granulated cake in a clean, dry container.
   - Remove lumps and large pieces of fiber.
   - Wash the motorized grater before and after use.
6. **Drying:** Dry the granulated cassava to achieve a moisture content of ≤ 10%.
   - This can be done using different artificial drying methods such as a flash dryer, cabinet dryer, oven dryer, tunnel dryer, or rotary dryer. The flash dryer is preferred for HQCF/BCF due to its fast drying process and good final product.
   - Dry until product has ≤ 10% moisture content.
   - Ensure there is a clean container or bags to load dried product.
   - Drying equipment should be operated by trained technicians; ensure it is maintained and regularly serviced.
7. **Milling:** Grind the dried cassava grits into a fine, uniform flour suitable for bread-making.
   - Switch the mill on and pour the dried cassava grits into the mill.
   - Ensure there is a clean container or bags to collect milled product.
   - Allow flour to cool before packaging.

- Ensure equipment is cleaned after each use, particularly after milling other products.
- Ensure the milling machine is maintained and regularly serviced.

8. **Packaging:** To protect the flour from reabsorbing moisture from the environment, to lengthen its shelf life, and to provide product information and branding.
   - Transfer cooled flour into clean propylene or other suitable packaging.
   - Seal bags before storage and/or before marketing.
   - For HQCF/BCF, use polyethylene-lined bags to prevent moisture from entering the flour.
   - For correct stock rotation and quality control, bags should be labeled with the processing date, best before date, batch/lot number, etc.
9. **Storage:** To provide a suitable environment to retain the product in good condition till distribution or usage.
   - Transfer bags/packaging to a clean, dry, and well-ventilated store until marketing.
   - Store bags off the ground using pallets.
   - Keep the perimeter around the bags accessible for inspection.
   - Ensure product is checked regularly.
   - Follow the "First in, First out" rule.

2.1.5 Good manufacturing and hygiene practices

Maintaining good manufacturing practices (GMP) and good hygiene practices (GHP) is critical throughout the BCF production process:

- **Sanitation**—Keeping all processing areas clean and well-maintained.
- **Equipment standards**—Using food-grade equipment and surfaces (stainless steel).
- **Waste disposal**—Implementing proper waste management systems.
- **Worker hygiene**—Providing handwashing facilities and training staff on personal hygiene and food safety.
- **Pest control**—Preventing insect, rodent, or other pest contamination.
- **Documentation**—Maintaining proper records for traceability and quality assurance.

SUMMARY OF GOOD MANUFACTURING PRACTICE (GMP) FOR HQCF

Step 1. **Always use good-quality cassava roots**
to ensure optimum recovery and white color of HQCF

Step 2. **Peel roots, removing any rot, within 12 hours of harvest**
to minimize waste, as roots will start to deteriorate 12 hours after harvest

Step 3. **Wash peeled roots in clean water**
to achieve low microbiological levels in flour

Step 4. **Produce a wet mash by grating (never use a chipper!)**
to facilitate water removal and minimize cyanide levels in flour

Step 5. **Remove as much water from grated mash as possible using a hydraulic press and pulverize the cake with a grater**
to speed up the drying process

Step 6. **Dry the pulverized cassava cake as quickly as possible (6 hours) and completely**
to avoid fermentation, bad odor, sour taste, and mold

Step 7. **Mill dried cassava grits to 0.25 µm**
to produce a fine flour

Step 8. **Sieve to produce fine, free-flowing flour**
and remove foreign matter

Step 9. **Bag in polypropylene bags with a liner and keep in a hygienic, dry, aerated store**
to maintain quality and prolong shelf life

The whole process must be completed within 24 hours

2.1.6 Quality specifications

For BCF to be suitable for bread-making, it must meet the following standards.

- **Appearance:** White (from white-fleshed cassava) or yellow (from biofortified cassava), odorless, and tasteless.
- **Texture:** Fine, smooth, and free from foreign matter or fungal growth. Particle size 250–500 µm.
- **Moisture content:** ≤10% to prevent microbial growth.
- **Starch content:** ≥ 60%.
- **Microbial safety:** Low bacterial and fungal counts.
- **pH level:** Typically 5.8–7.0, ensuring optimal yeast performance in baking.
- **Cyanide content:** Must be ≤ 10 ppm (mg/kg) to ensure food safety.
- **Aflatoxins and other contaminants:** Must meet Codex Alimentarius standards.
  - *While aflatoxin is not considered a serious risk in BCF, a few studies have reported aflatoxin in dried cassava chips and fermented flour. Thus, a precautionary approach is deemed appropriate.*

See also section 2.2 on specific standards.

Regular quality testing is essential to maintain these standards.

2.1.7 Recovery rate considerations

The recovery rate in BCF production refers to the percentage of flour obtained from fresh cassava roots. A target recovery rate of at least 25% is ideal for profitability. Factors influencing recovery rate include the following.

- **Cassava variety:** High dry-matter content varieties yield more flour.
- **Root maturity:** Mature roots (12–18 months after planting) contain optimum dry matter content (starch) and less fiber and root rots. Harvesting roots more than 18 months after planting results in flour that is too fibrous.
- **Processing efficiency:** Reducing waste and optimizing equipment usage.
- **Operator skill:** Proper handling at each stage minimizes losses.

2.1.8 Hazard Analysis and Critical Control Points (HACCP)

To ensure food safety, BCF production should incorporate HACCP principles.

- Identifying potential hazards (e.g., physical contaminants, microbial contamination, chemical residues).
- Establishing critical control points (e.g., right variety, proper peeling, drying temperature, moisture levels).
- Implementing monitoring and corrective actions to maintain product safety.

Proper monitoring at these control points ensures that the final product meets safety and quality standards.

SESSION 2.1 KEY TAKEAWAYS AND SUMMARY

- Cassava roots must be processed within 24 hours of harvesting to maintain quality.
- The processing steps include peeling, washing, grating, dewatering, granulation, drying, and milling.
- Strict adherence to GMP and GHP is required to ensure food safety.
- High-quality BCF should be white (or yellow if biofortified), odorless, tasteless, and fine-textured, with a moisture content of ≤ 10%.
- A recovery rate above 25% improves profitability, making high dry-matter cassava varieties preferable.
- HACCP implementation helps identify and control hazards, ensuring safe and consistent flour production.

By maintaining a consistent focus on quality at every stage, cassava processors can produce BCF that meets bread-making standards, supporting both consumer satisfaction and business sustainability.

2.2 BCF STANDARDS AND SPECIFICATIONS

SESSION 2.2 OBJECTIVE

To understand the essential elements of international (Codex Alimentarius), African, East African, and national (Democratic Republic of the Congo) standards for bread-making cassava flour, and the differences between them.

Bread-making cassava flour, wheat flour, composite cassava–wheat flour, and baked products must comply with standards at multiple levels, each adding specific requirements while building upon international foundations. At the international level, the Codex Alimentarius Commission establishes baseline requirements for food safety, including maximum limits for pesticide residues and contaminants, and sets expectations for GMP and GHP.

African and regional standards build on these foundations to foster harmonization across countries to enable easy intracontinental and intraregional trade. Individual countries then have their own standards (every sovereign nation needs its own laws and regulations, even if these simply repeat or ratify those at a "higher" level).

Thus, a bakery wishing to export its products across national borders must comply with standards, specifications, and regulations in both its home country and the target export country. In unified markets such as the African Continental Free Trade Area and East African Community, national standards are usually aligned with regional and continental standards to simplify trade.

2.2.1 International standards (Codex Alimentarius)

The Codex does not yet have a specific standard for BCF.

2.2.2 African standards (CD-ARS 838, 840)

African Standard CD-ARS [838]. 2014. Cassava flour—Specification. 1st edition. ARSO.

African Standard CD-ARS 840. 2014. High quality cassava flour—Specification. 1st edition. ARSO.

Raw material requirements

- High-quality cassava flour (HQCF) shall be produced from wholesome, freshly harvested cassava roots.

General quality parameters

The BCF must meet the following key quality criteria:

- Practically free from extraneous matter
- Free from off-flavors and off-odors
- Practically free from living insects and foreign matter
- Safe for human consumption
- Color characteristic of the product.

Physical properties

- Minimum 95% of the flour must pass through a 250 µm mesh screen
- Maximum 10 specks of extraneous matter per 100 cm^2.

Contaminant specifications

- Must comply with CODEX STAN 193 (Codex General Standard for Contaminants and Toxins in Food and Feed)
- Maximum total aflatoxin: 10 µg/kg
  - Maximum aflatoxin B1: 5 µg/kg (tested per ISO 16050).

Hygiene and preparation

- Preparation and handling must be in accordance with ARS 53 *General principles of food hygiene—Code of practice*.

Packaging and labeling

Packages must be marked with:

- Product name: "High-quality cassava flour"
- Name and physical address of manufacturer or distributor
- Trade name or brand name
- Date of manufacture
- Storage instructions (e.g., "store in a cool dry place, away from contaminants")
- Lot/batch identification
- Best before date
- Country of origin
- Net weight in metric units
- Instructions for disposal of used packaging.

2.2.3 East African standards for high-quality cassava flour (EAS 779:2012, DEAS 779:2021)

East African Standard EAS 779:2012. High quality cassava flour—Specification. East African Community, Arusha.

Draft East African Standard DEAS 779:2021. ICS 67.230. High quality cassava flour—Specification. East African Community, Arusha.

Standardization overview

The East African Community developed this standard to harmonize quality requirements for HQCF, aiming to facilitate trade and ensure consistent product quality across the region. This standard provides comprehensive specifications for HQCF intended for human consumption and industrial applications.

Technical definition

HQCF is an unfermented product derived from fresh cassava roots (*Manihot esculenta* Crantz). The production process involves carefully controlled steps: peeling, chipping or grating the roots, followed by systematic dewatering, drying, and milling to ensure optimal quality and safety.

Key quality criteria

Processors must ensure the flour meets the following essential characteristics:

- Complete freedom from extraneous materials
- Absence of off-putting odors or flavors
- No presence of living insects or foreign matter
- Full suitability for human consumption
- Consistent color characteristic of the cassava variety
- Ability to produce a blue-black coloration when tested with iodine—indicates that starch has not been degraded during processing; color intensity is related to the concentration of starch
- Pasting temperature (the temperature at which swelling and bursting of starch granules, and subsequent increase in viscosity, begin) below 75 °C.

Physical specifications

- Particle size: Minimum 90% must pass through a 0.25 mm (250 µm) sieve
- Extraneous matter: Maximum of 10 specks per 100 cm^2.

Detailed compositional requirements

See Table 2.1.

Contaminant management

- Pesticide residues: Manufacturers must ensure the flour complies with maximum residue limits established by the Codex Alimentarius Commission, preventing potential chemical contamination
- Comprehensive contaminant control: The flour must meet the stringent maximum levels specified in the Codex General Standard for Contaminants and Toxins in Food and Feed (CODEX STAN 193).

Microbiological safety limits

See Table 2.2.

Table 2.1. Detailed compositional requirements of BCF per DEAS 779.

PARAMETER	MAXIMUM/MINIMUM LIMIT	ANALYTICAL METHOD
Total acidity	≤ 0.25% (by mass)	AOAC 942.15
pH range	5.5–7.0	AOAC 943.02
Acid-insoluble ash	≤ 0.35% (dry matter basis)	EAS 82
Cyanide content	≤ 10 mg/kg	EAS 744
Starch content	≥ 60% (by mass)	ISO 10520
Moisture content	≤ 12% (by mass)	EAS 901
Crude fiber	≤ 5% (dry weight basis)	ISO 5498

Table 2.2. Microbiological safety limits of BCF per DEAD 779.

MICROORGANISM	ACCEPTABLE LIMIT	TEST METHOD
Escherichia coli	Absent	ISO 7251
***Salmonella* spp.**	Absent in a 25 g sample	ISO 6579-1
Yeasts and molds	≤ 10 000 CFU/g	ISO 21527-2

Table 2.3. Key points where continental and East African standards for BCF differ.

PARAMETER	AFRICAN STANDARD	EAST AFRICAN STANDARD
Particle size requirement	95% through 250 µm	90% through 250 µm
Unique specifications	■ Aflatoxin limit: 10 µg/kg total; 5 µg/kg B1	■ pH range: 5.5–7.0 ■ Max 10 mg/kg cyanide content ■ Max 5% crude fiber ■ Min 60% starch content ■ Microbiological limits specified

Hygiene and processing

Manufacturers must adhere to the hygienic handling guidelines outlined in EAS 39 (Hygiene in the food and drink manufacturing industry), ensuring optimal safety throughout production.

Packaging requirements

The packaging must:

- Be made from food-grade materials
- Protect the flour's safety, hygienic qualities, nutritional value, and organoleptic properties
- Maintain product integrity during storage and transportation.

Labeling specifications

Labels must clearly display:

- Product name: "High-quality cassava flour"
- Manufacturer's name and address
- Brand or trade name
- Production date
- Lot/batch identification
- Best before date
- Country of origin
- Net weight in metric units
- "Human food" statement
- Storage instructions
- Packaging disposal guidance.

Note for nonretail packaging: Product name, lot identification, and manufacturer details must appear directly on the package; additional information may be stated on accompanying documentation rather than on actual packaging.

2.2.4 Key differences between standards

Particle size requirements

- African standard: 95% through 250 µm
- East African standard: 90% through 250 µm

Unique specifications

- African standard: 10 µg/kg total Aflatoxin (5 µg/kg Aflatoxin B1)
- East African standard:
  - Maximum 5% crude fiber
  - Minimum 60% starch content
  - Microbiological limits.

SESSION 2.2 KEY TAKEAWAYS AND SUMMARY

Understanding and effectively communicating BCF standards is crucial for ensuring quality products and regulatory compliance. Here are the essential points to emphasize when training industry stakeholders.

Core quality parameters

BCF must meet basic quality criteria across all standards:

- Be free from foreign matter and off-flavors/odors
- Be safe for human consumption
- Have color characteristics appropriate to the cassava variety used
- Meet specific particle size requirements for proper incorporation into wheat flour.

Critical control points

Focus attention on these key quality control areas:

- Moisture content (generally ≤ 10%)
- Cyanide levels (10–20 mg/kg depending on jurisdiction)
- Particle size distribution (90–98% passing through specified mesh sizes)
- pH control (ranges differ by standard)
- Aflatoxin limits (differ by jurisdiction).

Standard variations and implications

Understand and explain why standards differ:

- African standards focus on broad regional harmonization
- East African standards emphasize detailed technical specifications
- Different limits may affect processing requirements and final product characteristics.

Practical application

When training processors and quality control personnel:

- Emphasize the importance of regular testing and monitoring
- Explain how each parameter affects product quality and safety
- Demonstrate proper sampling and testing procedures (Module 3)
- Discuss common compliance challenges and solutions.

Documentation and compliance

Stress the importance of:

- Proper labeling and batch identification
- Record-keeping for traceability
- Regular quality testing and documentation
- Understanding which standard applies in different market contexts.

Future considerations

Be prepared to address:

- Evolving standards as the industry develops
- Integration of new cassava varieties (including biofortified)
- Changing market requirements
- Technology updates in testing and quality control.

These takeaways provide a framework for ensuring consistent quality in BCF production while meeting regulatory requirements across different jurisdictions. They should be adapted according to the specific needs and capabilities of the training audience.

2.3 WHEAT FLOUR STANDARDS FOR BREAD

SESSION 2.3 OBJECTIVE

To understand the essential elements of international (Codex Alimentarius), African, East African, and national (Democratic Republic of the Congo) standards for wheat flour, and the differences between them.

2.3.1 International standards (CODEX STAN 152-1985)

The Codex Alimentarius provides the international reference standards for wheat flour.

Scope and application

Codex STAN 152-1985 applies to wheat flour intended for human consumption derived from common or bread wheat (*Triticum aestivum* L., also known by *T. aestivum* subsp. *aestivum*) or club wheat (*Triticum compactum* Host., also known by *T. aestivum* subsp. *compactum*) or mixtures thereof. The flour may be prepackaged for direct consumer sale or intended for use in other food products.

The standard does **not** apply to:

- Products made from durum wheat (*Triticum durum* Desf., also known by *T. turgidum* subsp. *durum*)
- Whole-grain wheat flour or ground semolina
- Flour for brewery use or starch/gluten production
- Flour for nonfood industrial uses
- Reduced-protein flour or flour given special treatment other than drying/blanching.

General quality requirements

- Safe and fit for human consumption
- Free from abnormal odors and tastes
- Free from live insects
- Free from dirt and impurities of animal origin at health-risk levels.

Specific technical requirements

- Moisture content: Maximum 15.5% (by mass)
  - Lower moisture content may be required depending on climate, transport duration, and storage conditions
- Fatty acid content: Maximum 70 mg/100 g (dry basis) expressed as sulfuric acid
  - Or maximum 50 mg KOH/100 g to neutralize free fatty acids in 100 g flour
- Protein content: Minimum 7% (dry basis) or 12–14%
- Particle size: 98% must pass through a 212 µm sieve.

Optional ingredients permitted for technological purposes

- Malted products with enzymatic activity from wheat, rye, or barley
- Vital wheat gluten
- Soy and legume flours.

Food additives

Enzymes—per good manufacturing practice (GMP):

- Fungal amylase from *Aspergillus niger*
- Fungal amylase from *A. oryzae*
- Proteolytic enzyme from *Bacillus subtilis*
- Proteolytic enzyme from *A. oryzae*.

Flour treatment agents (maximum levels):

- L-ascorbic acid and Na/K salts: 300 mg/kg
- L-cysteine hydrochloride: 90 mg/kg
- Sulfur dioxide (biscuit/cake flour only): 200 mg/kg
- Monocalcium phosphate: 2500 mg/kg
- Lecithin: 2000 mg/kg
- Chlorine (special cake flours): 2500 mg/kg
- Chlorine dioxide (yeast-raised goods): 30 mg/kg
- Benzoyl peroxide: 60 mg/kg
- Azodicarbonamide (yeast bread): 45 mg/kg.

Contaminants

- Heavy metals: Must be below health-risk levels
- Pesticide residues: Must be no more than Codex Alimentarius maximum residue limits (FAO and WHO 2023)
- Mycotoxins: Must be no more than Codex Alimentarius maximum limits (CXS 193).

Hygiene

- Must follow Codex General Principles of Food Hygiene (CAC/RCP 1-1969)
- Must be free from undesirable materials according to GMP
- When tested according to appropriate methods:
  - Free from harmful levels of microorganisms
  - Free from harmful parasites
  - Free from harmful substances from microorganisms.

Sampling and analysis

- Per appropriate Codex tests.

Testing methods

- Ash content: AOAC 923.03, ISO 2171:1980, or ICC 104/1 (1990)
- Fatty acids: ISO 7305:1986 or AOAC 939.05
- Protein content: ICC 105/1 or ISO 1871:1975
- Particle size: AOAC 965.22.

Packaging and labeling

- Must preserve hygienic, nutritional, technological, and organoleptic qualities
- Materials must be food-grade and safe for intended use
- Must not impart toxic substances or undesirable odors/flavors
- Sacks must be clean, sturdy, and securely sewn/sealed
- Labeling per CODEX STAN 1-1985, plus
  - "Wheat flour"
- Nonretail labeling on container: name of product; lot identification; name and address of manufacturer/packer; or an ID marker linked to the same information
  - All other information may be provided on either the container or the accompanying documentation.

2.3.2 African standards (CD-ARS 860) as pertaining to "baker's flour"

ARSO. 2014. African standard CD-ARS 860. Fortified wheat flour—specification. 1st edition. https://www.arso-oran.org/wp-content/uploads/2015/03/CD-ARS-860-2014-Fortified-wheat-flour-Specification.pdf.

Raw material requirements

- Sound quality wheat grain
- Free from sand
- Must have a characteristic odor and flavor conforming to relevant African Standard CD-ARS 465.

General requirements

- Characteristic color
- Free from objectionable flavors and odors
- Free from insects, worms, fungal infestation, rodent contamination, and foreign matter
- No flour from other cereals (except up to 1% malted barley flour permitted in baker's flour).

Specific requirements for baker's flour

- Moisture content: maximum 13% (by mass)
- Crude fiber: maximum 1.0% (by mass)
- Total ash: max 0.7% (by mass)
- 99.2% must pass through a 180 µm sieve
- Protein content: minimum 11.0% (by mass).

Micronutrient fortificants and other additives

See Table 2.4.

Fortificants may be mixed with diluents or carriers, if appropriate, but these should conform to any one of the seven standards specified in CD-ARS 860.

The Standard also provides details of levels of fortificants and constituent nutrients in "premixes" (blend of fortificants and diluents for adding to wheat flour).

When included in wheat flour at 2.5 g/kg with a moisture content of 13.5–14.5%, vitamin fortificants and premixes must retain 80% of their original activity after storage at 45 °C for 21 days.

Any food additives must conform to CODEX STAN 192.

Hygiene requirements

- Production, preparation, and handling must follow ARS 53 (see section 2.2.2)
- Product must be free from pathogenic microorganisms.

Contaminants

- Heavy metals must conform to Codex limits
- Pesticide residues must conform to Codex limits
- Mycotoxins:
  - Total aflatoxins: maximum 10 µg/kg
  - Aflatoxin B1: maximum 5 µg/kg (tested per ISO 16050)
- Must be free from pathogenic microorganisms
- Total plate count: Maximum 1000 CFU/g
- *Staphylococcus aureus*: Maximum 100 CFU/g
- *E. coli*: Absent
- *Salmonella*: Absent in 25 g sample
- *Coliforms*: Absent in 100 g sample
- *Bacillus cereus*: Absent in 25 g sample
- Yeasts and molds: Maximum 1000 CFU/g
- *Vibrio cholerae*: Absent.

2.3.3 East African standards (EAS 1:2011)

East African Standard EAS 1:2011. ICS 67.060. Wheat flour—Specification, 2nd edition. East African Community, Arusha.

The East African Standard covers wheat flour intended for human consumption, excluding durum wheat flour. The standard defines several types of wheat flour.

- Baker's flour: White wheat flour from high-protein wheat intended for bread-making
- Home baking flour: White wheat flour from hard and soft wheat blends for domestic use

Table 2.4. Requirements for levels of micronutrients in fortified wheat flour.

NUTRIENT	FORTIFICANT COMPOUND	RECOMMENDED FACTORY LEVEL (MG/KG)	REGULATORY LEVELS (MG/KG)	
			Min.	Max.
Vitamin A	Vitamin A (retinol) palmate, spray-dried or equivalent, 0.075% retinol, min.	1.0 ± 0.4	0.5	1.4
Vitamin B1	Thiamin mononitrate, activity level, 81%, min.	9.8 ± 4.4	4.6	NA*
Vitamin B2	Ribofavin, activity level, 100%, min.	6.6 ± 3	3.3	NA*
Niacin	Niacinamide, activity level, 99%, min.	60 ± 30	30	NA*
Vitamin B6	Pyridoxine, activity level, 82%, min.	6.5 ± 3.5	3	NA*
Folate	Folic acid, activity level, 100%, min.	2.3 ± 1	1.1	3.2
Vitamin B12	Vitamin B12 (water soluble), activity level, 0.1%, min.	0.02 ± 0.009	0.01	NA†
Zinc	Zinc oxide, activity level, 80%, min.	60 ± 10	40	80
Total iron	Total iron	30 ± 10	20	NA*
Added iron	NaFeEDTA† activity level, 13% Fe, min.	30 ± 10	20	40
	Ferrous fumarate† activity level, 32%, min.	40 ± 10	30	50

* NA: not applicable. The maximum limits for these nutrients are unnecessary, as their upper tolerance levels are very high.
† The use of one of these would be considered.
Source: CD-ARS 860.

- Biscuit flour: White wheat flour with a high percentage of soft wheat for biscuit manufacture
- Cracker flour: White wheat flour from low-protein wheat with no improvers
- Self-raising flour: White wheat flour with raising agents added
- Standard flour: Higher extraction rate than home baking flour
- Whole-grain flour: Entire wheat grain milled to fine particles without separation
- Atta flour: Whole-grain flour with coarse particles.

Quality requirements (per EAS 51)

Raw materials

- Sound quality wheat grain
- Free from sand
- Must have a characteristic odor and flavor.

General requirements

- Characteristic color
- Free from objectionable flavors and odors
- Free from insects, worms, fungal infestation, rodent contamination, and foreign matter
- No flour from other cereals (except up to 1% malted barley flour permitted in baker's flour)
- Shelf life: 3 months for whole-grain/atta flours, 6 months for other types.

Specific compositional requirements for baker's flour, with strict limits on:

- Moisture content (maximum 13%)
- Fiber content (maximum 1.0%)
- Ash content (maximum 0.70%)
- Protein content (minimum 11.0%)
- Residue on 180 µm sieve (0.5–55% depending on flour type; baker's flour 0.80%).

Permitted food additives (per EAS 103)

Improvers (maximum levels):

- Ascorbic acid: 200 ppm
- Potassium persulfate: 100 ppm
- Ammonium persulfate: 250 ppm
- Monocalcium phosphate: 2500 ppm
- Chlorine dioxide: 30 ppm.

Bleaching agents (single use only):

- Nitrogen peroxide: per GMP
- Benzoyl peroxide: maximum 150 mg/kg
- The use of azodicarbonamide (ADA) and potassium bromate is prohibited.

Diastatic active ingredients:

- Barley malt flour: per GMP
- Fungal enzyme: 45 mg/kg.

Hygiene:

- Must follow EAS 39 requirements
- Free from pathogenic microorganisms at harmful levels
- Free from parasites at harmful levels
- Free from substances from microorganisms at harmful levels.

Microbiological limits:

- Total plate count: maximum 10^5 per g
- *E. coli*: not detectable in 1 g sample
- *Salmonella*: not detectable in 25 g sample
- Yeasts and molds: maximum 10^4 CFU/g
- *Staphylococcus aureus*: not detectable in a 25 g sample.

Contaminant limits:

- Heavy metals: must adhere to Codex limits (CXS 193)
- Pesticide residues: must adhere to Codex limits (FAO and WHO 2023)
- Total aflatoxins: maximum 10 µg/kg
  - Aflatoxin B1: maximum 5 µg/kg
- Fumonisin: maximum 2 µg/kg.

Test methods and standards

The East African Standard references several international standards for testing and verification.

Quality testing

- ISO 6540: Moisture content determination
- ISO 5498: Fiber content determination
- ISO 2171: Ash content determination
- ISO 1871: Nitrogen/protein determination by Kjeldahl method
- EAS 82: Methods for testing milled cereal products.

Safety and contamination

- ISO 16050: Determination of aflatoxins B1, B2, G1, and G2
- ISO 13690: Sampling methods for static batches
- CODEX STAN 193: General standards for contaminants and toxins.

Related East African Standards

- EAS 35: Edible salt specification
- EAS 38: Labeling requirements for prepackaged foods
- EAS 39: Hygiene code for food/drink manufacturing
- EAS 51: Wheat grain grades specification
- EAS 217: Microbiological test methods.

Understanding these standard references is important as they provide the detailed testing procedures and specifications needed to verify compliance with the quality and safety requirements outlined above.

Packaging and labeling

- Food-grade containers that protect product quality
- Clean, sturdy, sewn/sealed sacks if used
- Maximum 50 kg where manual handling is involved
- Label per EAS 38, plus
  - Product name as "Wheat flour"
  - Name, address, and location of manufacturer/packer/importer
  - Batch number
  - Net weight (kg)
  - "Food for human consumption" declaration
  - Storage instructions: "Store in a cool, dry place away from contaminants"
  - Manufacturing and best before dates
  - Package disposal instructions
  - Country of origin.

The East African Standard aims to ensure consistent wheat flour quality across East Africa while protecting consumer safety. Regular monitoring helps verify compliance with these requirements.

2.3.4 DRC standards

DRC has adopted the Codex standard.

2.3.5 Key differences between standards levels

- Moisture content: Continental/EAS, ≤ 13%; DRC/Codex, ≤ 15.5%
- Protein content: EAS, ≥ 11%; DRC/Codex, ≤ 7% (dry) / 12–14%
- Particle size: EAS, 45–99.5% through 180 µm; DRC/Codex, 98% through 212 µm
- Only in East African standard: Shelf-life specifications
- Only specifically defined in the Codex/DRC standard: fatty acid limits; gluten content.

SESSION 2.3 KEY TAKEAWAYS AND SUMMARY

The various standards for wheat flour share core requirements but differ in specific details. Key points for trainers to emphasize include the following.

Quality framework

- International (Codex) standards provide the foundation for national and regional standards
- African standards build on these while adding specific regional requirements
- East African standards provide the most detailed specifications for different flour types
- DRC follows Codex standards.

Critical parameters

- Moisture content limits vary (13–15.5%) based on standard and intended use
- Particle size specifications are crucial for flour functionality
- Protein content requirements differ by flour type and intended use (EAS)
- Microbiological and contaminant limits protect consumer safety.

Testing and verification

- Standards specify internationally recognized test methods
- Regular monitoring ensures compliance
- Documentation must be maintained for traceability
- Cross-border trade requires meeting multiple standards.

Practical applications

- Millers must understand and meet all applicable standards
- Different flour types have specific requirements based on end use
- Storage and transport conditions affect flour quality
- Proper packaging and labeling are essential for compliance.

For successful implementation, flour producers should:

- Maintain detailed quality control procedures
- Conduct regular testing using specified methods
- Keep comprehensive records of test results
- Stay informed about standards updates.

Understanding these standards helps ensure consistent flour quality while facilitating trade across borders. Regular monitoring and verification of compliance protects both producers and consumers.

2.4 COMPOSITE FLOUR STANDARDS

SESSION 2.4 OBJECTIVE

To understand the essential elements of African, East African, and national (Democratic Republic of the Congo) standards for composite cassava–wheat flour, and the differences between them.

2.4.1 African standards (CD-ARS 842:2014)

African standard CD-ARS 842. 2014. Cassava wheat composite flour—Specification. 1st edition. ARSO.

The standard aims to promote the processing and use of cassava flour in baking products while ensuring quality and safety. It specifies requirements for cassava–wheat composite flour but does not apply to other nonwheat composite flours.

General requirements

The composite flour must be:

- Homogeneous in size and color
- Practically free from "filth" ("impurities of animal origin") and foreign matter
- Free from rancidity, off-odors, and off-flavors.

Raw materials

- Cassava flour must conform to CD-ARS 838:2013
- Wheat flour must conform to ARS 470.

Physical specifications

- Minimum 90% must pass through a 0.25 mm sieve for fine flour
- Moisture content maximum 13.5%.

Compositional requirements

- Minimum protein content: 8.0% (by mass)
- Minimum crude fat content: 2.0% (dry matter)
- Maximum crude fiber content: 1.25% (dry matter)
- Maximum acid value: 50
- Maximum acid insoluble ash: 0.35% (by mass)
- Maximum total hydrogen cyanide: 10 mg/kg (by mass).

Fortification and food additives

Fortification may be required by and must follow national legislation, while optional food additives must comply with CODEX STAN 192.

Contaminants

- Must comply with Codex maximum pesticide residue limits
- Maximum total aflatoxins: 10 µg/kg (maximum 5 µg/kg for aflatoxin B1)
- Must be free from harmful parasites and objectionable matter
- Must conform to CODEX STAN 193 contaminant limits.

Hygiene

Handling and preparation must comply with ARS 53 and national public health regulations.

Microbiological limits

- *E. coli*: absent
- *Salmonella*: absent in 25 g sample
- Maximum yeasts and molds: 10 000 CFU/g
- Maximum *Staphylococcus aureus*: 100 CFU/g
- Coliform bacteria: absent in 100 g sample.

The standard also specifies sampling and testing methods for both composition and microorganisms.

Packaging and labeling

Packaging must:

- Be made from food-grade materials
- Protect the product's hygienic, physical, nutritional, and organoleptic qualities
- Meet destination country weight regulations.

Labels must include:

- Product name: "Cassava–wheat composite flour"
- Manufacturer or distributor details or trade/brand name
- Ingredients list
- Manufacturing date
- Storage instructions
- Lot identification
- Expiry date
- Country of origin
- Net weight
- Package disposal instructions.

For nonretail packages, key information (product name, lot, manufacturer/packager details) must appear on packages, while other details can be in accompanying documentation.

The standard aims to facilitate trade while ensuring consistent quality of composite flour products across Africa.

2.4.2 East African standards (DEAS 782:2018, EAS 741:2010)

East African Standard EAS 741:2010. ICS 67.080.20. Cassava wheat composite flour—Specification. 1st edition. East African Community, Arusha.

Draft East African Standard DEAS 782: 2018. ICS 67.060. Composite flour—Specification. 2nd edition. East African Community, Arusha.

Substitution levels

- Minimum 10% cassava flour by weight must be included in the composite flour.

Raw materials requirements

- Food plants or their products used for milling must be clean, sound, and practically free from foreign matter
- All raw materials must comply with relevant East African Standards.

General requirements

- The flour must be homogeneous in particle size and color
- Must be practically free of dirt, dead and living insects, and foreign matter
- Must have no off-odors/flavors
- Constituent cassava and wheat flours must conform to DEAS 740 and EAS 1, respectively.

Physical specifications

- Minimum 90% must pass through a 0.25 mm sieve
- Total hydrogen cyanide (HCN) content must not exceed 10 mg/kg
- Fat acidity: maximum 80 mg KOH
- Acid insoluble ash: maximum 0.40%
- Moisture content: maximum 14% (DEAS 782); 13.5% (EAS 741)
- Crude fiber: maximum 1.25% (dry matter basis)
- Protein content: minimum 8.0%
- Crude fat content: minimum 2.0%
- Insoluble ash: ≤ 0.35%.

Food additives

- Use in accordance with CODEX STAN 192/EAS 103
- Fortification nutrients per national legislation.

Microbiological requirements

- Must comply with EAS 39
- *E. coli*: < 100 CFU/g or absent in 10 g sample
- *Salmonella*: absent in 25 g sample
- Yeasts and molds: maximum 10^4 or 10^3 CFU/g.

Contaminants

- Heavy metals:
- Arsenic: ≤ 0.1 mg/kg
- Lead ≤ 0.2 mg/kg
- Cadmium: ≤ 0.1 mg/kg
- Pesticide residues: per Codex Alimentarius maximum limits
- Mycotoxins:
  - Aflatoxins, total: ≤ 10 µg/kg
  - Aflatoxin B1: ≤ 5 µg/kg
  - Fumonisins: ≤ 2000 µg/kg
- Others: per CODEX STAN 193.

Packaging requirements

- Only food-grade materials may be used
- Must protect product quality (hygienic, nutritional, organoleptic)
- Labeling per EAS 38, plus:
  - "Cassava–wheat composite flour"
  - Percentage substitution of wheat with cassava
  - List of ingredients in descending order of proportion
  - Net weight
  - Name and physical address of manufacturer/packer/distributor and trade/brand name
  - Lot identification code
  - Manufacturing and best before dates
  - Storage instructions: "store in a cool dry place"
  - Instructions for disposal of used packaging
- For nonretail packages, information may be given in accompanying documentation, except the product name, lot identification, and name/address of manufacturer which must appear on packages.

2.4.3 DRC standards (NCD ISO 004 : 2020)

Norme Congolaise NCD ISO 004:2020. Norme Nationale Congolaise pour la Planification et la Pâtisserie [Congolese national standard for bread making and pastries]. Comité National de Normalisation.

The DRC standard relates to bread and pastries rather than composite flour per se. However, several of its specifications also apply to the flour and are detailed here. The remainder of the standard is covered in section 2.5.2.

Scope

- The Standard applies to bread and pastry products made from wheat–cassava composite flour
- Two types of flour specified for the Congolese market:
  - For bread-making: minimum 5% cassava flour
  - For pastry products: minimum 10% cassava flour.

Product categories

Bread products: ordinary bread, whole-grain bread, sandwich bread, English bread, cycling bread, buttered bread, French baguette, ball bread, and big bread.

Pastry products: biscuits, doughnuts, cakes, and waffles/pancakes.

Base ingredients

Bread: Bread-making cassava flour produced in DRC—wheat flour, potable water, iodized salt, fats, yeast, authorized additives.

Pastry: Bread-making cassava flour produced in DRC—wheat flour, potable water, iodized salt, milk, butter/margarine, sugar, yeast (biological and chemical), and eggs; optional: colorants, vanilla sugar.

Quality requirements

- Must be free from abnormal flavors and odors
- Must be free from living insects
- Must be free from filth (including dead insects) that may be hazardous.

Regulatory requirements

- Only additives authorized by Congolese food additive standards may be used
- Must be free from heavy metals in harmful quantities
- GMO usage requires Ministry of Health authorization
- Must follow national hygiene principles according to NCD CAC/RCP 1-1969, Rev. 2-1985
- Must comply with national weight regulations
- Must comply with national packaging and labeling standards according to NCD CODEX STAN 1-2018.

The standard is based on several normative references, including Cameroon bread standard NC 213:2003-03, various NCD CODEX STAN standards, COMESA ISO standards, and East African Standard EAS 740:2010.

2.4.4 Key differences between standards

Substitution levels

- The African standard does not specify a level
- The East African standard specifies a single minimum (10%)
- DRC specifies different levels for bread (5%) and pastry (10%).

Focus and scope

- African and East African standards specify requirements for the composite flour product
- DRC standards focus on end products (bread and pastry) and their formulation.

Quality parameters

- African and East African standards provide detailed quantitative specifications:
  - Physical parameters (particle size, moisture content)
  - Chemical parameters (protein, fiber, ash content, etc.)
- DRC standards emphasize qualitative parameters for finished products:
  - Visual characteristics (golden crust)
  - Textural qualities (light and airy)
  - Sensory properties (free from abnormal flavors and odors).

Technical parameters

- African and East African standards provide comprehensive technical specifications with test methods
- DRC standards focus on general quality and safety requirements with reference to overarching standards.

Microbiological control

- East African standards specify numerical limits for *E. coli*, *Salmonella*, yeasts, molds, etc.
- DRC standards reference general hygiene principles without specific microbial limits.

Testing and compliance

- African and East African standards prescribe specific test methods for each parameter
- DRC standards refer to Codex Alimentarius Vol.13 for testing procedures.

Product categories and applications

- African and East African standards focus solely on flour specifications
- DRC standards detail specific end products:
  - Nine types of bread products
  - Four types of pastry products
  - Specific ingredient requirements for each category.

Regulatory emphasis

- African and East African standards emphasize physical specifications and technical compliance
- DRC standards emphasize administrative controls (e.g., GMO authorization) and end-product characteristics.

Raw material requirements

- ☐ Cassava flour sourced from wholesome, freshly harvested cassava roots
- ☐ Cassava flour meets CD-ARS 838:2013/DEAS 740 specifications
- ☐ Wheat flour meets ARS 470/EAS 1 specifications
- ☐ All raw materials clean, sound, and free from foreign matter

Physical specifications

- ☐ Flour homogeneous in size and color
- ☐ Minimum 90% passes through 0.25 mm (250 µm) sieve
- ☐ Moisture content: Maximum 13.5%
- ☐ Free from dirt, dead/living insects, and foreign matter
- ☐ No rancidity, off-odors, or off-flavors

Compositional requirements

- ☐ Minimum protein content: 8.0% (by mass)
- ☐ Minimum crude fat: 2.0% (dry matter basis)
- ☐ Maximum crude fiber: 1.25% (dry matter basis)
- ☐ Maximum acid value: 50
- ☐ Maximum acid insoluble ash: 0.35% (by mass)
- ☐ Maximum total hydrogen cyanide: 10 mg/kg

Substitution levels

- ☐ Flour for bread products: minimum 5% cassava flour inclusion
- ☐ Flour for pastry products: minimum 10% cassava flour inclusion
- ☐ Clear documentation of actual substitution percentage

Contaminant controls

- ☐ Pesticide residues within Codex Alimentarius limits
- ☐ Heavy metals:
  - ☐ Arsenic: ≤ 0.1 mg/kg
  - ☐ Lead: ≤ 0.2 mg/kg
  - ☐ Cadmium: ≤ 0.1 mg/kg
- ☐ Mycotoxins:
  - ☐ Total aflatoxins: ≤ 10 µg/kg
  - ☐ Aflatoxin B1: ≤ 5 µg/kg
  - ☐ Fumonisins: ≤ 2000 µg/kg

Microbiological requirements

- ☐ *E. coli*: absent or < 100 CFU/g
- ☐ *Salmonella*: absent in 25 g sample
- ☐ Yeasts and molds: maximum 10 000 CFU/g
- ☐ *S. aureus*: maximum 100 CFU/g
- ☐ Coliform bacteria: absent in 100 g sample

Processing controls

- ☐ Good manufacturing practices (GMP) implemented
- ☐ Good hygiene practices (GHP) followed
- ☐ HACCP system in place
- ☐ Fortification per national legislation (if applicable)
- ☐ Food additives comply with CODEX STAN 192/EAS 103

Packaging requirements

- ☐ Food-grade packaging materials only
- ☐ Protects hygienic, nutritional, and organoleptic qualities
- ☐ Packages clean, sturdy, and properly sealed
- ☐ No transfer of toxic substances or undesirable odors/flavors

Labeling compliance

- ☐ Product name: "Cassava–wheat composite flour"
- ☐ Percentage substitution clearly stated
- ☐ Manufacturer/distributor details
- ☐ Ingredients list in descending order
- ☐ Manufacturing date
- ☐ Best before date
- ☐ Lot/batch identification
- ☐ Net weight in metric units
- ☐ Storage instructions (e.g., "Store in a cool dry place")
- ☐ Country of origin
- ☐ Package disposal instructions

Documentation and traceability

- ☐ Raw material purchase records maintained
- ☐ Batch production records complete
- ☐ Quality test results documented
- ☐ Compliance certificates available
- ☐ Customer feedback system in place

Special requirements (DRC specific)

- ☐ GMO ingredients have Ministry of Health authorization (if applicable)
- ☐ Compliance with NCD CODEX STAN 1-2018 for packaging/labeling
- ☐ National weight regulations met

Quality verification

- ☐ Regular testing schedule established
- ☐ Calibrated testing equipment available
- ☐ Trained quality control personnel
- ☐ External laboratory verification (as needed)
- ☐ Corrective action procedures documented

Figure 2.1. Standards compliance checklist for cassava–wheat composite flour production.

SESSION 2.4 KEY TAKEAWAYS AND SUMMARY

The East African composite flour and DRC bread and pastry standards represent two distinct regulatory approaches.

Focus

- ARS and EAS take a product-centric approach, specifying detailed requirements for the composite flour itself
- DRC takes an application-centric approach, focusing on end products and their formulation.

Specification style

- ARS and EAS provide quantitative, measurable specifications with defined test methods
- DRC emphasizes qualitative characteristics and references broader standards.

Compliance framework

- ARS and EAS rely on direct measurement and testing against specific limits
- DRC relies on adherence to general principles and administrative controls.

Key implementation differences

- ARS is generic for cassava–wheat composite flours
- EAS mandates uniform 10% substitution across applications
- DRC differentiates between bread (5%) and pastry (10%) applications
- ARS and EAS require specific technical parameters to be met
- DRC requires approval processes (e.g., GMO authorization) and end-product validation.

These differences have practical implications for:

- Quality control procedures
- Testing requirements
- Production processes
- Regulatory compliance
- Product development.

Manufacturers and regulators must understand all three standards to ensure compliance, particularly as DRC is now part of the East African Community.

2.5 CASSAVA BREAD STANDARDS

SESSION 2.5 OBJECTIVE

To understand the essential elements of African and national (Democratic Republic of the Congo) standards for cassava-based bread, and the differences between them.

2.5.1 African standards for cassava bread (CD-ARS 853)

African Standard CD-ARS 853. 2014. Cassava bread—Specification. 1st edition. ARSO.

African standards for cassava bread (CD-ARS 853) specify requirements for cassava bread intended for human consumption. The key requirements cover quality, food additives, contaminants, hygiene, packaging, and labeling.

Definition

The standard defines cassava bread as "a thin, cracker-like bread made by leaching and drying the root of the cassava plant". This is not a definition of bread made from cassava–wheat composite flour; however, the standard also applies to "related products, intended for human consumption, obtained from the processing of cassava."

Quality requirements

Cassava bread must be free from abnormal flavors and odors, living insects, and filth (including dead insects) that may pose health hazards. The product must meet specific technical parameters:

- Maximum 12% moisture content
- 3.5–4.0% crude fiber
- 2.0% ash content
- Maximum 0.20% acid insoluble ash
- pH range 5.3–6.0
- Maximum 10.0 mg/kg hydrogen cyanide content.

Raw materials requirements include cassava flour meeting CD-ARS 838:2014 and CD-ARS 840:2014 specifications and edible oils/fats complying with relevant African Standards. Optional ingredients such as edible salt must comply with ARS 471.

Food additives used in cassava bread production must comply with CODEX STAN 192 requirements.

Contaminant controls

The standard specifies limits for:

- Pesticide residues—must meet Codex Alimentarius Commission maximum limits
- Heavy metals (lead, cadmium, copper, iron, zinc)—must be below harmful levels prescribed by CODEX STAN 228
- Other contaminants—maximum levels prescribed by CODEX STAN 193.

Hygiene requirements

Production must follow ARS 53 hygiene guidelines and meet these microbiological limits:

- Maximum 104 CFU/g total viable count
- Absence of *E. coli*
- Absence of *Salmonella* in a 25 g sample
- Maximum 103 CFU/g yeasts and molds.

During handling, storage, and transportation, measures must be taken to prevent cross-contamination.

Packaging and labeling requirements

The packaging must:

- Protect the bread from breakage
- Use new, clean, food-grade materials
- Not impart toxic substances or undesirable odors/flavors
- Meet destination country weight regulations.

Labels must include:

- Product name "Cassava bread"
- Manufacturer/distributor name and address and/or trade/brand name
- Date of manufacture
- Ingredient list
- Lot identification
- Best before date
- Net weight
- Storage instructions
- Flavoring declarations
- Packaging disposal instructions.

For nonretail packages, key information can be provided in accompanying documentation except for product name, lot ID, and manufacturer/packer details, which must appear on packages.

The standard aims to ensure cassava bread quality and safety while facilitating trade through harmonized requirements across Africa. Manufacturers must comply with all specifications for their products to be certified as meeting the standard.

The standard does not specify production methods or processing parameters; it focuses only on end-product requirements and specifications.

2.5.2 DRC standards for bread and pastries (NCD ISO 004: 2020)

Norme Congolaise NCD ISO 004:2020. Norme Nationale Congolaise pour la Planification et la Pâtisserie [Congolese national standard for bread making and pastries]. Comité National de Normalisation.

DRC standards overview

The DRC national standard for bread and pastry (NCD ISO 004:2020) establishes requirements for products made with wheat–bread-making cassava composite flour. The standard specifies two types of flour blends:

- For bread making: minimum 5% cassava flour
- For pastry products: minimum 10% cassava flour.

Product categories

The standard covers these bread types: ordinary bread, whole-grain bread, sandwich bread, English bread, cycling bread, French baguette, ball bread, and big bread.

For pastries, it covers: biscuits, doughnuts, cakes, and waffles/pancakes.

Basic ingredients

Each bread type has specific required ingredients. For ordinary bread, these include:

- Bread-making cassava flour produced in DRC
- Wheat flour
- Potable water
- Oil
- Iodized salt
- Fats
- Yeast
- Various permitted additives.

Optional ingredients vary by product. For example, sandwich bread may include sugar, milk, and eggs, while whole-grain bread includes bran.

Quality requirements

The finished bread should have:

- A golden-brown crust
- Light, airy texture
- Even crumb structure.

Regulatory controls

The standard specifies:

- Only authorized food additives per Congolese standards may be used
- Products must be free from harmful levels of heavy metals
- GMO ingredients require Ministry of Health authorization
- Production must follow national hygiene principles
- Products must meet national weight regulations
- Packaging and labeling must comply with NCD CODEX STAN 1-2018 and national food standards.

Product testing

The standard requires sampling and testing according to Codex Alimentarius Vol. 13 methods, including:

- Weight verification
- Microbiological analysis
- Heavy metals testing
- Sugar content measurement
- Product rheology assessment.

The standard aims to ensure consistent quality while promoting local cassava production and reducing wheat imports. Manufacturers must comply with all specifications for their products to be certified as meeting the national standard.

2.5.3 Key differences between standards

The African standard (CD-ARS 853) and DRC standard (NCD ISO 004:2020) have several notable differences in their approaches and requirements.

Scope and focus

The African standard specifically addresses cassava bread, while the DRC standard covers both bread and pastry products made with bread-making cassava–wheat composite flour. The DRC standard provides more detailed product categorization, listing specific types of bread and pastries.

Flour composition requirements

The most significant difference is in flour composition specifications. The DRC standard mandates minimum cassava flour inclusion levels (5% for bread, 10% for pastries), while the African standard does not specify composite flour ratios.

Technical specifications

The African standard provides more detailed technical parameters for the finished product, including specific limits for moisture content, crude fiber, ash content, acid insoluble ash, pH, and hydrogen cyanide content. The DRC standard focuses more on qualitative characteristics such as a golden-brown crust and light, airy texture.

Regulatory approach

The DRC standard includes additional regulatory requirements not found in the African standard:

- GMO ingredients require Ministry of Health authorization
- Specific provisions for locally produced cassava flour
- More detailed weight regulation requirements.

Quality control

The standards differ in their testing requirements:

- The African standard emphasizes microbiological limits and contaminant controls
- The DRC standard includes additional tests for sugar content and product rheology.

Product categories

The DRC standard provides more detailed product categorization, specifying requirements for different types of bread (ordinary, whole-grain, sandwich, etc.) and pastries (biscuits, doughnuts, cakes, etc.). The African standard treats cassava bread as a single category.

These differences reflect the DRC's focus on promoting local cassava production while maintaining product quality and safety standards.

Raw materials and ingredients

- ☐ **Cassava flour quality**
  - ☐ Meets CD-ARS 838/840 specifications for HQCF
  - ☐ Moisture content ≤12%
  - ☐ pH within specified range (5.5–7.0 for East African; > 5.8 for DRC)
  - ☐ Cyanide content ≤10 mg/kg
  - ☐ Free from off-odors and off-flavors
  - ☐ Appropriate color (white or yellow for biofortified)
  - ☐ Particle size meets specifications
- ☐ **Wheat flour quality**
  - ☐ Meets relevant national/regional standards
  - ☐ Moisture content within limits
  - ☐ Free from contamination
- ☐ **Composite flour requirements**
  - ☐ Minimum 5% BCF for bread (DRC requirement)
  - ☐ Minimum 10% BCF for pastries (DRC requirement)
  - ☐ Homogeneous blend achieved
- ☐ **Other ingredients**
  - ☐ All ingredients from approved suppliers
  - ☐ Within expiry dates
  - ☐ Properly stored and handled
  - ☐ Only authorized food additives used (DRC requirement)

Production process controls

- ☐ **Hygiene and sanitation**
  - ☐ Production area meets hygiene requirements (ARS 53)
  - ☐ Equipment properly cleaned and sanitized
  - ☐ Personnel following hygiene protocols
  - ☐ Pest control measures in place
- ☐ **Process parameters**
  - ☐ Mixing procedures documented and followed
  - ☐ Fermentation time and temperature controlled
  - ☐ Baking temperature and time within specifications
  - ☐ Cooling procedures followed

Product quality specifications

- ☐ **Physical characteristics**
  - ☐ Maximum 12% moisture content
  - ☐ Crude fiber 3.5–4.0%
  - ☐ Ash content 2.0%
  - ☐ Maximum acid insoluble ash 0.20%
  - ☐ pH range 5.3–6.0
  - ☐ Maximum hydrogen cyanide 10.0 mg/kg
- ☐ **Sensory qualities**
  - ☐ Free from abnormal flavors and odors
  - ☐ Free from living insects
  - ☐ Free from filth that may pose health hazards
  - ☐ Appropriate crust color and texture
  - ☐ Good crumb structure

Contaminant controls

- ☐ **Chemical contaminants**
  - ☐ Pesticide residues below Codex limits
  - ☐ Heavy metals (lead, cadmium, copper, iron, zinc) below harmful levels
  - ☐ Other contaminants meet CODEX STAN 193 requirements
- ☐ **Microbiological safety**
  - ☐ Total viable count ≤ 10^4 CFU/g
  - ☐ *E. coli* absent
  - ☐ *Salmonella* absent in 25 g sample
  - ☐ Yeasts and molds ≤ 10^3 CFU/g

(continued next page)

☐ **Mycotoxins**
- ☐ Total aflatoxins ≤ 10 µg/kg
- ☐ Aflatoxin B1 ≤ 5 µg/kg

Packaging and labeling

☐ **Packaging materials**
- ☐ Food-grade materials used
- ☐ New and clean
- ☐ Protects product from breakage
- ☐ Does not impart toxic substances or odors
- ☐ Meets destination country weight regulations
- ☐ Comply with NCD CODEX STAN 1-2018

☐ **Labeling requirements**
- ☐ Product name: "Cassava bread"
- ☐ Manufacturer/distributor name and address and/or trade/brand name
- ☐ Date of manufacture
- ☐ Ingredient list
- ☐ Lot identification
- ☐ Best before date
- ☐ Net weight (metric units)
- ☐ Storage instructions
- ☐ Flavoring declarations (if applicable)
- ☐ Package disposal instructions
- ☐ Comply with NCD CODEX STAN 1-2018

Documentation and traceability

☐ **Records maintained**
- ☐ Ingredient purchase records
- ☐ Production batch records
- ☐ Quality test results
- ☐ Temperature monitoring logs
- ☐ Cleaning and sanitation records
- ☐ Staff training records

☐ **Compliance verification**
- ☐ Regular quality testing performed
- ☐ Test results meet specifications
- ☐ Corrective actions documented
- ☐ Audit trails maintained

Storage and distribution

☐ **Storage conditions**
- ☐ Clean, covered display cases
- ☐ Appropriate temperature maintained
- ☐ First-in-first-serve rotation
- ☐ Time limits for perishable products (4 hours maximum)
- ☐ Products dated/time-stamped

Regulatory compliance

☐ **Standards adherence**
- ☐ Meets national standards (NCD ISO 004:2020 for DRC)
- ☐ Meets regional standards (where applicable)
- ☐ Meets African standards (CD-ARS 853)
- ☐ GMO authorization obtained (if applicable)
- ☐ All food additives authorized

Date checked: _____ Checked by: _____ Signature: _____

Notes/Nonconformities identified: _____

_____

_____

Figure 2.2. Compliance checklist for cassava bread production.

MODULE 2 KEY TAKEAWAYS

Standards framework and hierarchy

- International standards (Codex Alimentarius) establish baseline requirements for food safety and quality
- Regional standards facilitate trade while adding specific requirements for the African context
- National standards reflect local priorities and processing capabilities
- Products for export must meet standards at all applicable levels.

Critical quality parameters

- Raw material selection impacts final product quality
- Cassava root characteristics affect flour properties
- Wheat flour specifications determine bread quality
- Processing controls are essential for consistent quality
- 24-hour timeline from harvest to drying (for HQCF)
- Moisture content management throughout production
- Testing and verification requirements differ by jurisdiction.

Implementation requirements

- Manufacturers must establish:
  - Documented quality management systems
  - Regular testing and monitoring protocols
  - Traceability from raw materials through finished products
- Staff training should emphasize:
  - Critical control points
  - Testing procedures
  - Record-keeping requirements.

Strategic context

- Standards support both:
  - Regional trade harmonization through consistent requirements
  - National development through local cassava utilization
- Understanding this dual purpose helps stakeholders navigate compliance requirements effectively.

These takeaways provide trainers with a framework for communicating standards' requirements in ways that emphasize practical implementation while maintaining technical accuracy.

MODULE 3:
PRACTICAL SKILLS DEVELOPMENT

MODULE 3 OBJECTIVES

After completing this module, trainers will be able to:

1. Train bakers in core practical skills needed for cassava–wheat composite bread production:
   - Quality assessment of ingredients
   - Equipment operation and maintenance
   - Ingredient storage and handling
   - Recipe formulation and adaptation
   - Production techniques
   - Product storage
   - Hygiene and safety management
2. Demonstrate and teach systematic procedures that ensure consistent quality and food safety
3. Troubleshoot common production issues and implement corrective actions
4. Establish documentation systems for quality control and compliance.

These sessions are probably best performed in a bakery or across two bakeries to give trainees physical demonstrations and hands-on experience.

3.1 RAW MATERIAL QUALITY ASSESSMENT

Consistent quality of raw materials ensures successful bread production. Bakers must regularly check the quality of their ingredients using simple but effective methods. This section covers essential quality tests that can be performed without specialized laboratory equipment. (For final product quality evaluation, see section 3.6.)

SESSION 3.1 OBJECTIVES

After completing this session, trainers will be able to:

1. Demonstrate key quality assessment techniques for testing flours and other baking ingredients using simple methods without specialized equipment
2. Explain and demonstrate proper methods for evaluating:
   - Flour strength and moisture content
   - Physical contamination and purity
   - Freshness indicators (odor, taste, color)
   - Yeast viability
   - Egg quality and freshness
3. Apply objective criteria to accept or reject ingredients based on quality assessment results
4. Teach others how to consistently perform these quality checks as part of standard bakery operations.

Figure 3.1. Flour moisture levels: (A) proper moisture level, wheat flour; (B) proper moisture level, BCF; (C) overmoist wheat flour; (D) overmoist BCF.

3.1.1 Visual and physical testing of flours

Test for flour strength

Flour strength affects bread texture and volume. Test using the following methods.

Method 1: Water mixing test

1. Place a flour sample in your palm
2. Add a small amount of water
3. Mix with one finger.

Method 2: Compression test

1. Place flour sample in palm
2. Compress with four fingers
3. Open hand
4. Rub flour between fingers.

For wheat flour, observe:

- High gluten flour forms a hard, viscous mass
- The more viscous the mass, the greater the strength
- Bread flour feels slightly coarse when rubbed
- Bread flour falls apart after squeezing
- Color should be creamy white.

Test for moisture content (Figure 3.1)

Controlling moisture prevents spoilage. To test:

1. Use very dry hands
2. Fill palm with flour sample
3. Compress with four fingers
4. Open palm and observe.

Well-dried flour will:

- Leave a non-sticky trace
- Not stick to your palm.

Test for impurities and specks (Figure 3.2)

Check for contaminants using water separation:

1. Fill glass beaker with clean water
2. Add flour (one part flour to four parts water by volume)
3. Stir mixture vigorously
4. Observe separation:
    - Fibrous materials float
    - Dirt, specks, and sand sink.

Test for flour purity

Method 1: Bran check

- Sprinkle flour in water
- Bran will float.

Method 2: Chalk test

- Add dilute hydrochloric acid to the sample
- Bubbles indicate chalk contamination.

Test for odor

Fresh flour should have a neutral odor. BCF should be odorless. Test by:

- Direct smell assessment (Figure 3.3)
- "Scald" with hot water (about 65 °C) to enhance odors.

Bad flour may smell stale, musty, or almost sour. Discard any flour with a bad smell immediately.

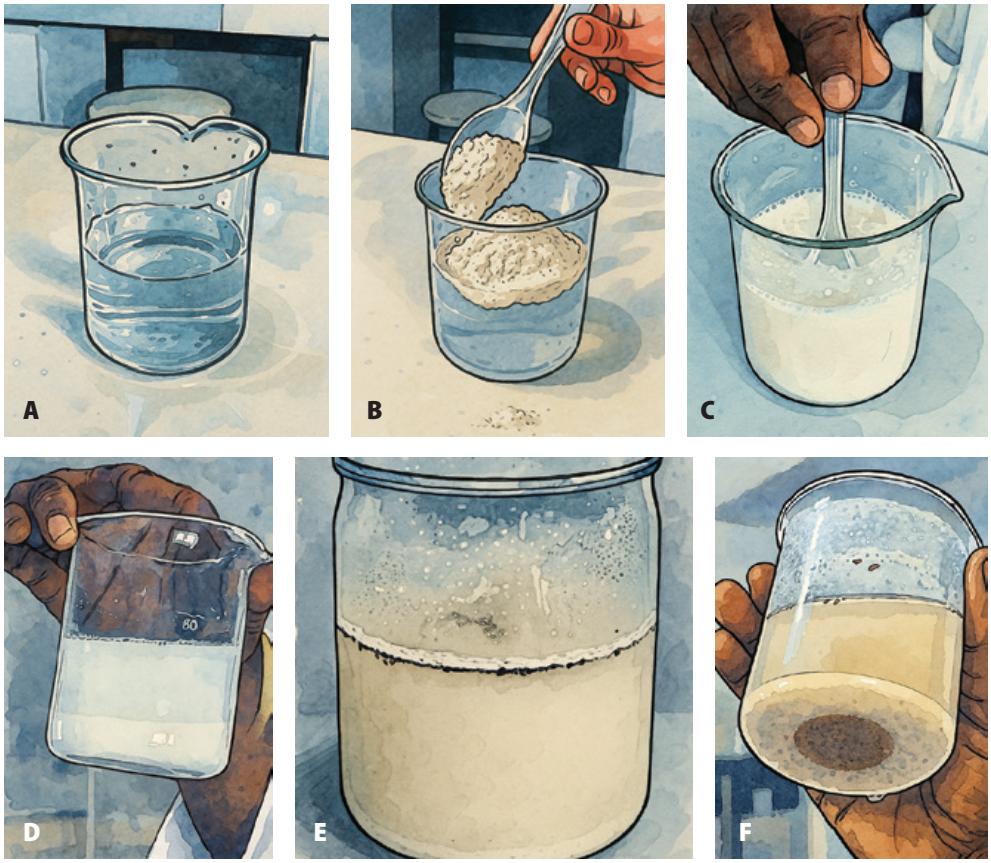

Figure 3.2. Testing flour for physical contamination: (A)–(C) setup; (D) no impurities; (E) floating impurities; (F) sinking impurities.

Test for taste and color

Wheat flour has a distinctive, subtle taste, which is mild, nutty, and has a slightly buttery flavor; BCF should be tasteless.

Evaluate by:

- Tasting directly
- Taste after "scalding" with hot water (c. 65 °C), by mixing one part flour with two parts hot water (enhances off-flavors)
- Visual color assessment (Figure 3.4)
  - Wheat flour should appear white
  - BCF should also be white, unless made from a biofortified cassava variety, in which case it will be yellow.

Figure 3.3. Correct technique for smelling flour (direct method).

Figure 3.4. Color comparisons: (A) good wheat flour; (B) good BCF; (C) typical color poor-quality wheat flour; (D) typical color poor-quality BCF.

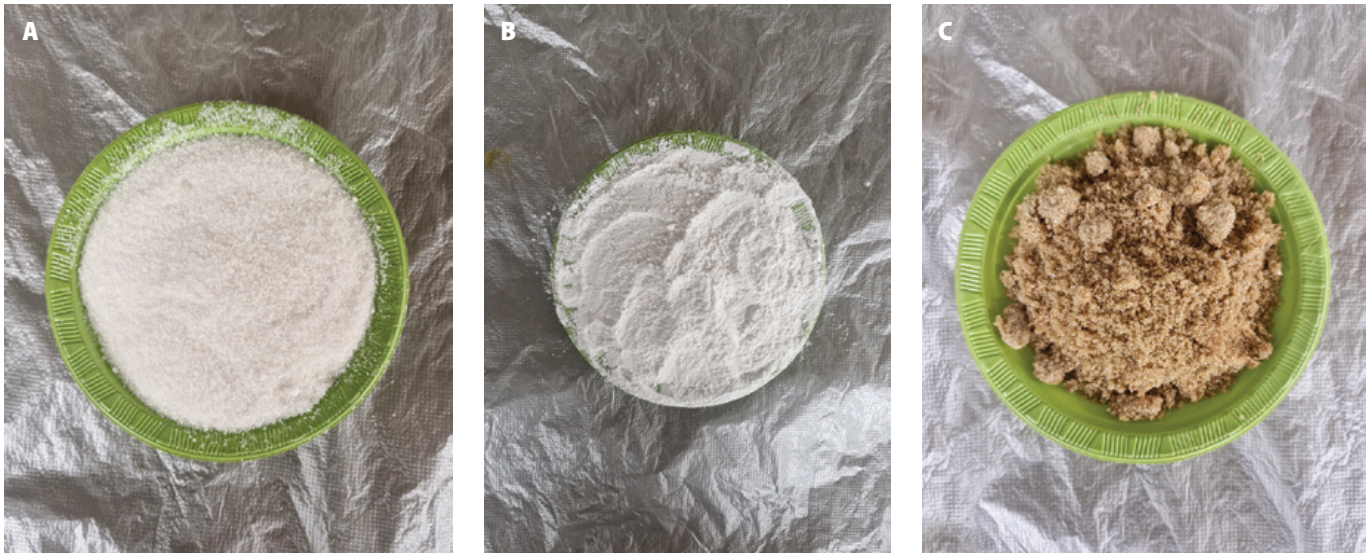

Figure 3.5. Sugar types: (A) regular granulated; (B) superfine granulated; (C) brown.

3.1.2 Quality assessment of other ingredients

Quality checks for sugar (Figure 3.5)

Choose sugar based on use:

- Fine granulated sugar for doughs/batters:
  - Dissolves quickly
  - Creates uniform texture
  - Improves volume
- Coarse sugar:
  - Use in dough/batter may result in undissolved grains, leading to dark crust spots, irregular texture, and syrupy areas
  - Better for clear syrup.

Simple visual test—visual check for color consistency and the presence of lumps or foreign particles.

- Color consistency: Observe the sugar for uniformity in color. Ideally, white sugar should be white and free from any discoloration.
- Presence of lumps/particles: Check for any lumps, foreign particles, or debris within the sugar.
- Moisture: Ensure the sugar is not overly moist, as this can lead to lumping and affect baking results.

Quality checks for yeast

Since yeast is a microorganism, it is important to ensure it is still alive before using it for baking, to be sure it will confer the expected rise and texture to the bread.

Test viability:

1. Pour yeast into sugar syrup or honey
2. Observe bubble formation: more bubbles indicate better activity.

Results:

- If numerous bubbles appear quickly, the yeast is considered viable and active
- If very few or no bubbles form after a few minutes, the yeast may be dead or inactive.

Quality checks for eggs

Use multiple methods to assess egg freshness.

Flotation test (Figure 3.6)

1. Place the egg in a bowl or a wide glass of cold water
2. Observe position:
   - Lying flat = fresh
   - Standing but touching bottom = aging but usable
   - Floating = not fresh.

Sound test (Figure 3.7)

1. Hold to ear
2. Shake gently
3. Sloshing indicates aging, but may still be edible (conduct another test to verify).

Break-out test (Figure 3.8)

1. Break egg (without damaging yolk) onto a plate
2. Check spread:
   - Compact = fresh
   - Spreading = past its peak
3. Examine yolk:
   - Flat/breaks easily = old
   - Moving freely = weakened chalazae.

Odor (smell) test (Figure 3.9)

- Break open egg and smell.

Figure 3.6. Egg freshness floatation test.

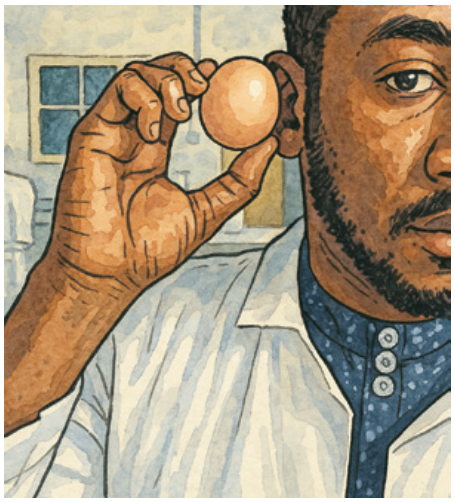

Figure 3.7. Shake egg beside ear to hear if it "sloshes".

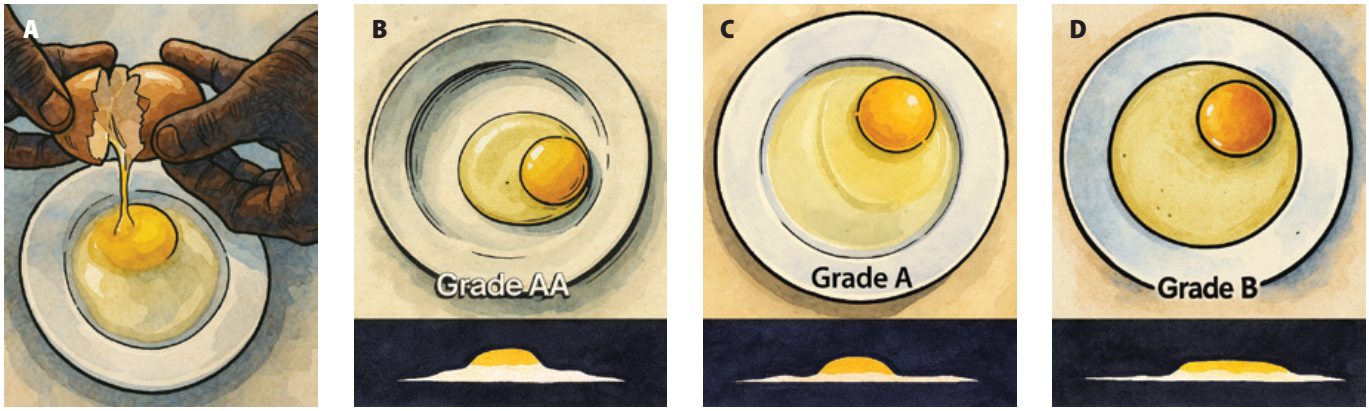

Figure 3.8. Break-out egg freshness test: (A) break egg onto a plate without breaking the yolk; (B) grade AA (fresh) egg; (C) grade A (ageing but edible) egg; (D) grade B (old, not to be used) egg.

Figure 3.9. Egg odor test

SESSION 3.1 KEY TAKEAWAYS

Systematic quality assessment of ingredients is fundamental to consistent bread production and food safety. Simple but effective testing methods allow bakers to evaluate raw materials without specialized laboratory equipment.

Flour quality assessment requires multiple evaluation approaches:

- Physical tests for strength, moisture content, and contamination provide immediate insight into flour functionality
- Sensory checks for odor, taste, and color help identify spoilage or quality issues
- Water-based separation tests reveal impurities and adulterants.

Proper evaluation of supporting ingredients is equally critical:

- Sugar granulation affects solubility and final product texture
- Yeast viability directly impacts fermentation and bread volume
- Egg freshness influences both safety and performance.

Quality assessment must be:

- Systematic and consistent
- Documented appropriately
- Linked to clear accept/reject criteria
- Integrated into standard operating procedures.

Training others in quality assessment requires:

- Clear demonstration of proper techniques
- Understanding of why each test matters
- Practice performing evaluations
- Knowledge of corrective actions when issues are found.

3.2 EQUIPMENT MASTERY

SESSION 3.2 OBJECTIVES

After completing this session, trainers will be able to:

1. Explain the proper operation, maintenance, and basic troubleshooting of key bakery equipment:
   - Mixers (vertical and spiral)
   - Dough divider, sheeter, and molder
   - Proofing cabinet
   - Different types of ovens
   - Bread slicer
   - Small tools and utensils
2. Demonstrate safe operating procedures and teach proper equipment handling techniques
3. Implement systematic equipment cleaning and maintenance schedules
4. Identify when equipment problems require professional service versus in-house maintenance
5. Train others on equipment operations using clear, step-by-step instruction methods suitable for various skill levels.

3.2A BAKERY EQUIPMENT

3.2.1 Mixers

Specifications and selection

Two main types of mixers are used in small- and medium-sized bakeries:

- **Vertical (planetary) mixers:** The vertical or planetary mixer is the most common type. The term "planetary" describes the beater attachment's motion—like a planet, it spins on its axis while rotating in an orbit to reach all parts of the stationary mixing bowl.
- **Spiral mixers:** In spiral mixers, the dough hook and mixing bowl move in opposite directions, automatically scraping dough from the bowl surface during mixing.

Operation

Using a mixing protocol based on trial and error is not good quality management practice. Instead:

- Start mixing at graduated and regulated speeds
- Most bread recipes require mixing dough at particular speeds for optimal gluten development
- This allows proper alignment of both small and large starch granules

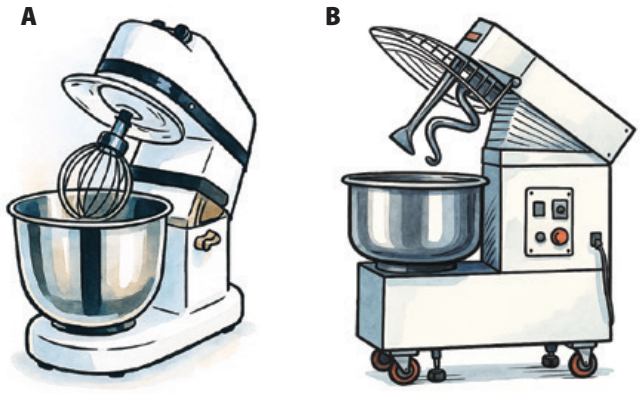

Figure 3.10. Mixers: (A) vertical (planetary); (B) spiral.

- Different starch granule shapes must align for adequate mixing with other ingredients
- Note that bigger granules pose higher resistance during mixing.

Laboratory investigation of flour properties should determine:

- Size of deformation needed
- Required mixing time
- Appropriate temperature
- Proper shear rate (speed of kneading rollers).

These parameters ensure consistent dough quality.

Operating procedure:

- Only trained staff should operate mixers
- Use correct attachment size for mixing bowl
- Secure mixing bowl and attachment firmly before starting
- Use recommended voltage and electrical specifications
- Insert the mixing tool securely into the mixer arm
- Turn off mixer before scraping bowl or inserting mixing tool
- Disconnect from power after use.

The mechanical energy during mixing is crucial for:

- Developing a viscoelastic dough matrix
- Creating the gluten network
- Ensuring uniform distribution of ingredients.

Maintenance

Proper hygiene practices must be followed:

- Clean mixer before and after each use
- Follow systematic cleaning procedures
- Maintain regular cleaning schedule.

Safety precautions

- **Bowl guards:** If the mixer is equipped with bowl guards, use them to protect against accidental contact with moving parts.
- **No loose clothing:** Avoid wearing loose clothing or jewelry that could become entangled in the mixer.
- **Do not touch moving parts:** Never touch moving parts, such as the mixing head, while the mixer is running.
- **Do not insert hand into mixer bowl:** Never reach into the bowl while the mixer is running.
- **Proper cleaning:** Unplug the mixer and remove parts before cleaning.
- **Power off:** Always turn the mixer off and unplug it from the power source before cleaning and when not in use.
- **Machine cooling:** Allow the mixer and any heated components to cool before cleaning or storage.
- **Storage:** Store the mixer in a safe, dry place, away from children and pets.
- **Regular maintenance:** Perform regular inspections and maintenance tasks, such as cleaning and lubricating bearings, as recommended by the manufacturer.
- **Preventive measures:** Use appropriate cleaning and lubrication solutions for the mixer.
- **Troubleshooting:** If you encounter any issues, consult the manual or a qualified technician for troubleshooting.

3.2.2 Dough divider, sheeter, and molder

These three pieces of equipment work together in the bread production process to ensure consistency and efficiency.

A dough divider divides dough into equal portions and shapes them into round balls. This ensures uniform portion sizes for standardized production.

A dough sheeter rolls out portions of dough into sheets of uniform thickness. This uniform thickness is crucial for consistent product quality.

A dough molder rolls and forms pieces of bread dough for standard loaves, baguettes, and rolls, eliminating the need to perform these tasks by hand. This automation helps maintain consistent product shape and appearance.

Figure 3.11. Dough divider (A, B), sheeter (C), and molder (D).

Specifications and selection

The dough divider is mostly used in large bakeries for dividing and shaping dough into round balls.

The dough sheeter consists of a canvas conveyor belt that feeds the dough through a pair of rollers. The rollers must be adjustable to achieve different dough thicknesses.

A dough molder should have the capability to form standard loaves, baguettes, and rolls.

Operation

To make thin sheets with the dough sheeter, pass the dough through the rollers several times. The operator decreases the space between the rollers gradually after each pass, making one to three passes depending on the hardness and springiness of the dough.

For the dough divider:

- Load dough into the hopper
- Machine portions and rounds automatically
- Collect divided pieces for next step.

For the molder:

- Feed portioned dough pieces into machine
- Monitor shaped products coming out
- Transfer shaped products to proofing area
- **Safety:** Use only approved lubricants, avoid using water jets for cleaning, and ensure proper maintenance and service by qualified technicians
- **Maintenance:** It is recommended that the machine is serviced annually and that users avoid tampering with the mechanical or electrical systems.

Maintenance

Follow manufacturer's guidelines and industry best practices.

Troubleshooting

Refer to manufacturer's guidelines and industry best practices.

3.2.3 Proofing cabinet

Equipment specifications

Proofing cabinets, also known as proofer ovens, are available in three types:

- Electric models
- Gas models
- Pressure steam models.

Figure 3.12. Proofing cabinet.

Since proofing cabinets can be of different sizes and materials of construction (stainless steel or aluminum frames, and glass), specifications should include:

- Dimensions and capacity
- Power requirements
- Construction materials
- Control panel features.

Operation

The proofing cabinet works by controlling temperature and humidity within the chamber. Control knobs are often available to preset the temperature and humidity. The warmth and humidity cause yeast to activate and more carbon dioxide to be produced.

This creates optimal conditions for:

- Even dough development
- Consistent fermentation
- Prevention of surface drying.

For advanced operations, retarder proofers (proofers that keep dough frozen, cold, or cool to delay fermentation) allow:

- Shaping bread in the evening for later baking
- Automatic temperature adjustment for programmed baking times
- Freezing shaped bread to stop yeast function
- Bringing dough to a cold but not frozen state
- Raising temperature and humidity for proper proofing.

Maintenance

Key maintenance aspects should include:

- Daily cleaning procedures
- Temperature calibration
- Humidity system maintenance
- Seal inspection and replacement
- Preventive maintenance schedule.

Troubleshooting

Common issues to address:

- Unwanted water condensation
- Germs and microbial contamination on inner surfaces
- Temperature control problems
- Humidity system failures
- Door seal issues
- Control panel malfunctions
- Uneven proofing conditions
- Emergency shutdown.

3.2.4 Ovens

The correct temperature for baking bread depends on the type of bread and desired crust. Generally, lean-dough breads such as baguettes are baked at 230–273 °C (446–523 °F) with steam. "Nigerian" or "British" style bread is typically baked at 200 °C (392 °F).

Purpose

An oven provides a controlled hot environment for baking bread. Dough is transferred into the oven that has been preheated to the desired temperature, as required by the type of bread. The starch is gelatinized and proteins further denatured at an internal temperature of 60–80 °C. The carbon dioxide trapped in the dough during fermentation expands causing the dough to rise further while the coagulation of the gluten fixes the size and shape of the loaf. The bread produced this way is usually palatable, light, and has a spongy texture.

Specifications and selection

Several types of ovens are used in modern bakeries.

Deck oven

- Large enclosed baking chamber having one or more shelves or decks
- Uses gas or electricity for heating
- Uses forced hot-air circulation to spread heat uniformly across the baking chamber
- Suitable for bread, biscuits, pizza, pastries, and other items requiring even cooking
- Ensures consistent results across all shelves.

Rack oven

- Large oven into which entire racks full of sheet pans can be wheeled for baking
- Standard racks hold 10 or more pans
- Holds 1 to 4 racks at once
- Often equipped with steam injectors
- Available in gas and electric models.

Mechanical oven

- Dough is in motion while it bakes
- The most common type is a revolving oven: the mechanism is like a Ferris wheel
- Mechanical action eliminates hotspots or uneven baking through rotation
- Can be equipped with steam injectors
- Particularly suited to high-volume operations.

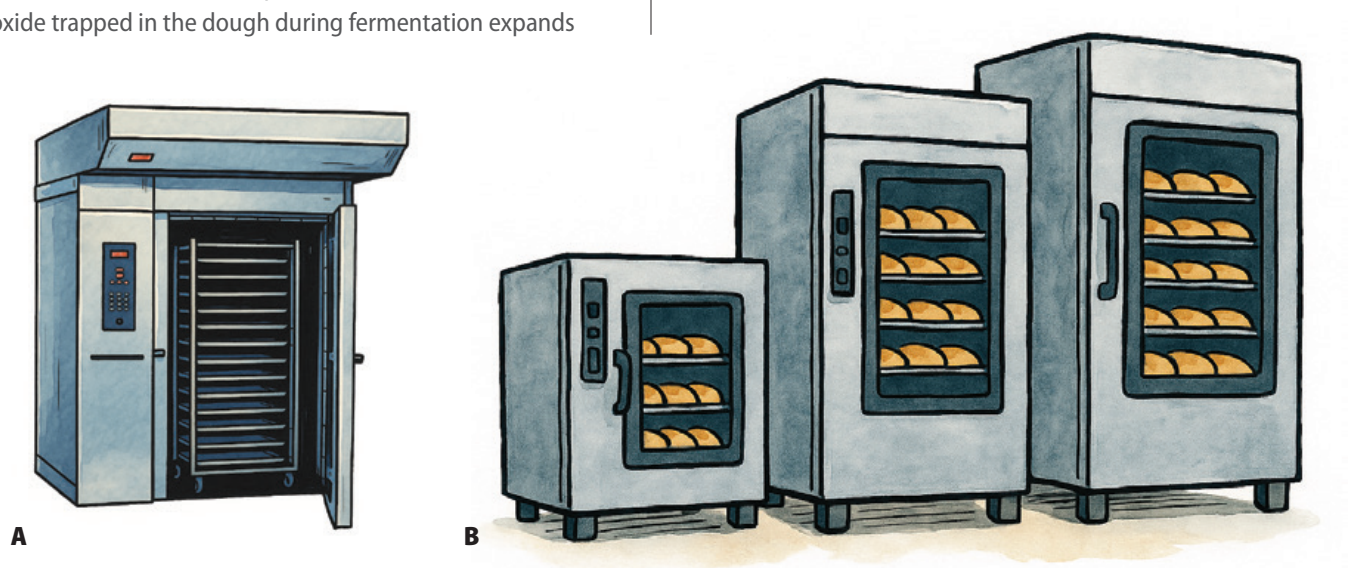

Figure 3.13. Gas (A) and electric (B) rack ovens.

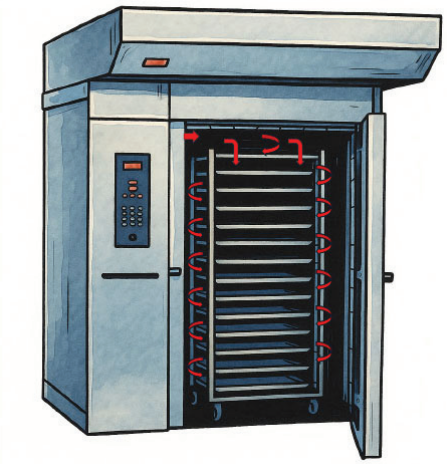

Figure 3.14. Air circulation in a rack oven.

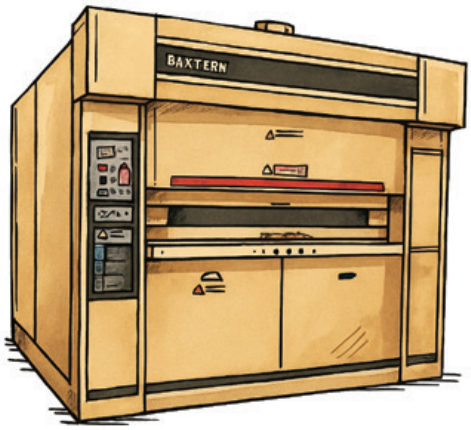

Figure 3.15. Mechanical oven.

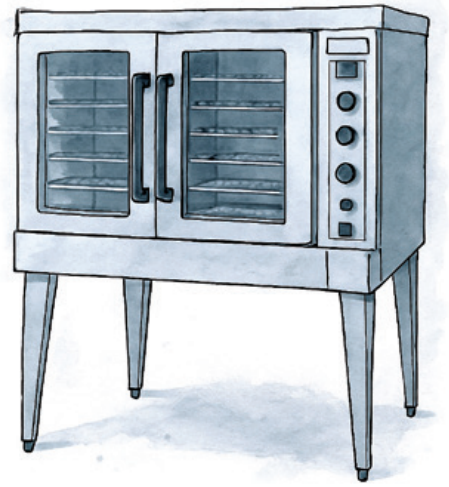

Figure 3.16. Convection oven.

Figure 3.17. Air circulation in a convection oven.

Convection oven

- Contains fans that circulate air and distribute heat rapidly throughout the interior
- Foods cook more quickly at lower temperatures due to forced air
- Strong forced air can distort items made with batter or soft dough
- Airflow may be strong enough to blow baking parchment off sheet pans
- Not as versatile as other kinds of ovens.

Hot air is forced into the oven via the fan, which also keeps the air moving within the chamber. Additional heat transfer by convection from the hot inner walls.

Operation

- Baking temperature range: 200° C / 230–273 °C
- Standard baking time: 15 minutes for bread
- Requires preheating before loading dough
- Temperature and timing management are critical for quality results.

3.2.5 Bread slicer

Specifications and selection

A tabletop slicer slices one loaf of bread at a time and operates on single-phase power. A gravity slicer can slice up to 20 loaves per minute and works with three-phase power supplies.

Hot bread shops and mini bakeries use tabletop slicers, while bigger commercial bakeries use gravity slicers.

3.2.6 Small utensils and equipment

Small utensils and equipment are essential tools for efficient bread production. Each serves specific functions in the bread-making process.

Specifications and selection

Work table

- Options include wooden or stainless steel tables
- Maple wood is nonporous and very hygienic

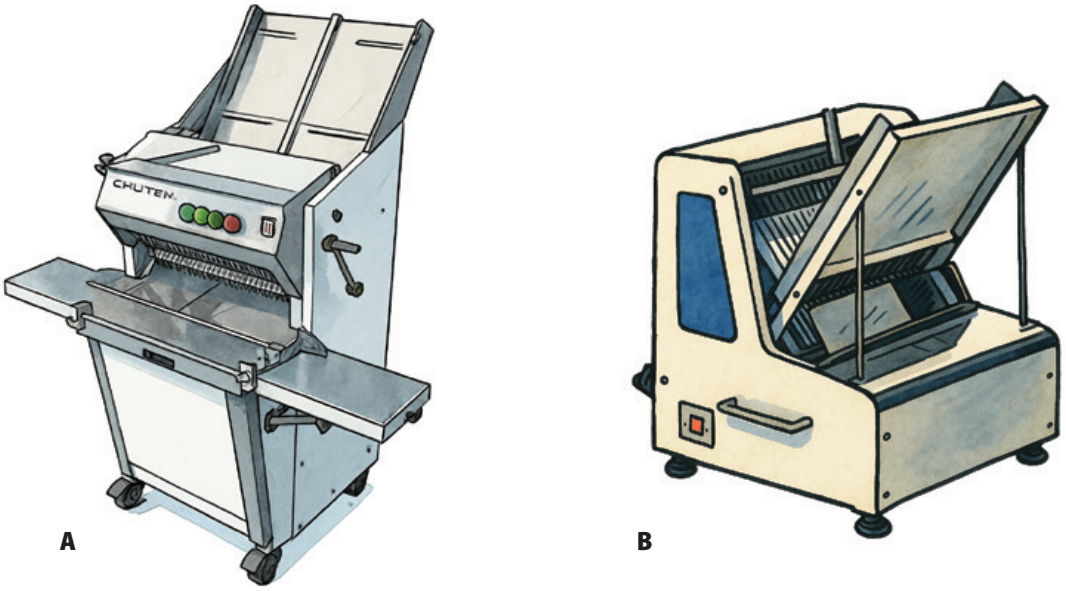

Figure 3.18. Bread slicers: (A) gravity, (B) tabletop.

- Wood is a poor conductor of heat and hence does not take heat from or give heat to the dough
- Dough rarely sticks to wooden surfaces
- Granite or marble table tops are alternatives where wood is either not available or expensive
- Iron is not recommended because it can react with the dough and discolor it.

Weighing scale

- Purpose: Ensures accurate measurement of ingredients
- Essential for consistent product quality.

Sieve

- Manual aluminum sieve available
- For whole-grain flour, use a coarse mesh to retain bran and other nutritious components
- Purpose: Separates coarser materials from finer flour particles.

Dough scraper

- Used to scrape the dough and cut the dough into different sizes
- Available in plastic or steel materials.

Dough scorer

- Features a sharp blade at one end
- Used to score the bread at an angle before baking.

Baking trays/pans

- Available in stainless steel, iron, or Teflon-coated for nonstick trays/pans.

Pastry brushes

- Purpose: For applying glazes, coatings, or washes.

Long-handled wooden spatulas/paddles

- Purpose: For handling dough and products.

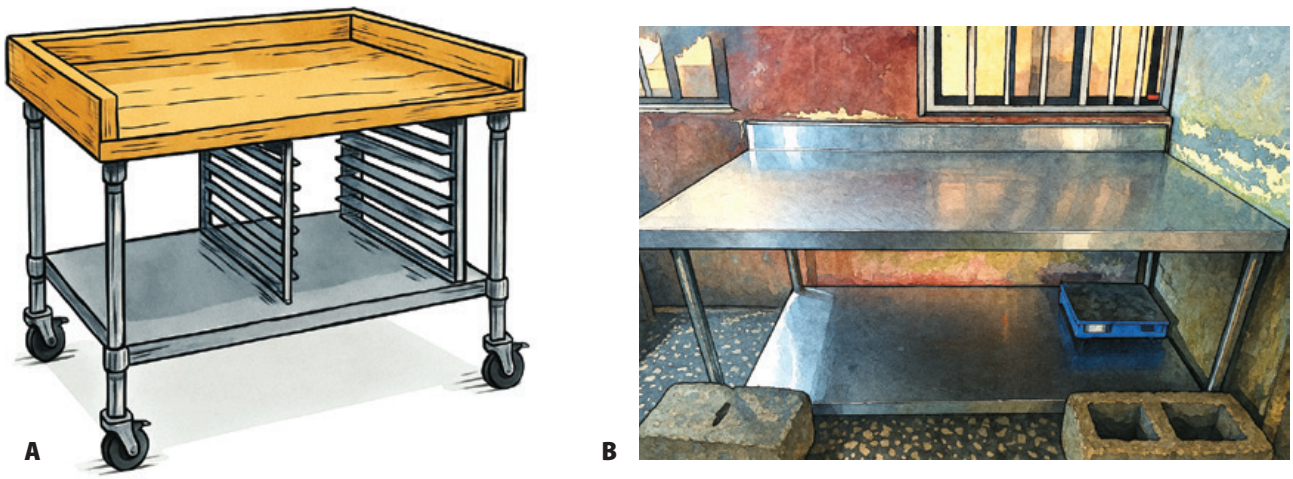

Figure 3.19. Work tables: (a) wooden tabletop; (b) stainless steel tabletop.

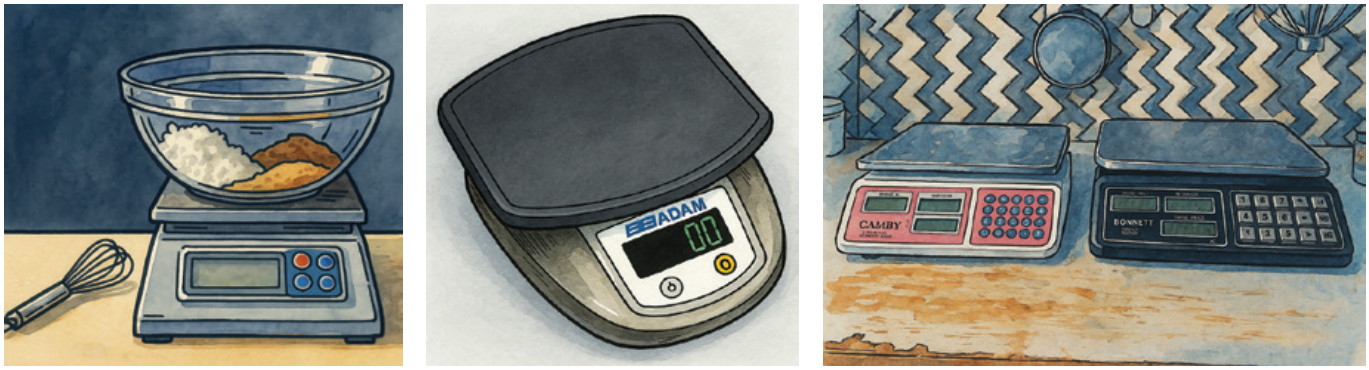

Figure 3.20. Digital weighing scales (various models).

Figure 3.21. Metal sieves (assorted).

Figure 3.22. Dough scraping.

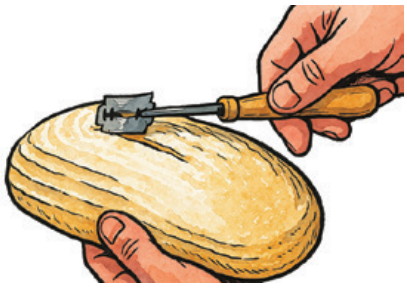

Figure 3.23. Dough scoring.

Figure 3.24. Baking tins: (A) loaf tins; (B) baguette tray (small); (C) muffin tin/tray for cupcakes; (D) cake tins (various shapes and sizes).

Plastic basins

- Purpose: For dough preparation and handling; containing water
- Medium size for bread processing.

Wooden trays

- Purpose: For product handling.

Quality requirements

When selecting small utensils and equipment:

- Equipment must be clean and sound
- Materials should be food-grade quality
- Items should be appropriate for commercial bakery use.

3.2B CASSAVA PROCESSING EQUIPMENT

3.2.7 Cassava graters

Mechanical grater (also used for granulation)

Cassava graters use a combination of impact, shear, and grinding forces to break down peeled cassava roots into a pulp or mash. This is typically achieved with a rotating drum or saw blade and a mesh or sieve that allows the desired size of the mash to pass through, while larger cassava root pieces are re-grated. The necessary force can be applied with an electric, petrol, or diesel-powered motor. The peeled cassava is usually fed into the grating machine through a hopper.

Pre-operation checks

- Ensure the grating surface is sharp and the rotating grating sheet drum is securely fastened
- Check the motor and belts for wear or damage
- Confirm electrical connections are safe and secure
- Clean the hopper and grating area.

Start-up

- Power on the motor or diesel engine
- Run the machine briefly without a load to confirm smooth operation
- Begin feeding peeled cassava roots gradually into the hopper.

Figure 3.25. Mechanical cassava grater.

Operation

- Maintain steady feeding to prevent clogging
- Use feeding tools, not hands, to push cassava roots
- Continuously check pulp output for uniformity.

Shut down

- Stop feeding cassava
- Allow the machine to clear the remaining material
- Power off the machine
- Clean the grating drum and remove the cassava mash residue.

Safety guidelines

- Never insert hands or metal objects into the hopper
- Always wear gloves, goggles, and ear protection
- Keep the machine area dry to prevent electrical hazards
- Do not operate with missing or damaged safety guards.

Troubleshooting

ISSUE	POSSIBLE CAUSE	SOLUTION
Low output	Dull blades	Sharpen or replace blades
Machine vibrates excessively	Unbalanced drum or loose fittings	Rebalance drum, tighten parts
Clogged hopper	Feeding too fast or wet tubers	Slow feed rate, drain tubers
Motor overheating	Prolonged use or overload	Allow to cool, reduce load

3.2.8 Cassava dewatering press

The pressing machine is used in cassava processing to remove excess water from grated cassava, thereby improving drying efficiency and product quality. The pressing machine uses hydraulic pressure to remove water from grated cassava. This process reduces moisture content, preparing the pulp for further processing, such as drying. The pressing machine may be a screw or hydraulic type. It includes a pressing chamber, a pressing plate or screw, a motor or hydraulic system, and a collection tray for expelled water.

Pre-operation checks

- Check for hydraulic leaks or screw wear
- Ensure press plates/baskets are clean
- Confirm the motor or hydraulic pump is functional
- Clean pulp trays and ensure drains are open.

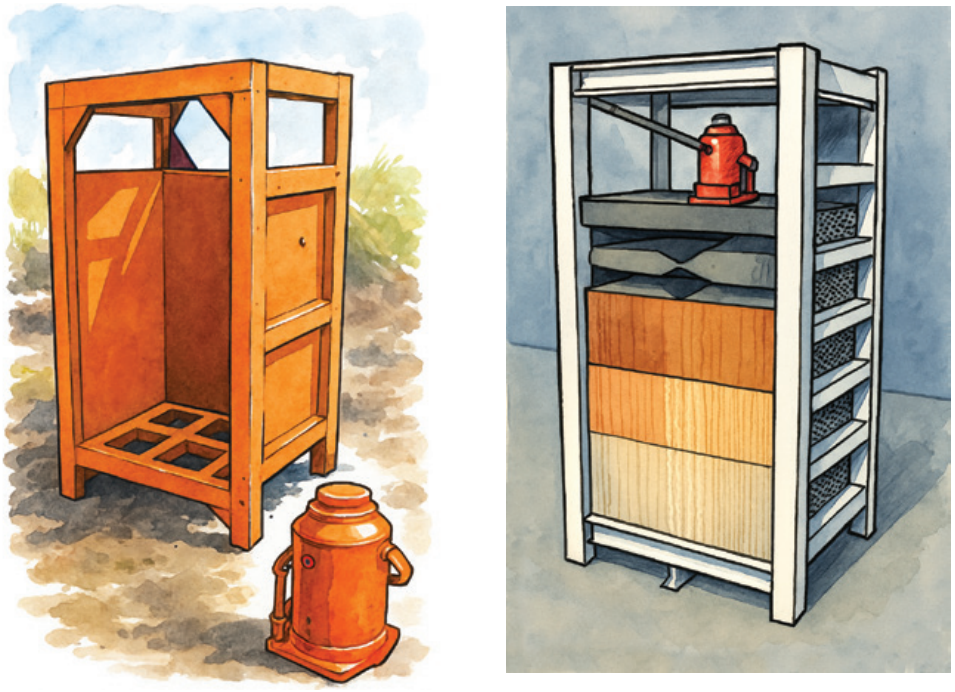

Figure 3.26. Cassava dewatering presses.

Start-up

- If a hydraulic-type pressing machine is used (not illustrated), power on the machine
- Perform a short test cycle without a load
- Load grated cassava mash into the pressing chamber.

Operation

- Activate the press to begin dewatering
- Monitor pressure levels (avoid exceeding design limit)
- Collect expelled water for treatment or disposal
- Once pressing is complete, release the pressure.

Shut down

- Remove pressed cassava cake
- Power off the machine
- Clean pressing chamber, plates, and drainage area.

Safety guidelines

- Wear gloves, aprons, and safety boots
- Do not open the pressing chamber under pressure
- Use caution with hydraulic systems
- Avoid loose clothing around moving parts.

Troubleshooting

ISSUE	POSSIBLE CAUSE	SOLUTION
Low pressure	Hydraulic fluid low or leak	Refill or repair system
Incomplete pressing	Overload or short cycle	Reduce load, extend cycle time
Leaking water tray	Blocked drain or damaged tray	Clear drain or repair tray
Loud operation	Worn mechanical parts	Inspect and replace parts

3.2.9 Cassava dryers

The flash dryer—a critical component in the cassava processing line—is used to rapidly dry cassava flour or starch to a safe moisture content for storage and further processing. A flash dryer operates on the principle of rapid moisture evaporation by exposing wet material to high-velocity hot air for a very short time, causing near-instantaneous drying. The material is typically suspended within the hot air stream, maximizing heat contact with the cassava particles' surface area and facilitating rapid heat transfer for moisture removal. The dried material is then separated from the air stream using cyclones or bag filters.

The flash dryer system consists of a hot-air generator, blower, drying column, cyclone separator, and product collection system. The system operates by introducing moist cassava grits into a hot air stream, causing instant drying as the material is suspended and conveyed through the drying column.

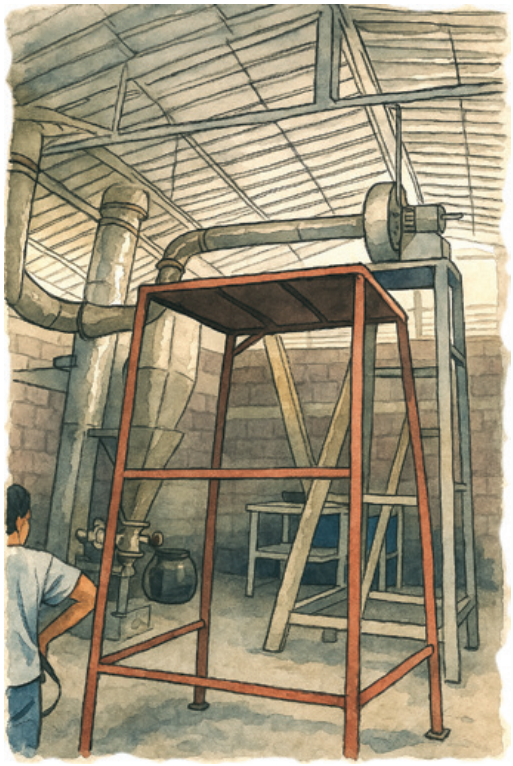

Figure 3.27. Cassava flash dryers.

Pre-operation checks

- Inspect all components (blower, furnace, cyclone, pipes) for physical damage
- Ensure that all fasteners are tight, and guards are in place
- Check power supply and fuel levels for the heat source
- Confirm that the input product is at a suitable moisture level.

Start-up

- Power on the blower and set airflow
- Ignite the furnace and set to operating temperature (180–200 °C)
- Allow system to stabilize for 5–10 minutes
- Begin feeding moist cassava grits into the drying column when the temperature rises above 100 °C.

Operation

- Maintain steady feed rate to avoid under- or overdrying
- Monitor outlet air temperature (should be about 90–100 °C)
- Continuously observe the cyclone separator for proper product discharge
- Adjust airflow or heat level as necessary to maintain performance.

Shut down

- Stop feeding material
- Allow air flow to continue for 5 minutes to cool the system
- Turn off the blower and heating unit
- Clean residual products from the system.

Safety guidelines

- Always wear personal protective equipment (PPE): gloves, goggles, dust mask, ear protection
- Do not open access panels during operation
- Keep fire extinguishers accessible near the furnace
- Ensure ventilation in the working area.

Troubleshooting

ISSUE	POSSIBLE CAUSE	SOLUTION
Low drying efficiency	High moisture in input or low heat	Check feedstock, adjust temperature
Blocked pipes	Product build-up	Stop operation and clean pipes
Overheated product	High temperature	Reduce furnace heat setting
No product output	Cyclone clogged	Inspect and clean cyclone

3.2.10 Cassava mill

A hammer mill is used to mill dried cassava grits into fine flour suitable for baking. It relies primarily on impact and friction between the material, the hammers, and the mill casing to achieve the desired particle size. Multiple rotating hammers cause impact and friction to break the dried cassava grits into fine particles. The mill forces the finest milled particles to pass through a sieve or screen of predetermined aperture size to produce a fine flour.

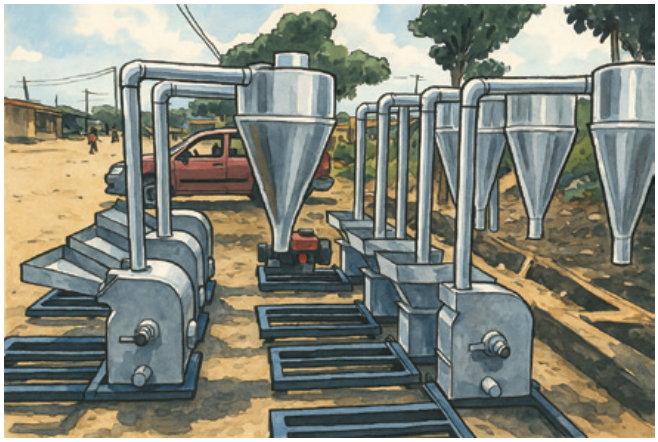

Figure 3.28. Cassava mill.

Pre-operation checks

- Inspect hammers and screen for wear or damage
- Ensure the feed hopper is clean and free from blockages
- Check electric motor, belts, and power connections
- Secure all covers and safety guards.

Start-up

- Power on the electric motor or diesel/ petrol-powered engine
- Operate the machine empty for at least 2 minutes to confirm smooth rotation
- Introduce the dried cassava grits slowly into the machine through the hopper.

Operation

- Feed material steadily; avoid overloading
- Monitor particle output to ensure consistent size
- Stop adding the dried cassava if the machine vibrates or makes an unusual noise.

Shut down

- Stop adding the dried cassava
- Allow the mill to run empty for a minute to clear the chamber
- Power off the machine
- Clean internal chamber and screen.

Safety guidelines

- Wear safety glasses, a dust mask, and ear protection
- Never open machine covers while in operation
- Do not use wet or damp cassava in the dry hammer mill
- Keep hands and tools away from the feed hopper.

Troubleshooting

ISSUE	POSSIBLE CAUSE	SOLUTION
Uneven flour size	Damage to the mesh	Repair mesh/use appropriate mesh size
Motor overload	Overfeeding or hard material	Reduce feed rate
Excessive noise	Loose hammers or bearings	Tighten or replace components
Poor output	Blocked screen or blunt hammers	Clean or replace parts

3.2C GENERAL EQUIPMENT PROTOCOLS

In a bakery operation, proper equipment management directly affects product quality, operational efficiency, and food safety. This section outlines the key protocols for equipment use and maintenance.

Purpose and roles

Each piece of bakery equipment serves specific functions in transforming raw ingredients into quality bread:

- Mixers combine ingredients and develop the dough structure through controlled mixing and kneading
- Dough dividers ensure consistent portioning
- Molders form the dough pieces into standard shapes
- Proofing cabinets provide a controlled temperature and humidity for optimum fermentation
- Ovens apply precise heat for baking
- Slicers prepare the final product for sale.

Standard cleaning and sanitization procedures and schedules

Rule 1: Disassemble and thoroughly clean all surfaces that come in contact with dough after each shift.

Rule 2: Read the manual to ensure you are completely disassembling all parts of the machine.

Rule 3: Use approved and correct cleaning agents.

Rule 4: Perform a deep cleaning of the equipment at least once a month to sanitize any crevices that might get neglected during routine daily cleaning.

Rule 5: Stock spare parts that undergo significant wear and tear.

Rule 6: Follow a disciplined sanitation schedule and ensure all waste is disposed of properly.

Rule 7: Remember that all bread-making equipment is designed with efficiency and cleanliness in mind; do not break the chain.

See also section 3.8.2 for a sample cleaning schedule.

Safety compliance documentation

Document safety compliance (see example compliance form in Fig. 3.29). If action is required, the supervisor should prepare an action plan with a timetable. Once complete, file the forms safely.

Maintenance record-keeping

For equipment maintenance:

- Damaged or worn-out machinery parts can have uneven surfaces that allow microbes and crumbs to settle into the crannies
- Replace worn-out parts
- Conduct regular inspections and maintenance of equipment
- Promptly repair or replace damaged equipment to prevent contamination.

Equipment name: _____ **Serial number/ID:** _____

Date: _____ **Inspector name:** _____

Pre-operation safety check

Physical condition

- ☐ Equipment is free from visible damage
- ☐ All guards and safety devices are in place
- ☐ Emergency stop button functions correctly
- ☐ Electrical cords and plugs are intact
- ☐ Moving parts are properly secured

Operational safety

- ☐ Equipment operates smoothly without unusual noise
- ☐ All controls function as intended
- ☐ Warning labels are visible and legible
- ☐ Adequate workspace around equipment
- ☐ Proper ventilation in operating area

Hygiene compliance

Cleanliness status

- ☐ All surfaces that contact dough are clean
- ☐ No visible residue from previous use
- ☐ Equipment free from dust and debris
- ☐ Surrounding area is clean and organized
- ☐ No signs of pest activity

Sanitation verification

- ☐ Equipment disassembled per manufacturer guidelines
- ☐ Approved cleaning agents used
- ☐ All parts thoroughly cleaned and dried
- ☐ Deep cleaning performed (if monthly schedule)
- ☐ Cleaning documented in logbook

Staff compliance

Operator verification

- ☐ Operator trained on this equipment
- ☐ Wearing appropriate protective equipment
- ☐ Following proper hygiene protocols
- ☐ Aware of emergency procedures
- ☐ Training records on file

Corrective actions required:

Issue identified: _____

Action taken: _____

Follow-up needed: _____ Yes _____ No

Target completion date: _____

Certification: I certify that this equipment has been inspected according to established safety and hygiene protocols.

Inspector signature: _____ Date: _____

Supervisor review: _____ Date: _____

Next scheduled inspection: _____

This form must be completed daily before first use and filed in accordance with facility record-keeping procedures.

Figure 3.29. Sample safety and hygiene compliance form.

SESSION 3.2 KEY TAKEAWAYS

Critical equipment knowledge

- Proper equipment selection, operation, and maintenance directly impact product quality, operational efficiency, and food safety
- Each piece of equipment serves specific functions requiring distinct operational protocols and safety considerations
- Systematic documentation of equipment specifications, maintenance schedules, and operational procedures is essential.

Operational competency

Equipment operators must demonstrate a thorough understanding of:

- Proper assembly/disassembly procedures
- Operating parameters and controls
- Safety features and emergency protocols
- Cleaning and sanitization requirements
- Regular calibration and monitoring ensure consistent performance and compliance with food safety standards.

Maintenance management

- Implement preventive maintenance schedules to avoid equipment failures and maintain optimal performance
- Establish clear protocols for routine cleaning, inspection, and parts replacement
- Document all maintenance activities and equipment issues for traceability and continuous improvement.

Safety and training

- Comprehensive staff training programs must cover both theoretical knowledge and hands-on skills
- Regular assessment of operator competency helps maintain safety standards and product quality
- Clear communication channels for reporting equipment issues and safety concerns are vital.

3.3 INGREDIENT STORAGE AND HANDLING

SESSION 3.3 OBJECTIVES

After completing this session, trainers will be able to:

1. Implement proper storage systems for all bakery ingredients, including:
   - Temperature control requirements
   - FIFO (first-in first-out) procedures
   - Shelf-life monitoring
   - Prevention of cross-contamination
2. Demonstrate correct handling procedures for different ingredient types, with special attention to temperature-sensitive and potentially hazardous ingredients
3. Set up and maintain an effective ingredient organization system that ensures food safety and quality
4. Teach proper storage and handling protocols to bakery staff using clear, practical instruction methods.

Proper storage and handling of ingredients is fundamental to maintaining quality and safety in bread and pastry production. This section outlines key protocols for ingredient management in bakeries.

3.3.1 Ingredient storage requirements

Storage organization

- Clearly label store room shelves and areas
- Store different ingredients separately, with some air space between
- Keep sacks on pallets for air circulation, cleaning, and hygiene (reduced accessibility of sacks to pests and other contaminants).

Temperature control

- Store ingredients at appropriate temperatures
  - Keep chilled products (i.e., eggs and yeast) at or below 4 °C.
- For eggs:
  - Store at a cool temperature

If storing at room temperature, use the current batch and replenish stocks daily.

- For yeast:
  - Store an open package of unused yeast in a refrigerator
  - Store an unopened package of yeast in a refrigerator or freezer for long-term storage.

First-in, first-out (FIFO) implementation

Adopt the FIFO approach for all ingredients

- Do not use ingredients beyond their best-before date
- Place new stock behind old stock to avoid the risk of ingredients going beyond best-before date
- Keep invoices of ingredients purchased for traceability purposes.

Packaging requirements

- Use clean packaging to pack products
- Use only recommended packaging materials
- Ensure packages are clean and sound
- Packages must be free from insects and fungal infestation
- Packaging must safeguard:
  - Hygienic qualities
  - Physical integrity
  - Organoleptic qualities
- Packaging materials must not impart:
  - Toxic substances
  - Undesirable odors
  - Undesirable flavors.

3.3.2 Environmental control

Moisture prevention measures

- Store flour and other dry ingredients in sealed, airtight, moisture-resistant packaging
- Keep storage environment humidity low (< 70%)
- Maintain environment at moderate temperature (< 30 °C)
- Conduct regular monitoring and inspection.

Pest control protocols

- Have an effective pest control program
- Conduct regular inspections
- Practice good waste management
- Follow cleaning schedule.

Cross-contamination prevention

- Use clean gloves when handling raw materials and bread products.
- For egg handling:
  - Ensure eggshells are not cracked upon receipt
  - Discard cracked eggs
  - Pool only the number of eggs required
  - Use all pooled liquid egg on the same day
  - Do not top up with new eggs
  - Prepare raw eggs away from other ingredients

  - Wash hands, utensils, and surfaces thoroughly with soap and water after handling eggs.
- Clean equipment, utensils, and bread preparation surfaces thoroughly with soap and water after every step.
- Clear crumbs left after slicing products.
- Display bread in clean display cases, covered at all times.
- Time/date stamp bread to inform consumers of "best before" date.

3.3.3 Record-keeping

See section 3.8.3.

SESSION 3.3 KEY TAKEAWAYS

Proper storage systems are fundamental to maintaining ingredient quality and safety throughout the bread production process. Implementation requires systematic temperature control, robust FIFO procedures, and continuous monitoring protocols.

Temperature control represents a critical control point requiring specific management:

- Chilled products must be maintained at or below 4 °C
- Room temperature storage requires daily batch management and stock rotation
- Regular temperature monitoring and documentation ensure compliance.

Cross-contamination prevention demands multibarrier approaches:

- Physical separation of ingredients
- Dedicated preparation areas
- Proper handling protocols, especially for high-risk ingredients such as eggs
- Regular sanitation of storage areas and equipment.

Documentation and traceability systems are essential for quality assurance:

- Maintain detailed ingredient purchase records
- Monitor and document storage conditions
- Track batch usage and rotation
- Conduct regular audits of storage practices.

Storage area organization must support both operational efficiency and food safety:

- Clear zone designation for different ingredients
- Proper airflow and environmental controls
- Easy access for cleaning and inspection
- Visual management systems for stock rotation.

This systematic approach integrates food safety principles with practical operational considerations, providing a framework that trainers can use to guide implementation in various bakery settings.

3.4 RECIPE FORMULATION AND ADAPTATION

SESSION 3.4 OBJECTIVES

After completing this session, trainers will be able to:

1. Calculate and adapt bread recipes for different batch sizes while maintaining proper ingredient proportions
2. Adjust mixing protocols for different equipment types and environmental conditions
3. Modify water absorption and mixing times based on flour composition and local conditions
4. Guide bakers in adapting recipes based on:
   - Local climate conditions
   - Equipment variations
   - Production scale
   - Product specifications
5. Teach systematic approaches for recipe documentation and optimization.

3.4.1 Recipe management

The success of bread production using cassava–wheat composite flour depends on precise recipe formulation and careful adaptation to consumers' quality preferences and national standards or specifications for permitted ingredients.

It is important and valuable to know that with substitution levels up to 10%, bakers do not have to change the amounts of other ingredients in their tried-and-tested or standard bread recipes.

Standard recipe calculations

Two standard recipes from DRC demonstrate formulations for bread-making cassava–wheat composite bread using 10% BCF substitution.

Batch size adjustments

When scaling recipes, consider the various ratios of ingredients in mixes that give the best loaves of bread preferred by the consumers, depending on bread type and oven-baking parameters of the bakery.

Some examples from artisanal bakeries in DRC based on 45 kg cassava–wheat composite flour per batch for making baguettes:

- US$15 per 100 loaves of bread: 86–97 g of dough yields an 82–87 g bread loaf
- US$25 per 100 loaves of bread: 122–193 g of dough yields a 115–160 g bread loaf
- US$50 per 100 loaves of bread: 234–366 g of dough yields a 197–312 g bread loaf
- An average dough-to-bread ratio of 0.88
- Composite flour-to-dough ratio of 0.98
- Water-to-composite flour ratio of 0.54–0.67.

Digital weighing scales are recommended for measuring ingredients. Regular calibration and proper handling of scales ensure recipe accuracy and product consistency.

Water absorption modifications

The water absorption criteria are fundamental for proper dough consistency:

- Starch and protein content affect water absorption
- Understanding flour composition helps predict mixing outcomes
- Composite flour presents two types of starch (cassava and wheat) requiring careful water adjustment.

Mixing methods affect water absorption:

- By hand in a wooden box (traditional method)
- Using a mechanical kneader
- Adjust water content based on mixing method, ingredient combinations, consumer preferences, and local conditions.

Table 3.1. Example recipes from DRC based on the commercial weight of a bag of flour.

INGREDIENT	RECIPE 1	RECIPE 2
Wheat flour (kg)	45	45
BCF (kg)	5	5
Yeast (g)	300	900
Salt (g)	43.5	60
Water (liters)	25	30
Sugar (g)	0	80
Baking powder (g)	0	50
Colorant (g)	0	25
Vegetable oil (liters)	0	1

Mixing time adaptations

Start mixing at a graduated and regulated speed to allow proper alignment of starch granules. Important factors:

- Even distribution of ingredients through systematic mixing
- Development of gluten network through proper kneading
- Mixing method influences mixing time:
  - Hand mixing in a wooden box
  - Mechanical mixer and kneader
  - Monitor dough development for consistent texture and gluten formation.

3.4.2 Environmental considerations

Temperature impact assessment

- Fermentation temperature optimal range: 20–30 °C
- In practice, fermentation times vary; the following were observed among 12 bakers in DRC:
  - Shortest observed: 1 hour
  - Longest observed: 3 hours
- Case study example:
  - Baking temperature: 245–273 °C
  - Baking time: 15 minutes
- Oven types affect temperature management:
  - Bakers often judge the temperature by intuition/experience before loading the dough for baking
  - Temperature inside wood-fired brick ovens is more difficult to control during baking
  - Often, there is temperature variability in the different sections of the oven, requiring the oven to be opened during baking intermittently to change the position of each dough pan
  - After baking, loaves may not have uniformity in extent of cooking, color, and volume.

Humidity control measures

While steam injection in deck and rotary ovens is easy to use to achieve the precise level of humidity desired in the oven, water has to be sprayed into earthenware ovens to adjust the inner humidity.

Recipe variations and baking operation control

Field experience from different small bakeries in DRC shows variations in:

- Ingredient proportions
- Fermentation times
- Final dough weights
- Product types and sizes.

However, this variation leads to similar baking process outcomes:

- An average dough-to-bread ratio of about 0.88
- Composite flour-to-dough ratio of about 0.98
- Water-to-composite flour ratio of 0.54–0.67.

Thus, small bakeries can meet consumer quality preferences through local baking ingenuity, ingredients, and process manipulations consistent with each bakery's facility. Baker feedback indicates:

- Bread taste consistently meets consumers' expectations
- Product weight is satisfactory
- Good texture is achieved with proper fermentation management
- Products sell well in the market
- Some products show shrinkage after baking
- Color variations noted in final products.

Recipe information:

Recipe name: _____

Current batch size: _____ kg total flour Current yield: _____ loaves

New batch calculation:

Desired batch size: _____ kg total flour

Scaling factor calculation:

$$\frac{\text{Desired flour (kg):}\ \_\_\_\_\_}{\text{Current flour (kg):}\ \_\_\_\_\_} = \_\_\_\_\_ \text{ (scaling factor)}$$

Expected yield: _____ loaves

Ingredient quantities:

Ingredient	*Current quantity*	*Calculation (current quantity × scaling factor)*	*New quantity*
Wheat flour (kg)	_____	_____ × _____ =	_____
Bread-making cassava flour (BCF) (kg)	_____	_____ × _____ =	_____
Total flour (kg)	_____	_____ × _____ =	_____
Yeast (g)	_____	_____ × _____ =	_____
Salt (g)	_____	_____ × _____ =	_____
Sugar (g)	_____	_____ × _____ =	_____
Fat/oil (L or kg)	_____	_____ × _____ =	_____
Water (L)*	_____	_____ × _____ =	_____
Other:	_____	_____ × _____ =	_____

** Remember to have more than the calculated amount of (clean) water available, but be prepared to use less or more than the calculated amount to obtain correct dough hydration and consistency.*

Production notes (original recipe):

Mixing time: _____ minutes Fermentation time: _____ hours

Baking temperature: _____ °C Baking time: _____ minutes

Dough piece weight: _____ g per loaf

Quality check:

☐ All ingredients measured accurately

☐ BCF meets quality standards (white, odorless, fine texture)

☐ Proper mixing achieved

☐ Target dough consistency reached

☐ Expected yield achieved

Notes: _____

_____

Date: _____ Baker: _____

Remember: When using 10% BCF substitution, maintain all other ingredient proportions from your standard recipe.

Figure 3.30. Recipe scaling worksheet for cassava–wheat composite flour bread.

SESSION 3.4 KEY TAKEAWAYS

- Recipe calculations require systematic attention to proportions when scaling production volumes. The successful substitution of wheat flour with BCF demands precise measurement and careful adaptation to maintain product quality and consistency.
- Water absorption management is critical for proper dough development when using composite flour. The presence of both cassava and wheat starches requires careful adjustment of hydration levels based on:
  - Flour composition and protein content
  - Mixing method and equipment type
  - Local environmental conditions
  - Consumer preferences.
- Standard recipes from DRC demonstrate viable approaches for 10% BCF substitution, with documented success in commercial settings. These provide validated starting points for:
  - Ingredient proportions
  - Processing parameters
  - Final product specifications.
- Environmental factors significantly impact fermentation and proofing. Key parameters requiring monitoring and adjustment include:
  - Temperature control (optimal range 20–30 °C)
  - Fermentation timing (typically 1–2.5 hours)
  - Humidity levels
  - Equipment variations.
- Systematic documentation of recipe modifications and outcomes enables continuous improvement and consistent quality. Critical elements include recording:
  - Ingredient adjustments
  - Processing modifications
  - Product quality results
  - Customer feedback.

This section emphasizes the scientific principles underlying successful cassava–wheat composite flour bread production while providing practical guidance for implementation in diverse bakery settings.

3.5 PRODUCTION TECHNIQUES

SESSIONS 3.5 AND 3.6 OBJECTIVES

After completing these sessions, trainers will be able to:

1. Guide bakers through systematic blending, mixing, kneading, fermentation, and baking procedures for cassava–wheat composite bread
2. Demonstrate proper techniques for:
   - Dough development and handling
   - Fermentation monitoring
   - Temperature and timing management
   - Product quality assessment
3. Troubleshoot common production issues and teach corrective actions
4. Train others to consistently achieve quality standards in bread production using available equipment.

3.5.1 BCF–wheat flour blending

Proper blending of BCF with wheat flour is essential for achieving consistent product quality and optimal performance in bread production.

Industrial blending process

The addition of BCF to wheat flour during industrial milling requires precise control and monitoring. At flour mills, the two flours are conveyed in separate systems and combined at a carefully controlled microdosing point.

Blending procedure:

1. **Separate conveyance:** BCF and wheat flour are transported in dedicated conveyor systems
2. **Quality filtration:** The BCF conveyor opens into a holding bin equipped with a mesh screen that traps extraneous material
3. **Controlled dosing:** The holding bin feeder opens into the wheat flour conveyor at a regulated speed to deliver the desired substitution level (typically 5% or 10%)
4. **Homogenization:** The composite flour is cycloned through sets of sifters
5. **Bleaching treatment:** The blended flour passes through bleaching mechanisms
6. **Final blending:** The composite flour enters a blender to ensure complete homogeneity
7. **Fortification:** During final blending, the flour is fortified with premixed vitamins, oxidizing agents, and enzymes
8. **Packaging:** The finished composite flour is conveyed for packaging and warehousing.

Critical blending parameters

These essential quality parameters directly affect final product performance.

Moisture content management

- BCF moisture content must be lower than that of the wheat flour
- This ensures the composite flour maintains acceptable overall moisture levels
- Low moisture prevents microbial growth and extends shelf life.

Color compatibility

- For many millers, bakers, and consumers, BCF color needs to closely match wheat flour to ensure visual homogeneity
- White BCF (from white-fleshed cassava) provides the best color matching
- While yellow BCF (from biofortified cassava) may affect final product appearance, some may consider this an acceptable trade-off for the nutritional benefit of the biofortification.

Particle size uniformity

- BCF particle size must closely match wheat flour specifications
- Uniform particle size ensures proper distribution throughout the blend.

pH control considerations

- pH directly affects yeast activity and fermentation performance
- Optimal pH range is 6.0–8.0 for proper yeast function
- Lower or higher pH values may negatively impact bread quality.

Ash content implications

- Higher ash content results in a darker flour appearance
- This can impair the overall color of the composite flour
- Monitor ash levels to maintain visual quality standards.

Cyanide safety requirements

- BCF cyanide content must remain below maximum recommended limits (i.e., 10 ppm)
- Regular testing ensures food safety compliance
- Proper BCF processing is essential for achieving safe cyanide levels.

Microbiological quality

- Aflatoxin contamination is a critical concern for millers
- BCF must undergo rigorous testing before blending
- Contaminated BCF batches must be rejected to prevent quality issues.

Fermentation odor control

- BCF must be completely odorless
- Any odors will be carried into the composite flour
- Reject BCF batches with detectable odors.

Miller challenges and solutions

Quality consistency issues

Many small-capacity BCF processors cannot produce large volumes of uniform-quality flour. Common problems include:

- Inconsistent moisture content above acceptable limits
- Irregular or rough particle size distribution
- Dark color affecting the final product's appearance
- Low pH values impacting yeast performance
- Excessive microbial loads.

Traceability and inventory management

- BCF supplies often lack proper labeling and coding
- Missing manufacturing dates and batch numbers complicate stock rotation
- First-in-first-out (FIFO) procedures become difficult to implement
- Quality control tracking becomes challenging.

Solutions in progress

Nigeria's experience shows successful approaches:

- Expanding medium- and large-scale BCF processing capacity
- Implementing standardized quality control systems
- Developing consistent supply chains for uniform-quality BCF
- Training BCF processors in quality management.

Miller's responsibilities to bakers (bakers' requirements and miller's responses)

Bakers have specific performance needs that millers must address through proper flour processing.

- *Bread flour that yields more loaves*: Millers achieve this by ensuring optimal starch damage and tempering during flour milling.
- *High dough spring or loaf volume*: This requires millers to use good-quality wheat grains and proper flour treatment with enzymes and oxidizing agents.
- *Factory-blended bread flour containing cassava*: BCF and wheat should be blended by wheat flour millers and sold directly to bakers. Millers need to use flour improvers to enhance bread volume at the bakery level.
- *Good crumb color and structure*: Millers must ensure efficient extraction rates—not too low or too high. At the bakery level, excessive addition of improver should be avoided.

Figure 3.31. Sequence of bread production steps.

- *Elastic and extensible dough with good stability during proofing*: This requires millers to use good-quality wheat grains with high protein (gluten) content when manufacturing cassava–wheat composite flour. The composite must contain not less than 7% gluten content.

Critical consideration for bakers

Mixing BCF with commercial wheat flour at the bakery level leads to a reduction in the gluten content of the factory-made flour, affecting the bread volume. This is why factory blending by millers produces better results than bakery-level mixing.

3.5.2 Dough processing

Systematic mixing procedures

A well-balanced recipe formulation is fundamental to dough consistency. Water absorption is a key technical element during mixing and is influenced by the starch and protein content of the flour.

When using composite flour, understanding its composition is essential since it contains two types of starches—from cassava

root and wheat kernel. Start mixing at a graduated and regulated speed to allow proper alignment of both small and large starch granules for adequate mixing with other ingredients.

In the DRC, bakers use two approaches to mixing:

- By hand in wooden boxes (traditional method)
- Using mechanical kneaders (industrial method).

For cassava–wheat composite flour bread in DRC, typical recipes include:

- Recipe 1: 45 kg wheat flour, 5 kg BCF, 300 g yeast, 43.5 g salt, 25 L water
- Recipe 2: 45 kg wheat flour, 5 kg BCF, 900 g yeast, 60 g salt, 30 L water, 80 g sugar, 50 g baking powder, 25 g colorant, 1 L vegetable oil.

Proper kneading techniques

Kneading occurs in the bowl or bucket of the mixer by the spiral- or C-shaped hook or paddle, mixing the ingredients and pushing the dough against the side of the container to develop the gluten network. This process:

- Ensures uniform distribution of ingredients throughout the dough
- Develops the viscoelastic dough matrix and gluten network
- Imparts mechanical energy needed for proper dough development.

Fermentation monitoring and proofing control

After mixing, the dough undergoes fermentation and proofing. Baker's yeast (*Saccharomyces cerevisiae*) feeds on sugar in the dough, producing carbon dioxide gas, which is responsible for the increase in dough volume.

The dough can be fermented either:

- In bulk form, or
- Divided into portions in baking pans.

Key parameters for fermentation and proofing:

- Optimal temperature range: 20–30 °C
- In DRC bakeries, the typical fermentation time is approximately 2 hours
- Fermentation/proofing temperature can typically be achieved in tropical environments without specialized equipment, but near the heated baking oven in the bakery.

During this process:

- Carbon dioxide production causes dough to rise
- Enzyme activities are enhanced due to gluten and starch structure denaturation
- The ratio of elastic to viscous components changes, with elastic becoming more dominant.

Cutting and molding

The mixed dough needs to be relaxed before being:

- Rolled out
- Cut into desired shapes
- Allowed to proof in baking pans for the final rise before baking.

3.5.3 Baking process

Temperature control protocols

The oven should be preheated before baking begins. During baking, starch is gelatinized and proteins are further denatured at an internal temperature of 60–80°C, transforming raw dough into a light, porous, and readily digestible product. The carbon dioxide trapped in the dough during fermentation expands, causing the dough to rise further while the coagulation of the gluten fixes the size and shape of the loaf as allowed by the dimensions of the baking pan.

In DRC bakeries:

- Typical baking temperature range: 230–273 °C
- Standard baking time: approximately 15 minutes
- Both artisanal (wood-fired brick) and mechanical ovens are used.

Timing management

Critical timing points in the process include:

- Initial mixing and kneading
- Fermentation period (1–3 hours in DRC practice)
- Baking duration (15 minutes in DRC practice).

Cooling procedures

After baking, the bread must be carefully taken out of the oven and allowed to cool before packaging.

- Systematic cooling procedures are essential for product quality and safety
- Remove bread from the oven
- Place baked products on clean racks and trays for cooling at appropriate temperatures
- Proper air circulation and contamination prevention during cooling directly impact shelf life
- As much as possible, cover the baked products during the cooling process to prevent contamination
- Clear any crumbs left after slicing the products.

3.6 PRODUCT EVALUATION

3.6.1 Consumer-preferred characteristics of bread

Understanding consumer expectations for bread quality is essential for successful production using cassava–wheat composite flour.

Visual characteristics

Crust appearance and color: A high-quality bread should exhibit a variety of hues in its crust, ranging from golden brown to a light golden color. The crust should have:

- Even color distribution without dark spots or pale patches
- Attractive surface finish that appeals to consumers
- Good glaze or sheen, especially on leavening breads, which indicates proper baking.

Surface finish quality: While a loaf does not need to look perfect to be tasty, attractive bread makes eating more enticing. Quality surface characteristics include:

- Smooth, well-formed shape appropriate to the bread type
- Even surface without cracks, tears, or irregularities
- Proper scoring marks where applicable
- Clean appearance free from flour residue or baking debris.

Internal structure and texture

Air pocket distribution: Good bread is characterized by a variety of bubble sizes throughout the crumb. This indicates:

- Proper gluten development during mixing and kneading
- Successful fermentation with adequate gas production
- Correct proofing time and conditions
- A well-controlled baking process.

Avoid overworking dough, which results in bread that is too dense with poor internal structure.

Crumb characteristics: The interior bread structure should demonstrate:

- Light, airy texture with good volume
- Even crumb structure without large holes or dense areas
- Slightly glossy interior finish (though not all bread should appear wet inside)
- Proper elasticity—the bread should spring back when pressed gently with a finger.

Sensory qualities

Flavor profile: Quality bread must have distinctive, appealing flavor characteristics:

- The flavor should be noticeable before taking a bite—good bread has an inviting aroma
- Clean, pleasant taste without off-flavors or staleness
- Appropriate flavor intensity for the bread type
- No bland or flat taste that lacks character.

Texture: Consumers expect bread to:

- Feel soft and pleasant in the mouth—neither too chewy nor too soft
- Have appropriate moisture content—not dry or overly moist
- Have good bite characteristics that make eating enjoyable
- Have consistent texture throughout the loaf.

3.6.2 Quality assessment methods

Visual inspection protocol

1. **Crust evaluation:** Examine color uniformity, surface finish, and overall appearance
2. **Shape assessment:** Check for proper form and symmetry appropriate to bread type
3. **Surface quality:** Look for defects such as cracks, tears, or uneven areas.

Internal structure analysis

1. **Cross-section examination:** Cut bread to reveal internal structure
2. **Crumb evaluation:** Assess bubble distribution, color, and overall texture
3. **Elasticity test:** Gently press the crumb to test the spring-back response.

Sensory evaluation procedure

1. **Aroma assessment:** Evaluate bread smell before and after breaking open
2. **Flavor testing:** Taste for proper flavor development and absence of off-flavors
3. **Texture analysis:** Assess feel in the mouth, chewiness, and moisture content.

3.6.3 Documentation and standards

Establish clear criteria for:

- Acceptable color ranges for different bread types
- Expected internal structure characteristics
- Flavor and aroma benchmarks
- Texture standards for consistent quality.

3.6.4 Identification of common quality issues

- Uneven crust color indicates temperature or timing problems
- Dense crumb structure suggests fermentation or mixing issues
- Off-flavors indicate ingredient quality or storage problems
- Poor volume indicates gluten development or yeast activity issues.

3.6.5 Corrective action protocols

1. Trace problems back to specific process steps
2. Adjust mixing, fermentation, or baking parameters as needed
3. Review ingredient quality and storage conditions
4. Implement preventive measures for future batches.

This systematic approach to quality assessment ensures that bread made with cassava–wheat composite flour meets consumer expectations while maintaining the standards that build customer loyalty and business success.

Figure 3.32. Cross-section of bread showing ideal internal structure and external characteristics.

SESSIONS 3.5 AND 3.6 KEY TAKEAWAYS

Systematic process control

- Successful cassava–wheat composite bread production requires precise control of mixing, fermentation, and baking parameters to achieve consistent quality
- Water absorption and mixing protocols must be specifically adapted for composite flour's dual starch components from cassava and wheat
- Regulated mixing speeds and proper starch granule alignment are fundamental for optimal dough development.

Critical production parameters

- Mechanical energy during mixing and kneading is essential for developing a proper gluten network and viscoelastic properties
- Fermentation temperature should be maintained between 20 and 30 °C for proper dough development and CO_2 production
- Standard baking requires 200 °C (Nigerian/British bread) or 230–273 °C (baguette) oven temperature with approximately 15-minute baking time.

Quality assessment criteria

- High-quality bread exhibits:
  - A variety of hues in its crust, ranging from golden brown to a light golden color
  - Well-developed internal bubble structure
  - Slight interior glossiness
  - Consistent texture that springs back when pressed
  - Clean, appealing flavor profile.

Practical implementation

- Both traditional and mechanical mixing methods can produce quality results when proper techniques are followed
- DRC experience demonstrates successful production across various bread sizes and formulations.

3.7 PRODUCT STORAGE

SESSION 3.7 OBJECTIVES

After completing this session, trainers will be able to:

1. Implement proper packaging and storage procedures that maintain product quality and safety
2. Establish systems for:
   - Temperature monitoring
   - Shelf-life management
   - Storage area sanitation
   - Product rotation
3. Train staff on display storage requirements and proper handling during distribution
4. Monitor and document storage conditions to ensure compliance with food safety standards.

Proper storage of baked products is essential for maintaining quality and ensuring food safety. The storage requirements and procedures outlined below help preserve the bread's characteristics and prevent contamination.

3.7.1 Packaging requirements

Packaging must comply with the standards laid down in both the African Standard for Cassava Bread (CD-ARS 853:2014) and the DRC National Standard for Bread and Pastry (NCD ISO 004:2020) (see also Module 2, section 2.5).

Protection and quality preservation

- Packaging must protect the bread from breakage
- Materials used must be new, clean, and of appropriate quality to avoid causing external or internal damage
- Packaging must safeguard the hygienic, physical, nutritional, and organoleptic qualities of the bread
- Package products only after they have properly cooled.

Materials safety requirements

- Containers and packaging materials must be:
  - Made of food-grade materials
  - Safe and suitable for intended use
  - Free from substances that could transfer toxic materials to the bread
  - Free from materials that could impart undesirable odors or flavors.

Labeling requirements

The package must be legibly and indelibly marked with:

- Product name ("Cassava bread")
- Name and physical address of manufacturer/distributor
- Brand or trade name
- Date of manufacture
- List of ingredients
- Lot identification number
- Best before date
- Net weight in metric units
- Storage instructions
- Declaration of flavoring agents/spices used
- Instructions for package disposal.

For nonretail packages, information may be provided in accompanying documentation, but the product name, lot ID, and manufacturer details must appear on the actual package.

Weight specifications

- Net weight of packaged bread must comply with relevant national (e.g., DRC) regulations.

Compliance

- Must conform to national (e.g., DRC) standards for food packaging and labeling
- Must meet requirements for hygiene and food safety as per national (e.g., DRC) standards.

3.7.2 Product storage requirements

Display storage for sale

- Store bread in clean display cases that must remain covered at all times
- Ensure bread is stored at appropriate temperatures
- For bread with perishable fillings (e.g., sardine bread), do not display beyond 4 hours at room temperature
- Adopt a first-in-first-serve approach in the display of bread for sale
- Consider using time/date stamps to inform consumers of the best-before date.

SESSION 3.7 KEY TAKEAWAYS

Packaging fundamentals

- Packaging material selection and timing must align with food safety requirements.

Environmental controls

- Temperature monitoring throughout storage phases requires consistent documentation
- Display case management demands careful attention to time and temperature limits
- First-in-first-serve principle helps optimize product freshness and reduce waste.

Storage system implementation

- Clear protocols for different storage phases (display, distribution) ensure product integrity
- Staff training on proper handling techniques reduces contamination risks
- Regular monitoring and documentation of storage conditions support quality assurance.

Critical control points

- Perishable products require strict time–temperature control during display
- Display case coverage and cleanliness directly impact product safety
- Adherence to the storage area sanitation schedule prevents cross-contamination.

Documentation requirements

- Temperature logs, cleaning records, and product rotation schedules enable traceability
- Storage condition monitoring helps identify system improvements needed
- Regular review of documentation ensures compliance with food safety standards.

3.8 HYGIENE AND SAFETY MANAGEMENT

SESSION 3.8 OBJECTIVES

After completing this session, trainers will be able to:

1. Establish comprehensive hygiene protocols covering:
   - Personnel hygiene requirements
   - Equipment sanitation schedules
   - Facility cleaning procedures
   - Pest control measures
2. Implement documentation systems for:
   - Cleaning records
   - Temperature monitoring
   - Staff training
   - Safety incidents
3. Train staff on proper hygiene practices and safety procedures using practical demonstrations
4. Monitor compliance with food safety standards and correct deficiencies promptly.

Sanitation and hygiene should be at the forefront of every staff member's mind in a bakery. Bread-making requires good hygiene practices covering personnel, equipment, and the environment. Personnel and environmental hygiene are very important in bakeries, as bread is highly prone to contamination from the environment and workers. Yet, local bakeries are generally characterized by poor hygiene.

3.8.1 Personnel hygiene

General requirements

- Do not work when unwell.
- Wash hands thoroughly with soap and water—including area under fingernails:
  - Before starting work
  - After visiting the toilet
  - Before handling raw materials and products
  - After handling eggs and before contact with other food
  - After touching your face, hair, or clothes
  - After handling cleaning materials
  - Before handling ready-to-eat products
  - At the end of the work shift.
- Never handle bread products with your bare hands.

Personal protective equipment (PPE) and clothing

- Wear a clean apron or work clothing daily
- Hairnets or caps covering all hair completely
- Wear clean gloves when handling raw materials and products
- Closed, nonslip shoes suitable for cleaning
- Wash and dry all aprons, shoes, and work clothing after each work day.

What to avoid or do

- Remove jewelry except plain wedding rings
- Avoid loose clothing that could come into contact with food or get caught in machinery
- Never handle bread or pastry products with bare hands—wear clean gloves.

Special handling procedures

For eggs:

- Ensure eggshells are not cracked upon receipt and discard cracked eggs
- Store eggs at a cool temperature (at or below 4 °C) until needed
- If storing eggs at room temperature:
  - Use current batch daily
  - Replenish stocks daily
- When pooling eggs:
  - Pool only required quantity
  - Use all pooled liquid egg the same day
  - Do not top up with new eggs
- Prepare raw eggs away from other food, especially cooked and ready-to-eat food.

Additional food safety protocols:

- Use designated preparation areas for different types of ingredients
- Have regular hand hygiene audits
- Monitor temperature for cold storage ingredients.

3.8.2 Facility management

Equipment sanitation schedules

Follow equipment sanitation rules.

Clean after every step of the preparation process:

- Mixing
- Proofing
- Baking
- Cooling.

Equipment sanitation rules

1. Disassemble and thoroughly clean all surfaces that come in contact with cassava or dough after each shift
2. Read the manual to ensure complete disassembly of all parts
3. Use approved and correct cleaning agents
4. Perform deep cleaning at least once a month to sanitize any crevices that might get neglected during routine daily cleaning
5. Stock spare parts that undergo significant wear and tear
6. Replace damaged or worn parts that can have uneven surfaces allowing microbes and crumbs to settle
7. Follow a disciplined sanitation schedule and ensure proper waste disposal
8. Remember that bread-making equipment is designed with efficiency and cleanliness in mind.

Facility cleaning procedures

Daily cleaning required for:

- Bakery area
- Make-up room
- Display areas
- Utensils
- Display cases.

Product handling requirements:

- Cool baked products on clean racks and trays
- Cover products during cooling whenever possible
- Clear crumbs left after slicing products
- Use only food-grade cleaning materials on product contact surfaces.

Display requirements:

- See section 3.7.2.

Waste handling protocols

- Practice good waste management
- Ensure proper drainage systems
- Implement a segregated waste disposal system
- Regularly remove waste from production areas.

Pest control measures

- Implement effective pest control programs
- Conduct regular inspections
- Maintain equipment properly to prevent damage that attracts pests
- Promptly repair or replace damaged equipment to prevent contamination
- Install window netting
- Cover all openings from the processing or baking building to the outside with wire gauze
- Keep ingredients, food, and flour stored in sealed containers
- Remove food debris and standing/waste water
- Document all pest control activities.

Storage requirements

- See sections 3.3.1 and 3.7.2.

Hygiene for bread bakery surroundings

The environment of bread bakeries is prone to serious infrastructure deterioration, inadequate waste disposal, and other environmental hazards. These hazards pose risks to bakery staff, bread consumers, and the bakery neighborhood.

Bakery management must ensure a hygienic environment for bread bakery operations by preventing contamination, pest infestations, and environmental hazards. The plan should apply to all nonfood-contact areas surrounding the bakery, including external compound and walkways, waste disposal and refuse areas, drainage systems, firewood depot (if applicable), raw material and bread loading and unloading bays, staff entrances and changing areas, external walls, doors, windows, and vents. There should be cleaning staff to carry out the cleaning activities, a quality assurance officer or bakery supervisor to verify the effectiveness of the cleaning, and access to maintenance technicians to repair cracks, drains, and structural defects. Appropriate cleaning chemicals and tools must be provided. Some of the hazards that require adequate attention include biological, chemical, and physical hazards such as pests (including rodents and insects), chemical residues, waste spills, dust, wood pieces, charcoal, ash from wood ovens, bottles, metal pieces, nylon, broken plastic, and broken glass.

It is recommended that cleaning tools be color-coded and dedicated to external use. Chemicals must be food-grade

DAILY CLEANING SCHEDULE

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Cleaning materials		
Date:								*Only use cleaning materials stated below*		
All areas										
Floors								Clean water, disinfectant		
Walls								Clean water, disinfectant		
Windows/screens										
Store										
Shelves										
Ingredient containers										
Pallets										
Blending										
Work surface										
Mixing box/mixer										
Tools/equipment										
Mixing and kneading										
Work surface										
Mixers										
Utensils										
Other equipment										
Fermentation										
Fermentation cabinet outside and inside, including shelves										
Utensils and tools										
Baking										
Ovens outside and inside, including shelves										
Utensils and tools										
– Baking pans										
– Baking trays										
– Oil containers and brushes										
– Baking trolleys/racks										
– Other utensils and tools										
Heat-resistant gloves										
Finishing										
Work surfaces										
Cooling racks outside and inside, including shelves and trays										
Cooling coverings										
Tools/utensils										
Pre-dispatch storage										
Pallets										
Shelves/baskets										
Forklift (if appropriate)										
Display										
Display cabinet outside and inside										
Utensils (tongs, etc.)										
Report any issues to the supervisor or manager										

Figure 3.33. Bakery cleaning schedule template with daily tasks.

approved and labeled. Waste bins must always be covered, and emptied and cleaned daily. Waste must not be allowed to accumulate near production areas, and cleaning is to be conducted outside production hours, to avoid food contamination.

3.8.3 Documentation

Required records

- Keep invoices of ingredients purchased for traceability
- Maintain cleaning schedule records.

Additional documentation:

- Equipment calibration, performance, and maintenance logs
- Temperature monitoring records (ambient, storage, proofing/fermentation, baking)
- Staff training records
- Pest control documentation.

WEEKLY/DAILY CLEANING SCHEDULE

	Activity	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Cleaning materials and tools		
Date:									*Use the cleaning materials and tools recommended below according to the bakery's size*		
Area:											
All areas											
Compound and walkways	Weed, sweep, and wash								Clean water, disinfectant	Weeder, sweeper machine, brush, hose, cutlass/machete, hoe, rake, shovel, wheelbarrow, etc.	
Wood storage area	Weed, sweep, and stack wood neatly										
Fuel (diesel, petrol) storage area	Sweep; wet-clean floor, wall, and container surfaces								Detergent, disinfectant		
Generator area											
Waste bins	Clean by scrubbing and disinfecting										
Drains to remove debris	Clean and flush								Detergent		
Loading area	Dry sweep								No chemicals		
Doors and walls	Wipe with a damp cloth								Detergent (mild)		
External structures, including old, unused machines	Cleaning										
Report any issues to the supervisor or manager											

Figure 3.34. Bread bakery external environment cleaning schedule template with weekly or daily tasks.

Temperature recording log

Area: _____ Date(s): _____

Target temperature range: _____ Recording frequency: _____

TEMPERATURE READINGS

Date	Time	Temperature recorded	Out of range?	Recorder's initials	Comments/ Actions taken

Supervisor name: _____ Signature: _____ Date: _____

☐ Data entered into IT system/database

This form should be completed according to facility hygiene and safety protocols. Store completed forms according to record retention policy.

Figure 3.35. Sample temperature recording log.

SESSION 3.8 KEY TAKEAWAYS

- Effective bakery hygiene requires systematic implementation of three interconnected pillars: personnel hygiene protocols, equipment sanitation procedures, and facility management systems. Each component plays a critical role in ensuring food safety and product quality.
- Personnel hygiene fundamentals must emphasize preventive measures including proper handwashing protocols, use of appropriate protective equipment, and specific handling procedures for high-risk ingredients such as eggs. Staff training should focus on both the technical requirements and rationale behind hygiene practices.
- Equipment sanitation demands a structured approach following the eight core rules, from thorough cleaning after each shift to proactive maintenance of equipment. Documentation and verification of cleaning procedures ensure consistent implementation across all production periods.
- Facility management requires integration of multiple systems including systematic cleaning schedules, waste handling protocols, pest control measures, and proper product storage procedures. Regular monitoring and documentation validate that standards are maintained.
- Documentation serves as both a compliance tool and a quality improvement mechanism. Records of cleaning schedules, temperature monitoring, staff training, and ingredient traceability enable systematic review and refinement of hygiene practices.

MODULE 3 KEY TAKEAWAYS

Quality foundation is critical

- Systematic quality assessment of ingredients directly impacts product consistency and food safety
- Regular testing using simple but effective methods prevents quality issues
- Clear documentation of quality checks builds traceability and compliance.

Equipment mastery enables success

- Each piece of equipment serves specific functions requiring proper operational protocols
- Regular maintenance and cleaning schedules prevent contamination and ensure consistent performance
- Understanding equipment specifications and limitations helps optimize production.

Storage systems protect quality

- Proper ingredient storage helps prevent contamination and maintains quality
- Temperature control and monitoring are essential for food safety
- First-in, first-out (FIFO) principles optimize inventory management and reduce waste.

Recipe formulation requires precision

- Accurate measurements and consistent procedures ensure product quality
- Water absorption management is critical when using composite flours
- Local conditions may require recipe adaptation while maintaining quality standards.

Production excellence demands attention to detail

- Each production step influences final product quality
- Temperature and timing control are critical success factors
- Regular monitoring and documentation enable continuous improvement.

Hygiene and safety cannot be compromised

- Personnel and equipment hygiene directly impact food safety
- Equipment sanitation requires systematic approaches
- Documentation validates compliance with food safety standards.

Knowledge transfer is essential

- Clear demonstration of techniques ensures consistent implementation
- Regular staff training maintains quality standards
- Documentation enables systematic improvement of practices.

MODULE 4: BUSINESS CONTEXT

MODULE 4 OBJECTIVES

After completing this module, participants will be able to:

1. Guide entrepreneurs through the key business planning steps required to establish and operate a profitable bakery enterprise using cassava–wheat composite flour
2. Analyze and communicate the financial benefits of incorporating BCF into bakery operations
3. Ensure bakery operations meet all regulatory requirements and quality standards
4. Implement comprehensive quality control and documentation systems
5. Train bakeries to maintain proper financial and operational records that support business sustainability.

This Module is based on the premise of establishing a bakery to use composite cassava–wheat flour in bread-making and pastries. The underlying principles can also be applied to establishing a cassava processing plant to make BCF.

4.1 BUSINESS PLANNING BASICS

SESSION 4.1 OBJECTIVES

After completing this session, participants will be able to:

1. Guide bakery entrepreneurs in evaluating key business start-up considerations including bakery type selection, premises requirements, and equipment needs
2. Calculate and explain initial investment requirements for small to medium-sized bakery operations
3. Develop practical resource allocation plans covering production scheduling, equipment maintenance, and staffing
4. Apply cost structure analysis to distinguish between fixed and variable costs in bakery operations
5. Assist entrepreneurs in identifying appropriate funding sources and financial monitoring requirements.

Starting a bakery enterprise needs careful consideration of the kind of bakery to operate and related start-up expenditures for an efficient launch and sustainable operation. Initial planning must account for the product's distribution channels and scope. Two main approaches exist: retail bakeries, which produce and sell directly to customers, and conventional (wholesale) bakeries, which sell only to distributors. While most start-up considerations apply to both types, conventional bakeries typically have higher distribution expenses.

4.1.1 Start-up considerations

Location selection

When selecting a viable bakery location, consider strong foot traffic regions, accessibility, rental cost, utilities, and proximity to suppliers and target customers, while also analyzing competition and national/local regulations. Choosing a location that is both accessible and visible to potential customers might give you an advantage over the competition.

Remember: A great baker can bake anywhere; the best bakeries choose the right location.

Premises

The building to be used may be available as owner's equity or rental. In the latter case, premises rental will be a major fixed ongoing capital commitment. The building can be modest or elaborate in size and cost, depending on the location, resources available, or the owner's wishes. The total budgeted funds

CHOOSING BAKERY LOCATION

Target the right customer base

Understanding your ideal customer is the first step in choosing a bakery location. Consider:

- **Young professionals?** Set up near offices and commercial hubs.
- **Families and homemakers?** Look for residential areas with steady foot traffic.
- **Students?** A spot near schools, colleges, or universities ensures daily business.
- **Tourists?** A prime location in a busy market or near attractions works best.

High foot traffic = higher sales

A location with high foot traffic and purchasing power is crucial. Areas that work best for bakeries include:

- **Busy streets and main roads**—More visibility = more walk-ins.
- **Shopping malls and markets**—Customers looking for quick snacks and desserts.
- **Near cafés and restaurants**—People often grab a bakery item after a meal.

Avoid locations that are hidden, hard to access, or have low visibility.

Check competition in the area

Before finalizing your choice of location, analyze existing bakeries and competitors.

- **Too many bakeries?** The market may be oversaturated.
- **No bakeries?** Either a great opportunity or a sign of low demand.

Affordability and operating costs

A viable location comes at a price! Before committing to a spot, consider:

- **Rent and lease costs**—Can your expected revenue cover the rent?
- **Utility costs**—Water, electricity, and gas expenses may vary by area.
- **Taxes and permits**—Check existing tax rates and business regulations.

Accessibility and parking space

Your bakery should be easy for customers to reach. Consider:

- **Is there parking nearby?** Essential for customers who drive.
- **Is the location pedestrian-friendly?** More walk-ins = more sales.
- **Is public transport available?** Ideal for urban areas.

A location that is hard to access will not draw in customers, no matter how good your products.

Proximity to suppliers and delivery services

Running out of ingredients during peak hours is *every bakery owner's nightmare*. Choose a location:

- Close to wholesale markets or ingredient suppliers for easy restocking
- Accessible for delivery services.

Space for kitchen and seating

Your bakery layout depends on whether you:

- **Only sell to retailers**—A big sales and cash collection room.
- **Only sell takeaway items**—A small space works.
- **Offer dine-in options**—Need enough space for tables and customer comfort.
- **Plan to expand**—Choose a location that allows for future growth.

Consider peak hours and seasonal demand

- Is the area busier in the **morning or evening**?
- Are sales higher on **weekends or weekdays**?
- Does foot traffic increase during **festivals or holidays**?

Government business regulations and licensing

Before signing a lease, ensure the location meets:

- Health and safety regulations
- Food licenses and fire safety approvals.

Avoid locations where you might face legal hurdles in the future.

Table 4.1. Example equipment investment breakdown for bakery start-up.

EQUIPMENT	INVESTMENT (LIKELY %)	ECONOMIC LIFE SPAN (YEARS)
Diesel or electric oven(s)	52	20
Delivery vehicle(s)	10	10
Dough mixers	19	25
Baking pans	4	5
Storage equipment (freezers)	2	5
Bread slicing machines	2	8
Dough dividers/cutters	3	12
Generator(s) for power backup	3	25
Bread cooling trolleys	2	12
Baker's table (stainless steel)	< 1	
Plastic basins	< 1	
Wooden trays	< 1	
Pastry brushes	< 1	
Long-handled wooden spatulas	< 1	
(Manual) aluminum sieve	< 1	
Digital scale	< 1	
Weighing scale	2	
Dough scrapers	< 1	

required for the first month of a start-up, excluding building costs or rental, could be around US$13 390.

Equipment procurement

When planning equipment procurement, focus on essential modern baking machinery. The most cost-intensive piece of equipment is the oven, constituting about half of the fixed investment cost.

Staff requirements

The staff requirement will depend on the size of the operation. For a bakery with the capacity to bake bread from 350 kg of flour a day, the basic staffing structure requires:

- One supervisor
- Two bakery attendants
- Total monthly wage bill (as used in Table 4.3B): US$92.80.

4.1.2 Operational planning

Production scheduling

Production involves two shifts per day. These typically run late at night and early in the morning to ensure fresh bread is available.

Resource allocation

An example of an operation's cost structure is shown in Table 4.2 (section 4.1.3).

Maintenance programs

Regular inspections and maintenance of equipment should be planned for:

- Daily cleaning after each production shift
- Monthly deep cleaning
- Replacement of worn parts.

4.1.3 Financial planning

Investment requirements

A new small to medium-sized bakery requires initial investment in:

- Fixed assets (equipment and infrastructure)
- Working capital for operations
- Marketing and administrative setup.

Investment capital for equipment replacement is accounted for in operational costing through depreciation (see section 4.2.1).

Table 4.2. Example of costs for a small-scale bakery business start-up, first month, Nigeria (excluding bakery building).

COST	COMPONENT	VALUE (US$)*	PERCENTAGE (%)†
Fixed	Utility, equipment, and installation cost: Production infrastructure and networking with public infrastructure, including drainage, septic tank, and electricity connection	8,950	67
	Electricity generator	2,150	16
	Administration‡	250	1.9
	Repairs and maintenance	560	4.2
	Waste and insurance	35	0.3
	Marketing—flyers, labels, signage, etc.	165	1.24
	Subtotal	*12,110*	*90.4*
Variable	Raw material	250	1.9
	Water	15	0.1
	Packaging	35	0.3
	Electricity	115	0.9
	Communication	30	0.2
	Wages (8 staff)	700	5.3
	Miscellaneous	135	1
	Subtotal	*1,280*	*9.6*
	Total§	**13,390**	

* Example only: will vary by time and place and almost certainly increase in the medium term; † of the total budgeted funds (guide only); ‡ may vary month to month and may include operational oversight, record-keeping, and compliance documentation; § excluding building construction or lease.

Working capital needs

Key working capital considerations include:

- Raw material inventory
- Staff wages
- Utility costs
- Packaging materials
- Daily operational expenses.

4.1.4 Specialist advice

It is strongly advised that the (would-be) business owner/entrepreneur hires a specialist (e.g., business development expert, accountant, or operations manager) to monitor the business operation and advise on the following as the company progresses:

- Revenue structure
- Profitability ratios
- Break-even analysis.

For optimal business planning, investors should consult investment analysts or bakery business consultants to prevent start-up investment mistakes.

SESSION 4.1 KEY TAKEAWAYS

Business model selection and initial planning

- Distinguish between retail (direct-to-consumer) and wholesale bakery models to inform operational strategy
- Consider distribution channels and scope when determining bakery type
- Account for premises requirements, whether owned or leased, in start-up planning.

Equipment investment strategy

- Prioritize essential modern baking machinery, with the oven being the primary capital investment (40% of fixed costs)
- Plan systematic depreciation calculations to accurately assess long-term costs
- Consider equipment's economic lifespan when budgeting for replacements.

Cost structure management

- Differentiate between fixed costs (90% of initial budget) and variable costs (10%)
- Account for production infrastructure as the largest fixed cost component (67%)
- Plan for ongoing operational costs, including utilities, labor, and maintenance.

Resource allocation planning

- Structure production around two daily shifts to maximize efficiency
- Implement systematic maintenance programs, including daily cleaning and monthly deep cleaning
- Establish clear staff roles and responsibilities with appropriate wage structures.

Financial management framework

- Develop comprehensive tracking systems for both fixed and variable costs
- Calculate and monitor depreciation costs systematically
- Consider consulting financial specialists for optimal business performance monitoring.

4.2 COST–BENEFIT ANALYSIS

SESSION 4.2 OBJECTIVES

After completing this session, participants will be able to:

1. Analyze and compare cost structures for conventional wheat flour versus composite flour bakery operations
2. Calculate and interpret key profitability indicators, including return on investment (ROI) and net benefits
3. Teach entrepreneurs how to conduct break-even analysis for bakery operations
4. Demonstrate how incorporating cassava flour can improve bakery profitability while maintaining product quality
5. Guide bakeries in tracking and analyzing financial performance metrics.

The financial viability of a bakery enterprise depends on careful management of both fixed and variable costs, strategic pricing, and efficient operations. This section examines the key financial considerations for establishing and operating a bakery using bread-making cassava–wheat composite flour.

4.2.1 Equipment investment considerations

Essential equipment

A small to medium-sized bakery requires the equipment listed in Table 4.1.

Depreciation calculations

Depreciation calculation is a systematic method of allocating the cost of tangible assets over their useful life.

Depreciation calculation formula: Depreciation is calculated using the straight-line method with the following formula:

> Daily depreciation cost = Asset value ÷ Economic life span (in days)

For annual calculations, this would be:

> Annual depreciation = Asset value ÷ Economic life span (in years)

Application in bakery operations: Daily depreciation costs are calculated for each item of bakery equipment with an "economic life span". For example:

- A medium-capacity diesel oven valued at US$9630.61 with an economic life span of 20 years has a daily depreciation cost of US$1.605
- A 10 kVA petrol generator valued at US$488.13 with an economic life span of 25 years has a daily depreciation cost of US$0.065.

For the bakery as a whole, economic depreciation is the sum of the depreciation costs of all equipment (and infrastructure) on a daily or annual basis.

Key depreciation principles

1. Asset-specific application: Different equipment types have different economic life spans based on durability and usage patterns.
2. Systematic allocation: Costs are distributed evenly throughout the asset's useful life.
3. Business planning integration: Depreciation must be factored into operational costs and profitability analyses.
4. Investment proportion assessment: Percentage calculations show each asset's contribution to total investment costs.

This approach ensures accurate financial analysis, allowing bakery enterprises to properly account for the gradual reduction in asset value when determining actual operational costs and profitability.

4.2.2 Operating costs analysis

Operating costs include the cost of raw materials, labor/staff, utilities, and a provision for maintenance.

Example of flour costs' comparison for 350 kg production

- 100% wheat flour: 82.9% of operational costs (US$322.00)
- With 10% bread-making cassava flour substitution (total 350 kg):
  - Wheat flour (315 kg)—US$289.80
  - Bread-making cassava flour (35 kg)—US$15.05

Thus, 10% substitution of wheat flour with BCF results in a net saving of US$17.15, which is a 5.3% saving in flour costs and a 4.4% saving in operational costs.

4.2.3 Revenue projections

Production capacity

Production capacity will be determined as the bakery reaches production efficiency and adjusted according to consumer demand.

Price points and revenue

Revenue is the price per loaf multiplied by the number of loaves sold.

Table 4.3A. Daily cost and return analysis of a typical bakery enterprise using BCF–wheat composite flour (at 10% BCF inclusion)—Fixed investment cost.

ITEM	QTY	UNIT PRICE (US$)	VALUE (US$)	ECONOMIC LIFE (YEARS)	DEPREC. (US$/DAY)	% OF INVEST-MENT COST
Diesel oven (medium capacity)	1	9,630.61	9,630.61	20	1.32	51.8
10 kVA petrol generator	1	488.13	488.13	25	0.053	2.62
Bread-cooling trolley shelves, 200-bread capacity	2	158.31	316.62	12	0.072	1.70
Dough mixer (50 kg capacity)	1	3,562.01	3,562.01	25	0.390	19.1
31-blade bread-slicing machine	1	422.16	422.16	8	0.144	2.27
Bread baking pan (3 in 1)	150	4.62	692.61	5	0.379	3.72
Dough scraper (small size, stainless steel)	5	4.62	23.09	5	0.013	0.12
Digital scale	1	72.56	72.56	6	0.033	0.39
Baker's table (stainless steel)	1	171.50	171.50	10	0.047	0.92
Delivery vehicle (tricycle)	1	1,978.89	1,978.89	10	0.542	10.6
Chest freezer (310 liters)	1	329.82	329.82	5	0.181	1.77
Dough divider/dough cutter	1	521.11	521.11	12	0.119	2.80
Plastic basins for bread processing (medium size)	4	3.30	13.19	5	0.007	0.07
Wooden trays	12	2.64	31.66	5	0.017	0.17
Pastry brushes	3	1.32	3.96	2	0.005	0.02
Long-handled wooden spatulas/paddles	3	4.62	13.85	3	0.013	0.07
Manual aluminum sieve	1	9.89	9.89	4	0.007	0.05
Weighing scale	1	329.82	329.82	35	0.026	1.77
	Total depreciated cost/day (US$)				3.37	100

Table 4.3B. Daily cost and return analysis of a typical bakery enterprise using BCF–wheat composite flour (at 10% BCF inclusion)—Operational cost.

ITEM	QUANTITY/VALUE PER DAY	UNIT PRICE (US$)	DAILY VALUE (US$)	% OF OP. COST
Wheat flour	315 kg	0.92	289.80	77.80
High-quality cassava flour	35 kg	0.43	15.05	4.04
Fuel cost (gasoline) for both tricycle and generator	15 liters	0.73	10.95	2.94
Salt at 0.1 kg/50 kg flour	0.7 kg	0.26	0.18	0.05
Baking soda per 350 kg of flour ($0.02/kg flour)	350 kg	0.02	7.00	1.88
Sugar at 1.2 kg per 50 kg bag of flour	8.40 kg	0.86	7.22	1.94
Improver at 0.3 kg per 50 kg flour	2.1 kg	4.40	9.24	2.48
Labor cost at US$92.8/month (1 supervisor at US$40 and 2 attendants at US$26.4 each)	US$3.87	N/A	3.87	1.04
Rent of factory house per day	1 day	2.64	2.64	0.71
Preservative (0.3 kg/50 kg flour)	2.1 kg	0.20	0.42	0.11
Yeast at 0.05 kg per 50 kg wheat flour	0.35 kg	3.96	1.39	0.37
Shortening at 0.5 kg per 50 kg flour	3.50 kg	1.98	6.93	1.86
Repairs and maintenance per day (US$)	1 day	1.32	1.32	0.35
Cost of electricity per day (US$)	1 day	0.82	0.82	0.22
Packaging cost (packs of 100)	12 packs	1.32	15.84	4.25

Table 4.3C. Daily cost and return analysis of a typical bakery enterprise using BCF–wheat composite flour (at 10% BCF inclusion)—Revenue.

ITEM	QUANTITY	US$/LOAF	TOTAL REVENUE (US$)
Sales of big bread	528	1.19	628.32
Sales of small-loaf bread	602	0.40	240.80
Total loaves of bread produced per day	1,130		
Total benefit (revenue) per day (US$)			865.17

Table 4.3D. Daily cost and return analysis of a typical bakery enterprise using BCF–wheat composite flour (at 10% BCF inclusion)—Analysis.

Total revenue (benefit) per day	869.12
Total investment cost per day	3.37
Total operational cost per day	372.67
Total cost per day	376.04
Net benefit (return to labor and management) per day	493.08
Total benefit per kg of wheat flour and BCF	2.48
Total cost per kg of wheat flour and BCF	1.07
Net benefit per kg of wheat flour and BCF	1.41
Return on investment (ROI)	2.31

Sales volume analysis

Sales volume is the total revenue from all the bread produced. This is used to calculate profit or net benefit.

Example analysis

Daily production using 10% cassava flour:

- Total output: 1130 loaves
  - Large bread: 528 loaves
  - Small bread: 602 loaves

Market prices:

- Large bread: US$1.19 per loaf (revenue: US$626.91)
- Small bread: US$0.40 per loaf (revenue: US$238.26)
- Total daily revenue: US$869.12

Per day:

- Total production cost: US$376.04
- Total revenue: US$865.17
- Net benefit: US$483.08

4.2.4 Profitability indicators

Return on investment

Return on investment (ROI) is calculated using the following standardized formula:

ROI = Total benefit (revenue) ÷ Total cost

This ratio provides a clear metric of financial efficiency, indicating how effectively invested capital generates profit.

Application in bakery business assessment

Example ROI calculation through comprehensive cost–benefit analyses:

- 100% wheat flour operation: ROI of 2.09
  - Total benefit: US$819.00 per day
  - Total cost: US$391.85 per day
  - Interpretation: Every US$1.00 invested generates US$1.09 in profit
- Composite flour operation (10% BCF inclusion): ROI of 2.31
  - Total benefit: US$869.12 per day
  - Total cost: US$376.04 per day
  - Interpretation: Every US$1.00 invested generates US$1.31 in profit

Comparative ROI analysis significance

The differential between these ROI values (2.09 vs. 2.31) demonstrates:

1. Higher financial efficiency with composite flour implementation
2. Reduced operational costs through strategic ingredient substitution
3. Enhanced production output (1060 vs. 1130 loaves per day)
4. Improved net benefit per kg of flour utilized (US$1.22 vs. US$1.41).

Strategic implications

ROI assessment enables:

- Quantitative evaluation of different production methodologies
- Data-driven decision-making for resource allocation
- Evidence-based policy recommendations for stakeholders
- Benchmarking opportunities across production environments.

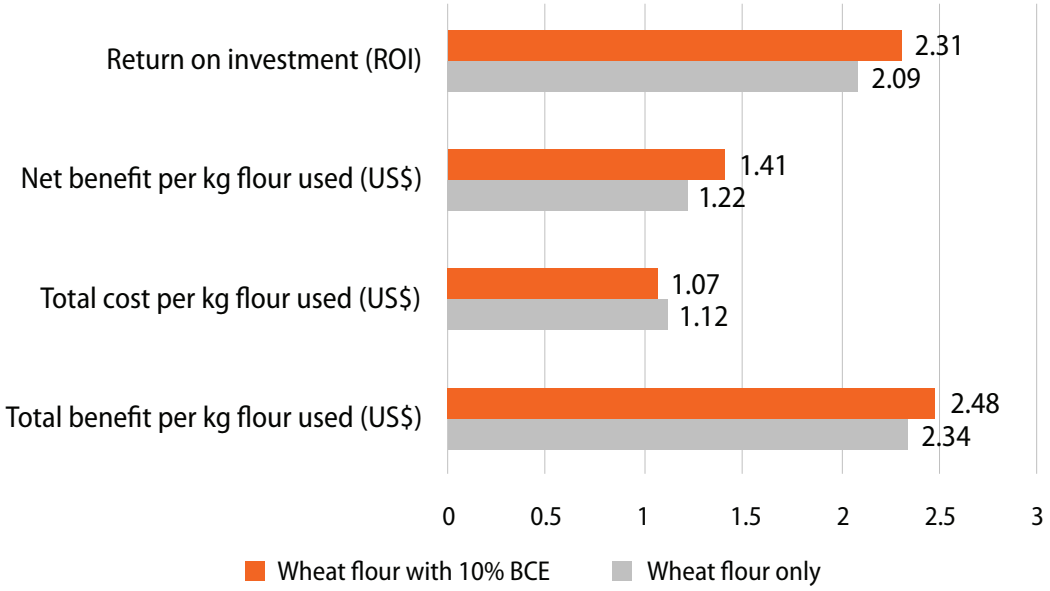

Figure 4.1. Total benefit (revenue), cost, and net benefit per kg of bread produced using 100% wheat flour and BCF–wheat composite flour.

Production economics

Per-kilogram metrics with composite flour:

- Total benefit: US$2.48
- Total cost: US$1.07
- Net benefit: US$1.41.

Break-even analysis

The break-even point is where revenue exactly matches costs—this means selling enough loaves to cover daily costs.

This analysis demonstrates that incorporating bread-making cassava flour into bread production offers clear financial advantages while maintaining product quality and meeting regulatory requirements.

SESSION 4.2 KEY TAKEAWAYS

Financial efficiency assessment

- Analysis demonstrates greater profitability (ROI) with composite flour implementation than with traditional wheat flour
- Structured cost reduction through strategic ingredient substitution yields measurable benefits
- Production capacity increases with composite flour.

Cost structure optimization

- Wheat flour may constitute over 80% of operational costs in traditional production
- BCF integration reduces flour costs to below 80% of operational expenses
- Net savings are achieved through 10% BCF substitution.

Revenue enhancement metrics

- Total daily revenue increases with BCF integration
- Net benefit per kg improves.

Production economics analysis

- Fixed costs require systematic depreciation tracking
- Variable costs demonstrate predictable reduction patterns with BCF adoption.

Performance monitoring framework

- Implement quantitative evaluation methodologies for production systems
- Establish data-driven decision-making protocols
- Develop evidence-based policy recommendations for stakeholders.

4.3 MARKET REQUIREMENTS AND REGULATORY APPROVALS

SESSION 4.3 OBJECTIVES

After completing this session, participants will be able to:

1. Explain DRC's regulatory requirements for incorporating BCF in bread and pastry products
2. Guide bakers in meeting national, regional, and international quality standards for composite flour products
3. Demonstrate compliance procedures for product labeling, and health and safety requirements
4. Train bakers on implementing quality assurance systems that meet regulatory standards
5. Help bakeries navigate the different layers of standards from local to international requirements.

Understanding regulatory requirements and market standards is essential for successful implementation of bread-making cassava–wheat composite flour in commercial baking. The DRC government promotes BCF use to reduce wheat import costs, estimated at US$87 million annually. In December 2020, the government amended the Congolese National Food Industrial Standards to require minimum levels of BCF in flour for bread and pastry products. Bakers and processors must navigate multiple layers of standards and regulations—from national requirements through to international benchmarks—while also meeting market demands for consistent quality products.

4.3.1 Government regulations compliance

Compliance with national standards and regulations is required in both the country of manufacture and any export-target country. Each level of standards builds upon those at the next level up the chain—from national/domestic through regional and continental to global/international standards.

See Module 2, section 2.5, for details of the African standard for cassava bread and the DRC standards for bread and pastries.

Minimum cassava flour inclusion requirements

The DRC government mandates:

- A minimum of 5% BCF in flour for bread-making
- A minimum of 10% BCF for pastry products.

Product labeling standards

See Module 2, section 2.5 and Module 3, section 3.7.1.

Health and safety (hygiene) requirements

See Module 2, section 2.5.

NOTES FOR TRAINERS

When delivering this section:

- Emphasize the importance of meeting all applicable standards
- Explain how standards at different levels relate to each other
- Provide practical guidance on implementing quality assurance systems
- Include hands-on exercises in quality testing where possible.

4.3.2 Quality standards adherence

Quality standards ensure that BCF and composite flour products are safe, consistent, and suitable for commercial baking. The production of BCF requires conscious adherence to good manufacturing practices (GMP) and good hygiene practices (GHP) to obtain a product that meets national, regional, and international quality standards. Noncompliance with GMP and GHP will not produce BCF desirable for industrial use. Quality assurance procedures must be established to produce unfermented flour with consistent characteristics acceptable to consumers, while ensuring contaminants remain below specified thresholds.

National standards

National standards establish baseline requirements for product quality, safety, and consistency that all producers must meet to operate in their domestic market. These standards cover essential parameters, including physical and chemical properties, microbial limits, contaminant thresholds, and labeling requirements. Conformity with national standards is a fundamental first step before considering regional or international trade opportunities.

The example of the DRC standard for bread and pastries is presented in Module 2, section 2.5.2.

Regional standards

As a member of the East African Community, DRC can benefit from harmonized regional standards that facilitate trade within the region.

Details of the East African standards are presented in Module 2, section 2.5.1, and key differences between the East African and DRC standards are presented in section 2.5.3.

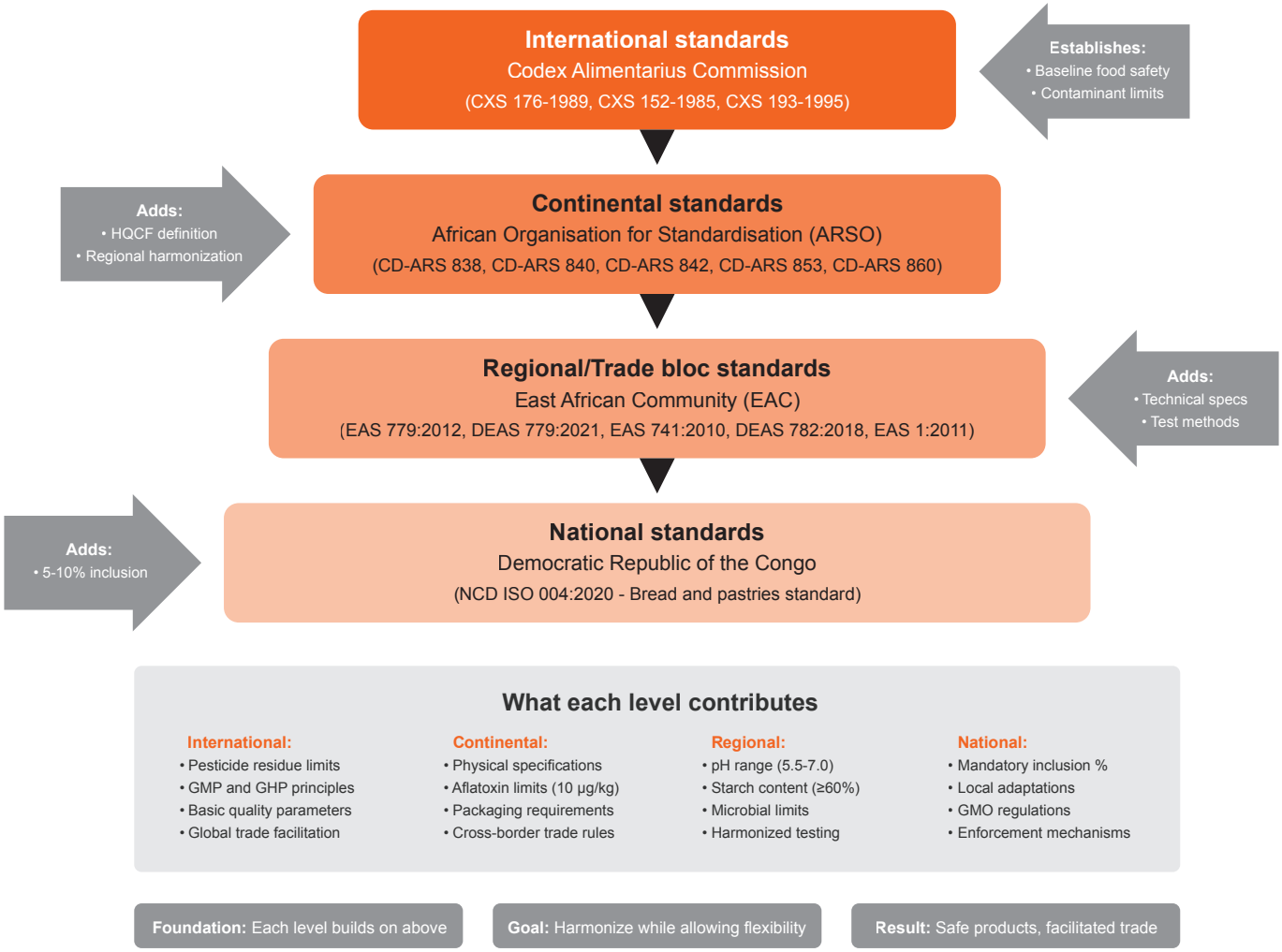

Figure 4.2. Hierarchy of standards pertaining to BCF, wheat flour, composite flour, and bread and pastry products.

International quality benchmarks

International standards, particularly those established by the Codex Alimentarius Commission, provide globally recognized benchmarks for food safety and quality. These standards inform the development of continental, regional, and national requirements, and facilitate international trade. For BCF and composite flour products, international standards establish critical limits for contaminants, residues, and microbial content that protect consumer health across borders.

BCF must conform to:

- Maximum residue limits for pesticides established by Codex Alimentarius
- Maximum levels for contaminants and toxins as per Codex standards
- Microbial limits, including absence of *Salmonella* and *E. coli*
- Maximum yeast and mold counts.

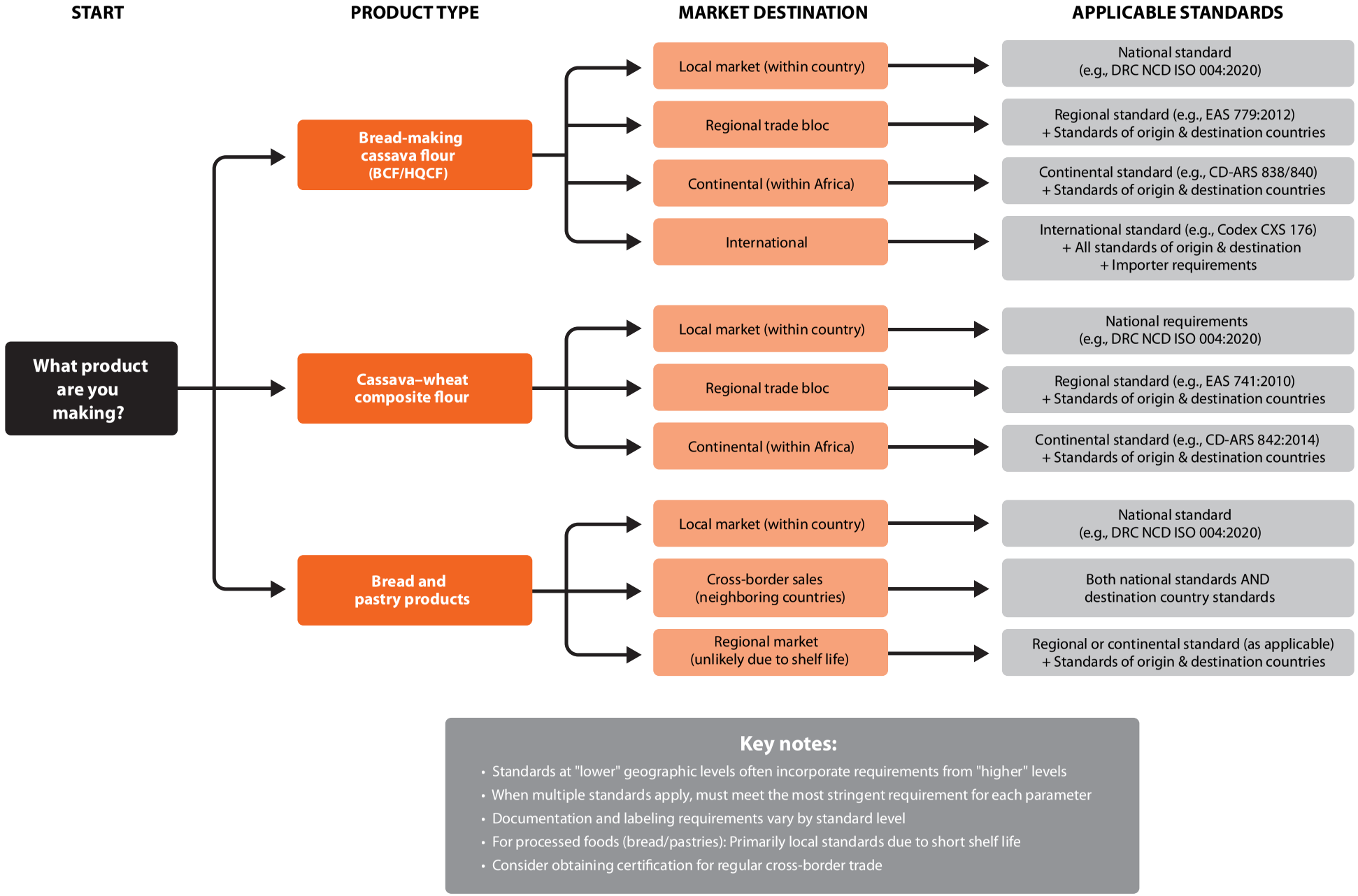

Figure 4.3. Decision tree to determine which standards apply to the product.

SESSION 4.3 KEY TAKEAWAYS

Regulatory framework implementation

- DRC national standards mandate minimum BCF inclusion levels:
  - 5% for bread
  - 10% for pastry products
- Compliance requirements span from national to international standards
- Integration with East African Community standards creates regional trade opportunities.

Quality standards hierarchy

- National standards establish baseline safety and quality requirements
- Regional harmonization facilitates cross-border trade potential
- International standards (Codex Alimentarius) provide global benchmarks for:
  - Contaminant limits
  - Pesticide residues
  - Microbial safety parameters.

Production quality assurance

- Systematic implementation of good manufacturing practices (GMP)
- Rigorous adherence to good hygiene practices (GHP)
- Documented quality control procedures ensuring:
  - Consistent product characteristics
  - Contaminant control below thresholds
  - Consumer safety assurance.

Compliance documentation systems

- Structured record-keeping protocols
- Regular quality parameter monitoring
- Traceability systems implementation
- Product labeling requirements adherence.

Market standards integration

- Evidence-based quality verification procedures
- Systematic monitoring of critical control points
- Regular assessment against regulatory benchmarks
- Documentation of compliance measures.

4.4 QUALITY CONTROL SYSTEMS IN BUSINESS

SESSION 4.4 OBJECTIVES

After completing this session, participants will be able to:

1. Guide bakeries in establishing verification systems for raw material quality
2. Train staff on production process controls and monitoring procedures
3. Implement final product assessment protocols and quality standards
4. Design sanitation and hygiene management systems that meet industry requirements
5. Teach quality control documentation and record-keeping practices.

Quality control in bakery operations encompasses ingredient purchase, storage, processing, and product handling. Following established hygiene and quality practices ensures safe, consistent products that meet standards.

4.4.1 Raw material quality verification

Purchase and receive ingredients only from reliable suppliers approved by government agencies. Check that ingredients are not expired and are properly packaged and transported at appropriate temperatures (chilled products at 4 °C or below). Keep invoices for traceability.

Store ingredients appropriately:

- Follow first-in first-out (FIFO) approach
- Do not use ingredients after best-before dates
- Store at appropriate temperatures
- Store eggs at a cool temperature until needed
- If storing eggs at room temperature, use the current batch daily and replenish stocks daily.

Detailed quality testing methods and protocols are provided in Module 3, section 3.1.

Flour testing protocols

See Module 3, section 3.1.1.

Other ingredient standards compliance

See Module 3, section 3.1.2.

Supplier evaluation criteria

Bakers will have to deal with several suppliers, including millers and wholesale or retail traders (for ingredients required in smaller quantities, such as salt, sugar, yeast, and additives). Eggs are a critical ingredient in terms of stock management; hence, bakers need a reliable daily source of fresh eggs or a reliable refrigerator.

One key to supply reliability (in terms of both quality and availability) is documentation: keeping records, keeping a file (or file folder on your computer) for each supplier, and monitoring reliability. This is especially important in the early days of a relationship or business, when setting up and working out which suppliers can be relied upon and with whom it would be worthwhile building long-term relationships.

A good working relationship with suppliers means they can be relied upon, and puts the buyer in a position to discuss any problems with them directly, knowing that both have a vested interest in solving the issues.

4.4.2 Production process controls

Mixing and kneading standards

See Module 3, sections 3.5.1 and 3.5.2.

Fermentation monitoring

See Module 3, section 3.5.2.

Baking parameter controls

See Module 3, section 3.5.3.

Post-baking controls

After baking:

- Cool products on clean racks and trays, covered during cooling if possible
- Clear crumbs after slicing
- Use clean packaging materials for packing products
- Store bread in clean display cases that are covered at all times
- Do not display bread with perishable fillings (e.g., sardine bread) beyond 4 hours at room temperature
- Use first-in-first-serve approach for display
- Time/date-stamp bread to inform consumers of the best-before date.

INGREDIENT QUALITY CHECKLIST FROM PURCHASE THROUGH STORAGE AND USE

Phase 1: Ingredient procurement and receipt

1. Supplier verification and ingredient receipt

Critical control point: Verify ingredients from approved suppliers with proper documentation

- Check supplier approval status and certifications
- Verify ingredient expiry dates and best before dates
- Confirm proper packaging and transport conditions
- Maintain purchase invoices for full traceability
- Ensure chilled products maintained at ≤4°C

2. Bread-making cassava flour (BCF) quality assessment

Critical control point: Systematic evaluation of BCF quality parameters

- Visual inspection: white color (or yellow if biofortified), fine texture
- Odor assessment: must be completely odorless
- Moisture content verification: ≤12%
- Particle size consistency: 90-98% through specified mesh
- pH range compliance: 5.5-7.0 (East African) / 4.0-4.5 (DRC)

3. Wheat flour quality verification

Critical control point: Comprehensive wheat flour assessment

- Gluten strength evaluation using water mixing test
- Moisture content assessment: ≤13-15.5% depending on standard
- Physical contamination check using water separation
- Color consistency: characteristic creamy white
- Protein content verification: minimum levels per standard

4. Supporting ingredient quality checks

Critical control point: Comprehensive evaluation of all baking ingredients

- Yeast viability testing using sugar syrup bubble test
- Egg freshness assessment: flotation, sound, and break-out tests
- Sugar granulation consistency and purity verification
- Salt purity and moisture content evaluation
- Oil/fat quality and storage condition assessment

Phase 2: Ingredient storage and inventory management

5. Temperature-controlled storage compliance

Critical control point: Systematic temperature monitoring and control

- Chilled products maintained at ≤4°C with continuous monitoring
- Dry goods stored in cool, dry conditions with humidity control
- Temperature logs maintained for all storage areas
- Automated alerts for temperatures outside specified ranges
- Regular calibration of temperature monitoring equipment

(continued next page)

6. First-in-first-out (FIFO) inventory control

Critical control point: Systematic inventory rotation protocols

- Clear labeling with receipt and expiry dates
- Structured storage arrangement supporting FIFO
- Regular stock rotation audits and verification
- Immediate removal of expired or compromised ingredients
- Documentation of inventory movements and usage

7. Cross-contamination prevention protocols

Critical control point: Comprehensive contamination control measures

- Dedicated storage areas for different ingredient types
- Food-grade packaging with secure sealing
- Elevated storage on pallets with accessible inspection areas
- Integrated pest control monitoring and management
- Regular cleaning and sanitization schedules

Figure 4.4. Ingredient quality checklist.

4.4.3 Final product assessment

Determinants of consumer acceptability are physical and sensory characteristics (see Module 3, section 3.6).

Physical characteristics evaluation

See Module 3, section 3.6.

Weight consistency checks

Bread consumers are observant about weight.

4.4.4 Sanitation and hygiene management

Maintaining high standards of cleanliness and hygiene throughout bakery operations is fundamental to ensuring product quality and safety. Regular cleaning, proper waste management, and effective pest control help prevent contamination and maintain a safe production environment. Well-implemented sanitation programs protect both product integrity and consumer health.

See Module 3, section 3.8.2, which provides detailed sanitation and cleaning procedures and protocols.

SESSION 4.4 KEY TAKEAWAYS

Raw material quality verification framework

- Implement systematic supplier evaluation protocols
- Establish documented ingredient acceptance criteria
- Institute structured storage management systems:
  - Temperature monitoring
  - First-in-first-out (FIFO) protocols
  - Contamination prevention measures.

Production process controls

- Standardize critical control points throughout the production cycle:
  - Mixing and kneading parameters
  - Fermentation monitoring protocols
  - Baking temperature verification
- Document process variations and corrective actions
- Maintain calibrated measurement systems.

Post-production quality management

- Establish systematic product assessment protocols:
  - Physical characteristics evaluation
  - Weight consistency verification
  - Quality standard compliance checks
- Monitor environmental conditions during storage and display.

Hygiene and sanitation systems

- Deploy comprehensive cleaning schedules:
  - Daily operational cleaning
  - Monthly deep cleaning protocols
  - Equipment-specific sanitation procedures
- Document sanitization procedures and verification steps
- Train staff in hygiene best practices.

Documentation and verification systems

- Maintain systematic records of:
  - Quality checks and outcomes
  - Process control parameters
  - Corrective actions taken
- Implement regular audit procedures
- Establish product traceability systems.

4.5 RECORD-KEEPING AND FINANCIAL MANAGEMENT

SESSION 4.5 OBJECTIVES

After completing this session, participants will be able to:

1. Train bakeries to maintain accurate production records and output tracking
2. Demonstrate effective financial documentation systems, including cost tracking and revenue recording
3. Implement inventory management procedures that minimize waste and stockouts
4. Design performance monitoring systems using key efficiency and quality metrics
5. Guide bakeries in adapting record-keeping templates for local conditions and literacy levels.

The management of costs, revenues, and net benefits is crucial for a sustainable bakery operation. Based on experiences from bakeries in DRC and Nigeria, this section outlines key aspects of business record-keeping.

4.5.1 Production records

Production records help track daily operations and ensure profitability. Experience from DRC bakeries shows that careful monitoring of ingredient quantities and product output is essential.

Daily output tracking

DRC bakeries track:

- Raw material quantities (e.g., 45 kg wheat flour, 5 kg BCF, 900 g yeast, 60 g salt)
- Product output (e.g., number of loaves by size category)
- Sales prices by product type.

Track also:

- Production parameters (fermentation time, baking temperature).

Quality control checks performed

Each production batch should record:

- Ingredient quality checks performed
- Dough characteristics
- Final product assessment
- Any quality issues encountered.

4.5.2 Financial documentation

Regular financial tracking is essential for managing costs and revenues, and calculating profitability.

Cost tracking systems

Based on the analysis of small-scale bakery operations, track the following.

Fixed costs, including capital expenditure

- Production infrastructure and networking
- Electricity generator
- Administration
- Repairs and maintenance
- Waste and insurance
- Marketing materials.

Variable costs

- Raw materials
- Utilities (water, electricity, fuel, and communications)
- Packaging
- Wages
- Miscellaneous, including contingency.

Revenue recording

Track sales data as demonstrated in DRC bakeries:

- Big bread: 500 loaves at US$1.19 per loaf = US$595.00
- Small bread: 560 loaves at US$0.40 per loaf = US$224.00
- Total revenue per day = US$819.00.

Profit margin calculations

Key metrics from case studies (as per section 4.2.4).

Using 100% wheat flour:

- Total benefit per day: US$819.00
- Total cost per day: US$391.85
- Net benefit (profit) per day: US$427.15
- Return on investment: 2.09.

Using 10% BCF composite:

- Total benefit per day: US$869.12
- Total cost per day: US$376.04
- Net benefit (profit) per day: US$493.08
- Return on investment: 2.31.

Daily production record template

DD/MM/YYYY	Product	Units produced	Quality control checks (Y/N)	Notes (e.g., issues, waste)
/ /	Cassava bread			
/ /	Pastry			

Trainers should emphasize daily recording to ensure accuracy and easy analysis.

Cost tracking template with example data

DD/MM/YYYY	Item	Quantity	Unit cost (US$)	Total cost (US$)	Remarks
/ /	Cassava flour	50 kg	0.43	21.50	
/ /	Wheat flour	315 kg	0.92	289.80	
/ /	Yeast	0.35 kg	3.96	1.39	
/ /	Packaging (bags)	100 pcs	1.32	1.32	
/ /	Electricity	–	–	0.82	
/ /	Labor	–	–	3.85	
Total cost for date:			318.68		

Encourage trainers to teach consistent daily entry to improve accuracy.

Revenue and profit margin calculation template with example data

DD/MM/YYYY	Product	Units sold	Price per unit (US$)	Total revenue (US$)	Total cost (US$)	Net profit (US$)	Profit margin (%)
/ /	Cassava bread	528	1.19	628.32	318.68	309.64	49.3%
/ /	Small bread	602	0.40	240.80	150.25	90.55	37.6%
Total/day		1130		869.12	468.93	400.19	46.0%

Note: Trainers can adapt this template to local currencies and market conditions.

Inventory tracking template with example data

DD/MM/YYYY	Item	Opening stock (kg)	Quantity received (kg)	Quantity used (kg)	Closing stock (kg)	Reorder point
/ /	Cassava flour	150	100	50	200	50
/ /	Wheat flour	500	350	315	535	150

Trainers should highlight the importance of identifying reorder points to avoid stockouts.

4.5.3 Inventory management

Efficient inventory management reduces waste and helps avoid production disruptions.

Stock level monitoring

Track inventory of:

- Raw materials (flours, yeast, etc.)
- Packaging materials
- Finished products.

Reorder point determination

Establish minimum stock levels that trigger reordering based on:

- Usage rates
- Delivery lead times
- Storage capacity.

Storage capacity planning

Plan storage considering:

- Raw material requirements
- Finished product turnover
- Storage conditions needed.

4.5.4 Performance monitoring

Efficiency metrics

Monitor and graph:

- Daily production versus targets
- Raw material usage efficiency
- Labor productivity.

Product quality trends

Track and analyze:

- Quality check results
- Customer feedback
- Product returns or complaints.

Waste reduction monitoring

Record:

- Production waste quantities
- Causes of waste
- Improvement actions taken.

Financial indicators

Based on bakery case studies, monitor:

- Daily net benefits per kg of flour used
- Return on investment ratios
- Total benefit-to-cost comparisons.

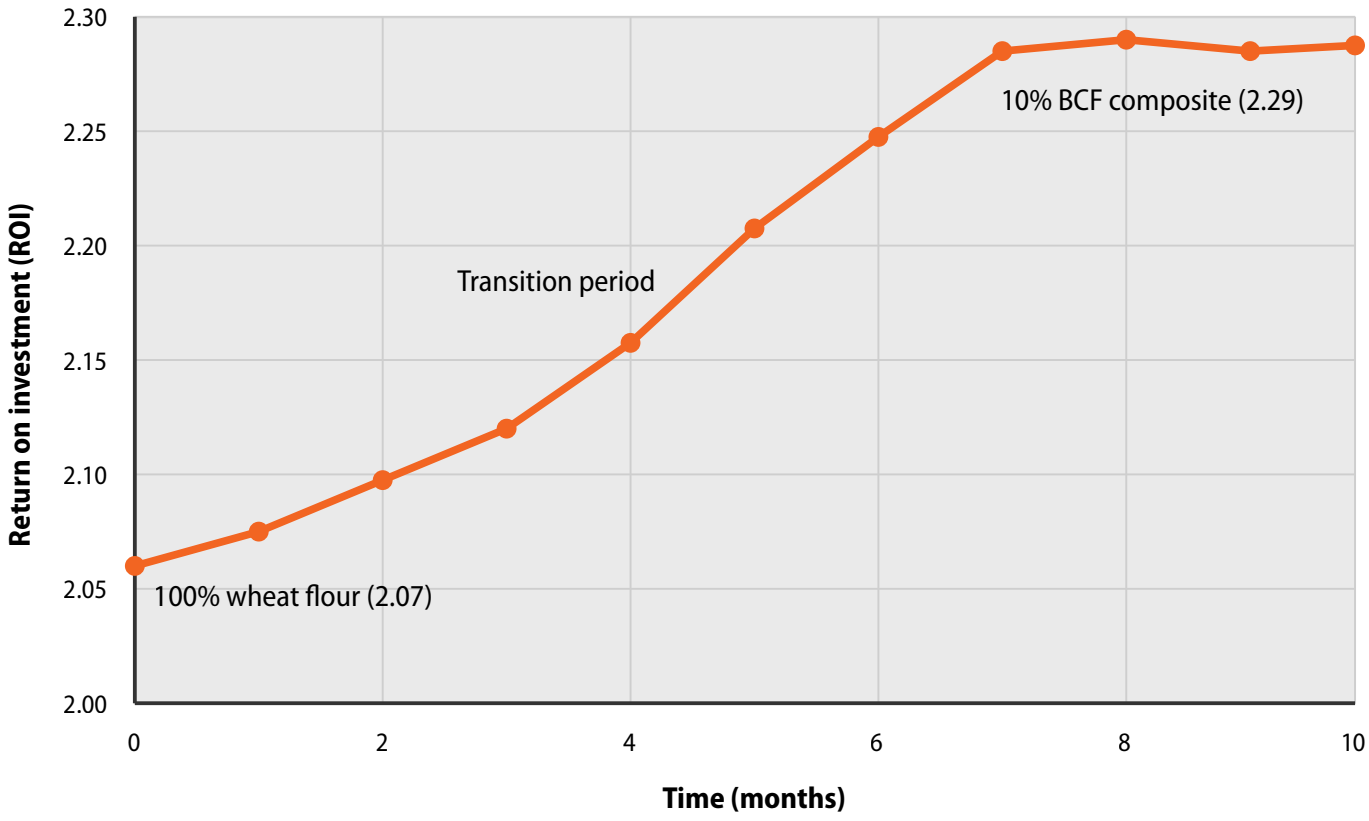

Figure 4.5. Example line graph of ROI over time during a transition to composite cassava–wheat flour from 100% wheat flour.

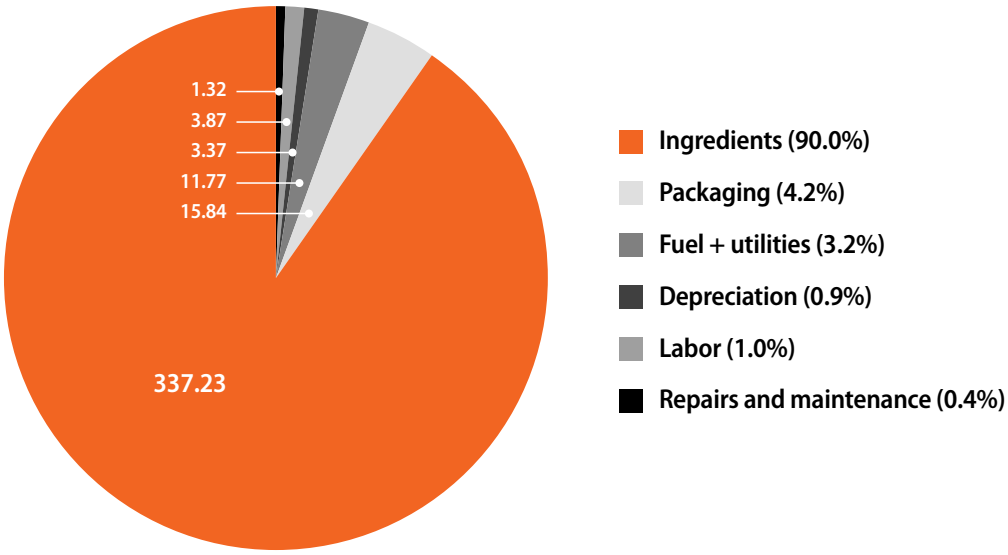

Figure 4.6. Pie chart of distribution of example monthly costs (based on Table 4.3 A–D).

TRAINER'S NOTES

Record-keeping principles

Emphasize:

- Importance of daily recording
- Consistency in documentation
- Accuracy in measurements and calculations
- Regular review and analysis of records.

Local adaptation

Guide trainers to:

- Adjust templates for local currency
- Modify formats based on literacy levels
- Use appropriate local examples
- Consider cultural factors in business practices.

Connection to profitability

Demonstrate how good record-keeping:

- Supports informed decision-making
- Helps identify cost-saving opportunities
- Enables accurate pricing strategies
- Facilitates business growth planning.

SESSION 4.5 KEY TAKEAWAYS

Production documentation systems

- Implement comprehensive daily output tracking:
  - Raw material utilization metrics
  - Product volume by category
  - Quality control parameters
- Monitor critical production indicators systematically
- Document process variations and corrective measures.

Financial performance documentation

- Structured cost tracking framework:
  - Fixed cost monitoring
  - Variable cost assessment
  - Systematic depreciation calculations
- Revenue documentation protocols:
  - Product-specific sales tracking
  - Price point monitoring
  - Margin analysis by category.

Inventory management systems

- Institute data-driven stock level monitoring:
  - Raw material inventory controls
  - Packaging material management
  - Finished product tracking
- Implement evidence-based reorder systems:
  - Usage rate analysis
  - Delivery lead time considerations
  - Storage capacity optimization.

Performance metrics framework

- Track key performance indicators::
  - Production efficiency metrics
  - Quality compliance rates
  - Waste reduction outcomes
- Monitor financial sustainability indicators:
  - Return on investment trends
  - Cost–benefit ratios
  - Profitability metrics.

Systematic documentation protocols

- Establish standardized record-keeping systems
- Implement regular performance review cycles
- Maintain comprehensive audit trails
- Ensure regulatory compliance documentation.

4.6 CASE STUDIES

SESSION 4.6 OBJECTIVE

To learn from real-life case studies of millers and bakers in Nigeria and the Democratic Republic of the Congo.

4.6.1 Challenges faced by millers

Millers play a vital intermediary role in the bread and pastries value chain. Traditionally, millers have taken (mostly imported) wheat grain and turned it into quality bread-making flour for onward sale to bakeries. With the advent of cassava flour substitution, many millers now also blend BCF into milled wheat flour in the proportions stipulated by government directives or bakers' demands (typically, 5–20% BCF in composite flour).

A case study from Nigeria highlights the challenges millers face in sourcing high-quality BCF.

- **Quality:** Vendors (cassava processors) typically cannot produce large volumes of uniform-quality BCF. Most small-capacity BCF processors lack the know-how to consistently produce and deliver high-quality BCF to the wheat flour mills for blending.

  The irregular quality observed at the BCF processors' level includes cases of production batches that are too moist (moisture content higher than dictated by standards), have irregular or rough particle size, dark color, low pH, and microbial load above permissible limits.

- **Traceability:** Most of the BCF supplied is unbranded, uncoded, and unlabeled. Most small-scale BCF supplies do not display vital information such as manufacturing dates, best-before dates, and batch numbers. First-in, first-out (FIFO) stock control in the miller's store is difficult to maintain, making stock management challenging.

However, there has been progress in advancing solutions to increase the production capacity of BCF processors in Nigeria. There is an ongoing effort in Nigeria to enlarge the pool of medium- and large-scale processors of BCF to address the inadequacy of BCF supply in meeting national and regional standards. Other countries (including DRC) may learn from these experiences.

4.6.2 Responsibilities of millers to bakers (Nigeria)

A baker may refuse bread flour that is too dark or too coarse because it will affect the quality of their bread. A baker's primary concern, however, is other inherent technical qualities that the bakery may not be resourceful enough in technology or investment to determine or test (Table 4.4). Thus, millers have a responsibility to be sensitive to these qualities and to deliver them in the cassava–wheat composite flour they produce for bakers.

4.6.3 Bakers' practices in the DRC

In general, there are two types of bakeries in DRC: artisanal (traditional) and mechanical or industrial (with electricity) bakeries. The equipment used is very similar, except that the majority of that used in traditional bakeries is made of wood, while that used in industrial bakeries is made of metal. The key

Table 4.4. Some baking qualities of mutual interest to bakers and millers.

BAKER'S INTEREST	HOW THE WHEAT FLOUR MILLING FACTORY ACHIEVES THIS
Bread flour that will yield more loaves	Ensuring optimal starch damage and tempering during flour milling
High dough spring or loaf volume	By using good-quality wheat grains and flour treatment with enzymes and oxidizing agents
Factory-blended bread flour containing cassava	BCF and wheat should be blended by the miller and sold directly to bakers. Millers need to incorporate flour improvers to enhance bread volume at the bakery Mixing BCF with commercial wheat flour at the bakery reduces gluten content, affecting bread volume
Good crumb color and structure	By ensuring efficient extraction of germ, bran, and shaft (not too low or too high) At the bakery, excessive addition of improver should be avoided
A dough that will be elastic, extensible, and with good stability during proofing	Use of good-quality wheat grains with high protein (gluten) content to manufacture cassava–wheat composite flour. The composite must contain at least 7% gluten Mixing BCF with commercial wheat flour by bakers reduces the gluten content of factory-made flour, affecting bread volume

equipment comprises: weighing scales, trolley, kneader, dough cutter, baking trays, cutter, and wood-fired or mechanical oven.

The principal ingredients used are wheat flour, water, yeast, and salt. Some bakers add additives (e.g., improver, colorant) to enhance flavor or color or to make their bread unique. The baking process involves weighing the ingredients, mixing (the dry ingredients, i.e., flour, salt, and yeast, are mixed together before adding water), kneading, fermentation/proofing (about 1.5–3 hours), cutting into different shapes and sizes, baking (temperature: 230–273 °C; time: 15 minutes), and cooling.

The practical experience of 12 bakers using BCF at 10% substitution in the DRC—in terms of recipes, production machinery and practice, dough input to bread output, and quality—is presented in a table in the Appendix.

MODULE 4 KEY TAKEAWAYS

Strategic business planning framework

- Evidence-based selection between retail and wholesale models
- Systematic assessment of capital requirements and operational costs
- Data-driven analysis has demonstrated enhanced profitability through BCF integration:
  - ROI improvement
  - Production capacity increase
  - Net cost reduction.

Regulatory compliance integration

- Structured implementation of multilevel standards:
  - National BCF inclusion requirements (5–10%)
  - Regional harmonization protocols
  - International safety benchmarks
- Systematic quality assurance frameworks
- Documented compliance verification systems.

Quality management systems

- Comprehensive control protocols spanning:
  - Raw material verification
  - Production process monitoring
  - Final product assessment
- Evidence-based hygiene management
- Systematic documentation requirements.

Financial sustainability metrics

- Data-driven performance monitoring:
  - Production efficiency indicators
  - Cost–benefit analysis frameworks
  - Revenue optimization metrics
- Structured inventory management systems
- Comprehensive record-keeping protocols.

Implementation support framework

- Clear operational guidelines for:
  - Equipment selection and maintenance
  - Staff training and supervision
  - Quality control implementation
- Systematic monitoring and evaluation protocols
- Evidence-based decision-making support.

MODULE 5: TEACHING METHODOLOGY

MODULE 5 OBJECTIVES

After completing this module, trainers will be able to:

1. Apply adult learning principles to effectively engage experienced bakers and pastry-makers in training sessions
2. Demonstrate bread-making techniques using appropriate demonstration methods and hands-on practice approaches
3. Adapt teaching methods to accommodate diverse learning styles, literacy levels, and cultural contexts
4. Use competency-based assessment methods to evaluate trainee skill development and provide constructive feedback
5. Structure training delivery that balances technical accuracy with practical application of composite flour bread-making skills.

Assumed trainee background: All participants are experienced bakers or pastry-makers, so training builds on their existing skills and industry knowledge. This allows the trainer to use advanced examples and focus on refining techniques rather than basic baking concepts. Training activities should acknowledge and draw on trainees' prior experience (e.g., inviting them to share their own baking tips), which respects their background and accelerates learning (Khisa 2004).

5.1 ADULT LEARNING PRINCIPLES AND ANDRAGOGY

- **Learner-centered approach:** Adopt core adult learning principles (andragogy) that emphasize active involvement and relevance to the learner's work. Unlike pedagogy for children, andragogy treats trainees as self-directed adults who learn best by doing and by solving real problems (Khisa 2004; Halim and Ali 1997). Encourage problem-solving and "learning by doing" rather than one-way lecturing, since the focus is on learning, not teaching (Khisa 2004).
- **Building on experience:** Recognize that adult trainees bring a wealth of practical experience. Invite sharing of experiences and peer learning—adults learn most from each other when given opportunities to discuss and collaborate (Khisa 2004). For example, trainers can facilitate group discussions in which trainees compare their past bread-making methods; this validates their expertise and lets them learn from peer successes and mistakes.
- **Relevance and immediate application:** Adults are motivated when content is directly applicable to their needs and goals. Ensure each topic (e.g., composite flour handling, new dough techniques) is linked to real bakery scenarios so trainees see why it matters and how to apply it in their work (Williams 2019). Clearly communicate learning objectives and highlight practical benefits (e.g., cost savings, product quality) to sustain motivation.
- **Respect and inclusivity:** Maintain a respectful learning atmosphere that values each trainee's contributions. Treat adult learners as equal partners; never demean or embarrass them for mistakes (Khisa 2004). Encourage questions and feedback, showing that their opinions count. Culturally, be sensitive—use local language or analogies familiar to trainees, and acknowledge traditional baking practices to make the training culturally relevant.
- **Experiential and participatory learning:** Integrate Kolb's experiential learning cycle (concrete experience, reflective observation, abstract conceptualization, active experimentation) by having trainees experience tasks, reflect on results, conceptualize improvements, and apply lessons (Williams 2019). Whenever possible, use participatory methods—make the trainer a *"guide on the side"* facilitating activities rather than a "*sage on the stage*" lecturing (Williams 2019). For instance, start a session by posing a problem ("bread is turning out too dense—why?") and let trainees brainstorm solutions, with the trainer guiding the discussion. This approach harnesses adult learners' desire for involvement and taps into their problem-solving skills, making learning more engaging and memorable.

5.2 DEMONSTRATION AND HANDS-ON TECHNIQUES

- **Show-then-do method:** Use demonstration-based learning as a core methodology for technical bread-making skills. The demonstration–practice method is highly effective for teaching procedures: the trainer first *demonstrates* each step of a task, then allows trainees to practice it themselves under supervision (FICSI and E3 undated). For example, the trainer might demonstrate mixing of cassava–wheat dough, highlighting proper ingredient ratios and techniques, then each trainee practices mixing their own batch. This "see one, do one" approach builds confidence and muscle memory in a controlled setting.
- **Step-by-step modeling:** Break down complex processes (e.g., dough kneading, fermentation monitoring, oven operation) into clear steps. Model each step slowly and visibly, using real ingredients and equipment. Ensure everyone can observe key details (e.g., position of hands when kneading, dough consistency, oven temperature settings). Encourage trainees to ask questions during the demonstration. By observing an expert performance, learners grasp the standard to emulate (FICSI and E3 undated) and can later mirror these actions.
- **Interactive demonstrations:** Keep demonstrations interactive to maintain adult learners' engagement. Rather than a silent demonstration, narrate your actions with explanations (e.g., "I'm adding water gradually because bread-making cassava flour absorbs moisture differently"). Prompt trainees with questions (e.g., "What difference do you notice in the dough texture with 10% bread-making cassava flour?") to engage their thinking. You can also invite volunteers to assist in the demonstration or have trainees critique a premade example (e.g., compare a well-baked loaf with a poorly fermented one)—turning the demonstration into a two-way conversation.
- **Hands-on practice and repetition:** After the demonstration, allocate ample time for hands-on practice. Adults learn technical skills best by *repeatedly performing* the task themselves (Halim and Ali 1997). Set up practice stations where small groups can work on mixing or shaping dough. The trainer and any assistants should circulate to coach, correct techniques, and answer questions in real time. Learning by doing with immediate feedback helps solidify competencies and addresses individual difficulties on the spot (Williams 2019). Ensure every trainee practices each key skill (measuring ingredients, mixing, baking) at least once, even if resource constraints require rotating through stations.
- **Use of teaching aids:** Use simple teaching aids to enhance demonstrations, especially in resource-limited settings. Large visual charts or infographics can illustrate the steps of cassava flour processing or optimal dough consistency. If literacy is an issue, rely on pictorial guides and live demonstrations rather than text-heavy handouts (Williams 2019). Physical samples of ingredients (showing high-quality compared with subpar flour) and finished product examples can serve as reference points during the demonstration. Such multisensory aids reinforce learning for adult trainees by showing tangible results of techniques.

5.3 AUDIENCE ADAPTATION STRATEGIES

For technical training to be effective, teaching methods must be adapted to the diverse backgrounds, learning styles, and educational levels of trainees. While Module 6 section 6.5 addresses planning for local adaptation, this section focuses on adapting teaching methods and delivery approaches to ensure learning success across diverse groups.

- **Teaching for diverse literacy levels:** Design teaching methods that accommodate diverse literacy and education levels. For groups with limited literacy, emphasize visual learning and oral instruction over written materials. Demonstrate procedures physically and supplement with verbal descriptions. When using written instructions, read them aloud and confirm understanding through discussion. Research shows pictorial representations and storytelling effectively convey information to low-literacy learners (Williams 2019). Keep content clear and minimize technical jargon to make learning accessible.
- **Language and communication adaptation:** Structure teaching delivery to maximize comprehension across language abilities. Explain technical terms (e.g., "gluten development" or "proofing") in simple language, relating them to familiar baking concepts. Allow trainees to ask questions and discuss in their preferred language. Where needed, provide interpretation support or bilingual materials. Clear communication ensures critical technical points (e.g., mixing ratios, temperatures, safety protocols) are understood regardless of language background.
- **Culturally responsive teaching:** Design teaching approaches that respect and incorporate trainees' cultural context. Connect new techniques to traditional baking practices they know. Use culturally relevant examples and analogies when explaining concepts. Be mindful of cultural norms around learning—for instance, if elders' knowledge is highly valued, create opportunities for experienced bakers to share insights. Cultural sensitivity in teaching methods helps trainees connect new skills to their existing knowledge.
- **Inclusive participation methods:** Use teaching techniques that engage all learners regardless of background. Mix discussion, demonstration, and hands-on practice to accommodate different learning styles. For group work, combine trainees of diverse experience levels

to encourage peer teaching. Draw quieter participants into discussions through targeted questions or by inviting them to demonstrate skills they are confident in. Create a supportive environment where everyone feels able to participate and learn.

- **Teaching with available resources:** Adapt teaching methods to work effectively with available equipment and materials. If modern bakery equipment is limited, demonstrate techniques using basic tools while explaining principles that apply to any setup. Use locally available ingredients to show how quality standards can be maintained even with different resources. This practical approach helps trainees learn to adapt techniques to their own teaching environments.

Effective adaptation of teaching methods ensures that training reaches all participants, regardless of their backgrounds. By consciously adjusting communication, examples, and teaching techniques while maintaining technical accuracy, trainers can create an inclusive learning environment that supports skill development for all trainees.

5.4 COMPETENCY-BASED AND PARTICIPATORY ASSESSMENT METHODS

Assessment in technical training must focus on measuring practical competencies and skill development. While Module 6 section 6.6 addresses assessment planning and documentation systems, this section focuses on methods for evaluating trainee learning and providing effective feedback during training.

- **Competency-based skill evaluation:** Base assessment on trainees' ability to perform key tasks to required standards (Halim and Ali 1997). Rather than traditional written tests alone, use practical skill assessments where trainees demonstrate bread-making processes from ingredient preparation through to final product evaluation. Create detailed checklists of competencies (e.g., correct measurement of ingredients, proper dough consistency, appropriate baking temperature control) and assess each trainee's performance against these standards. This performance-based approach ensures training achieves its goal of developing qualified trainers who can both demonstrate and teach essential skills.
- **Formative assessment techniques:** Incorporate ongoing checks throughout training sessions to gauge understanding and skill development. Ask probing questions during demonstrations to verify comprehension. Observe trainees during hands-on practice, noting common errors or difficulties. Use these observations to guide immediate corrective feedback or pause for group discussion of challenging points. Short knowledge checks through group problem-solving exercises help reinforce learning before moving to new topics. This continuous assessment helps identify areas needing additional attention before the final evaluation.
- **Summative assessment approaches:** Design end-of-training evaluations that comprehensively test both knowledge and practical skills. Consider combining written tests on key concepts with practical assessments where trainees demonstrate complete bread-making processes or teach segments to peers. Ensure assessment criteria are transparent—provide trainees with evaluation standards in advance so they understand performance expectations. Make summative assessments simulate real training scenarios that trainees will face when teaching others.
- **Feedback and reflection methods:** Use a constructive approach when providing assessment feedback. During practical work, offer immediate guidance on technique improvements while acknowledging successful elements. Lead group discussions analyzing results of practice sessions, encouraging trainees to reflect on their learning. Create opportunities for peer feedback in a supportive environment. This reflective practice helps trainees develop their own ability to assess and guide others.
- **Individual skills development:** When assessment reveals gaps in particular competencies, provide targeted support through additional demonstration, guided practice, or one-on-one coaching. Focus on building mastery rather than simply passing or failing trainees. Offer resources for continued practice and skill refinement. This individualized approach ensures each trainee achieves the required competency level before training others.

Effective assessment methods combine rigorous competency evaluation with supportive feedback to develop confident, capable trainers. By using various assessment approaches while maintaining focus on practical skills mastery, trainers can ensure training outcomes meet industry needs.

5.5 TEACHING METHODOLOGY FOR BREAD-MAKING SKILLS

Teaching bread-making requires careful attention to both technical accuracy and effective knowledge transfer. The trainer must break down complex processes into learnable components while maintaining focus on quality standards and safety. This section outlines specific teaching approaches for key bread-making competencies.

- **Quality assessment instruction:** Build trainees' skills in evaluating ingredients through structured comparative learning. Set up ingredient assessment stations where trainees can examine both acceptable and substandard samples of flour, yeast, and other ingredients. Guide them through systematic quality checks using industry-standard criteria. For instance, when teaching flour evaluation,

demonstrate the look, feel, and smell tests, then have trainees practice these assessments themselves. Make extensive use of visual aids showing quality indicators at different stages. The trainer should prepare examples that demonstrate both good- and poor-quality characteristics to help trainees develop strong evaluation skills.

- **Dough mixing and handling techniques:** Adopt a progressive approach to teaching dough preparation skills. Begin with basic mixing principles and gradually advance to more complex techniques. When demonstrating dough mixing, clearly explain each step while modeling proper technique. For composite flour dough, explicitly highlight differences from standard wheat dough handling. Have trainees first observe the entire process, then practice in small groups with close supervision. Provide immediate feedback on technique, paying special attention to the proper incorporation of bread-making cassava flour and assessment of dough consistency. Encourage trainees to feel properly mixed dough to develop a tactile understanding of correct texture.
- **Fermentation monitoring methods:** Structure teaching around the visual and tactile indicators of proper fermentation. Begin by demonstrating the characteristics of dough at different fermentation stages. Show trainees how to assess dough development through observation and the poke test. Create opportunities for trainees to monitor multiple dough samples at various fermentation stages, helping them understand the progression. Include practice sessions on timing dough fermentation under different conditions, as composite flour can affect fermentation rates. Use comparison samples to illustrate both proper and improper fermentation.
- **Temperature control instruction:** Build understanding of temperature's critical role through practical demonstrations. Show proper oven temperature measurement and adjustment techniques. Have trainees practice using temperature monitoring tools and recording readings. Demonstrate the effects of different temperatures using sample bakes, allowing trainees to observe and compare results. Include troubleshooting exercises that require trainees to identify and correct temperature-related issues. This hands-on approach helps develop the judgment needed for consistent baking results.
- **Product evaluation teaching:** Develop assessment skills through guided practice with clear quality standards. Start by showing examples of properly baked products and explaining evaluation criteria. Have trainees examine products with different characteristics—proper and improper crust color, texture, crumb structure, etc. Guide group discussions of quality factors, encouraging trainees to articulate their observations. Include blind evaluation exercises in which trainees assess product quality independently, then discuss their findings as a group. This builds confidence in quality judgment.
- **Safety and hygiene instruction:** Integrate proper practices throughout all demonstrations and hands-on sessions. Model correct hygiene procedures consistently, explaining their importance for food safety. Use role-playing exercises to practice proper handwashing, equipment sanitization, and personal protective equipment (PPE) use. Have trainees demonstrate proper practices during their practical work and provide immediate correction of any lapses. Make food safety a continuous theme rather than a separate topic.

The key to effective bread-making instruction is maintaining a balance between technical accuracy and practical application. Each teaching segment should combine clear demonstration, guided practice, and supportive feedback. As trainees progress, gradually reduce direct supervision while maintaining quality standards. This approach builds both competence and confidence in working with composite flour breads.

5.6 SUMMARY: BEST PRACTICES IN TEACHING METHODOLOGY FOR TECHNICAL TRAINERS

Effective technical training combines proven adult education principles with hands-on skill development. This section summarizes key methodological approaches that support successful training delivery.

- **Engage adults actively:** Make training participatory and problem-focused. Draw on trainees' experience and knowledge. Structure activities around real workplace challenges. Active engagement through discussion, practice, and problem-solving leads to deeper learning than lecture alone.
- **Use demonstration effectively:** Follow the "show–do–check" sequence. First, demonstrate the complete process, then break it down into steps, then guide trainee practice. Provide clear explanations during demonstrations. Allow time for questions and closer observation of critical techniques.
- **Enable hands-on learning:** Allocate substantial time for supervised practice. Give immediate, constructive feedback on technique. Create opportunities for trainees to work through real production scenarios. Hands-on experience builds practical competency and confidence.
- **Adapt to diverse learners:** Recognize different learning styles and backgrounds. Use multiple teaching methods, including visual, verbal, and tactile approaches. Adjust the pace and complexity based on trainee response. Create an inclusive learning environment that supports all participants.

- **Assess competency systematically:** Use clear performance criteria for evaluation. Combine observation of practical skills with understanding of principles. Track individual progress and provide targeted support where needed. Focus assessment on job-relevant capabilities.
- **Build confidence progressively:** Start with basic skills and advance to more complex techniques. Acknowledge successful performance and improvements. Help trainees learn from mistakes constructively. Support the development of independent judgment and problem-solving ability.
- **Maintain quality focus:** Emphasize quality standards consistently. Show examples of both good and poor results. Guide the development of quality assessment skills. Help trainees understand the reasons behind quality requirements.
- **Model professional practices:** Demonstrate proper safety and hygiene throughout training. Show efficient work methods and organization. Maintain a professional training environment. Help trainees develop good workplace habits.

Successful technical training requires attention to both teaching methodology and practical skill development. By applying these principles systematically, trainers can help participants develop the competencies needed for effective bread production with composite flour.

MODULE 5 KEY TAKEAWAYS

Essential adult learning principles

- Active participation and hands-on practice are fundamental for skill retention
- Building on trainees' existing bakery experience accelerates learning
- Immediate practical application reinforces theoretical concepts
- Problem-focused learning drives higher engagement than lecture-only approaches.

Effective demonstration methods

- "Show–do–check" sequence optimizes technical skill transfer
- Clear step-by-step modeling enables accurate replication
- Interactive demonstrations with guided observation build comprehension
- Regular practice opportunities with feedback cement proper techniques.

Adaptation strategies for diverse learners

- Multiple teaching methods accommodate different learning styles
- Visual aids and practical examples overcome literacy barriers
- Cultural sensitivity in examples and analogies enhances relevance
- Resource-appropriate demonstrations ensure applicability.

Assessment and quality focus

- Competency-based evaluation measures practical skill mastery
- Ongoing feedback guides continuous improvement
- Clear quality standard benchmarks maintain consistency
- Progressive skill-building develops technical confidence.

Professional standards integration

- Safety and hygiene practices modeled throughout training
- Quality assessment skills developed systematically
- Problem-solving abilities strengthened through guided practice
- Workplace-ready habits reinforced in training environment.

Bibliography for Module 5

Ciobanu (2018); Explore Psychology (2025); FICSI and E3 (undated); Halim and Ali (1997); Khisa (2004); Knowles (1984); WHO Africa (undated); Williams (2019).

MODULE 6: IMPLEMENTATION PLANNING

MODULE 6 OBJECTIVES

By the end of this module, trainers will be able to:

1. Conduct systematic training needs assessments to align program design with participant and stakeholder requirements
2. Develop structured session plans that effectively balance theory, demonstration, and hands-on practice while accommodating bread production timing
3. Create comprehensive resource plans covering equipment, materials, documentation, and personnel needs for training delivery
4. Design appropriate training spaces that support both classroom learning and practical bread production while meeting safety and hygiene requirements
5. Adapt training approaches and materials to local conditions, resources, and cultural contexts
6. Implement monitoring systems to track training effectiveness and participant progress
7. Establish follow-up support mechanisms to ensure the successful application of learning in trainees' workplaces.

Effective training delivery begins long before the first session. It requires careful planning to ensure that content meets learners' needs and that all necessary resources and support systems are in place. This module guides technical trainers through the key steps of planning and delivering successful training on cassava–wheat composite flour bread production.

6.1 TRAINING NEEDS ASSESSMENT

Before designing the training implementation, conduct a thorough training needs assessment (TNA) to ensure the program matches trainee and stakeholder requirements.

- **Profile target trainees:** Determine trainee characteristics and existing skills through pretraining surveys or interviews. Tools such as preworkshop questionnaires help gauge knowledge of cassava processing, years of baking experience, and previous training. Profile information should cover language abilities, literacy levels, cultural factors, and current baking practices. *For example, IITA training in Nigeria had participants complete detailed preworkshop forms about their experience with composite flours and production volumes (Sanni et al. 2007).* This profiling shapes decisions about training approach, translation needs, and support requirements.
- **Identify skill gaps:** Compare current capabilities with required competencies for successful composite-flour bread production. Look for gaps in technical areas such as flour quality assessment, dough handling, and process control. Consider both individual needs (e.g., inexperience with cassava flour) and common group gaps (e.g., limited understanding of quality standards). Document specific competencies that need development—for instance, if many trainees lack experience with composite flour doughs above 5% substitution, training must emphasize techniques for higher inclusion rates. Use gap analysis to prioritize training content and determine needed resources.
- **Define learning objectives:** Set clear, measurable objectives based on identified needs. For instance, rather than general goals such as "learn about composite flour", specify objectives such as "correctly mix and handle dough containing 10% BCF" or "accurately assess flour quality using standard tests". Ensure objectives are achievable within available time and resources. Consider both technical competencies and broader capabilities such as problem-solving and quality management. Align objectives with national standards and industry requirements for composite-flour bread production. Aligning objectives with

Table 6.1. Session planning template guide.

SESSION COMPONENT	PLANNING CONSIDERATIONS
Session objectives	What specific skills/knowledge will trainees gain?
Prerequisites	What must trainees know/have before this session?
Materials needed	List all ingredients, equipment, documentation
Time requirements	Duration for setup, activity, cleanup
Teaching methods	Which approaches best suit the content?
Practice activities	How will trainees apply the learning?
Assessment approach	How will competency be verified?
Contingency plans	What alternatives if equipment or materials unavailable?

real needs ensures the training is relevant and results-oriented (USAID Advancing Nutrition 2023).

- **Consult stakeholders:** Engage local bakery owners, flour producers, miller associations, and relevant government agencies. Their input will help identify practical implementation challenges (e.g., sourcing consistent quality BCF) and ensure training addresses workplace realities (USAID Advancing Nutrition 2023). Stakeholder support can facilitate access to equipment, ingredients, and training venues. Document stakeholder requirements and suggestions to inform planning.

6.2 SESSION PLANNING AND TIMING

Careful session planning ensures that training flows logically and fits within time constraints while meeting adult learners' needs. The trainer must consider both the natural timing of bread production processes and participants' learning requirements.

- **Plan modules with logical flow:** Break the training into modules arranged from fundamentals to advanced topics in a sequence that builds understanding. Each session should have a clear purpose and connect to the next. For instance, start with ingredient knowledge before moving on to dough preparation. Clearly define what each session will achieve and how it ties into the overall training goal. When planning a sequence, consider how to build trainee confidence through early successes while preparing them for more complex techniques. This progressive approach helps maintain motivation and ensures foundational skills are solid before advancing.
- **Design timing around bread production:** Use the natural timing of bread-making processes to structure the training day. While dough ferments, engage trainees in complementary activities such as quality assessment or discussion of results. Build in time for proper cleaning and preparation between batches. Consider local conditions—for example, scheduling baking during cooler hours in hot climates. This practical approach helps trainees understand real production timing while making efficient use of training hours.
- **Allocate time appropriately:** Determine realistic durations for lectures, demonstrations, practical exercises, discussions, and breaks. Give more time to complex or new concepts—for instance, first-time dough mixing with BCF may need a longer hands-on segment. Be realistic about timing and avoid overloading the schedule. Factor in setup and cleanup periods for practical work. Include short breaks to maintain learner focus, especially during intensive practical sessions. A typical 90-minute session might comprise 30 minutes of presentation, 50 minutes of practical exercise, and 10 minutes for recap.
- **Use a session plan format:** Prepare a session plan for each module, detailing the timing and method for each activity. Many trainer manuals recommend structuring sessions with an introduction, a development (main activity/lesson), and a conclusion or wrap-up. In the introduction, the trainer can recap previous lessons and state the session's objectives. The development section covers the teaching content or skills practice. The wrap-up should summarize key points and link to upcoming topics.
- **Build in flexibility:** While planning is important, be prepared to adapt during the training. Some groups may grasp concepts quickly and free up time for extra practice; others may need additional explanation or a slower pace. Include buffer time or optional activities in the schedule. If a session runs short, have enrichment activities ready (e.g., discussing case studies or troubleshooting scenarios). If running long, know which elements can be adjusted without compromising essential learning. This flexibility ensures the training stays on track while meeting participant needs. *Suggested durations for each session segment should serve as flexible guidelines rather than fixed timings. Facilitators are encouraged to adjust the schedule in response to trainees' interaction levels and emerging needs during the training.* This adaptive approach can enhance engagement and improve learning outcomes (CDAIS 2017; Keller 2019).

RESOURCE	QUANTITY REQUIRED	SOURCE	ORDERED	RECEIVED
Training materials and equipment				
Bread-making cassava flour				
Wheat flour				
Yeast				
Sugar				
Salt				
Improvers				
Ovens				
Mixers				
Proofing baskets				
Baking trays				
Graters				
Dryers (e.g., sun-drying mats)				
Power / fuel				
Aprons				
Gloves				
Hairnets				
First-aid kit				
Stationery and instructional aids				
Flip chart / whiteboard				
Markers				
Participant notebooks				
Pens (for participants)				
Handouts (specify):				
Visual aids (specify, e.g., posters, laminated diagrams):				
Job aids (specify, e.g., recipe cards, "do's and don'ts"):				
Venue and utilities				
Training venue				
Water				
Electricity (if available/ required)				
Food and drink				

Figure 6.1. Sample resources list.

- **Plan for parallel activities:** When training involves multiple tasks or limited equipment, create efficient rotation systems. For example, while one group works on dough mixing, another can practice quality assessment or documentation. Use waiting periods (e.g., fermentation time) productively for theory sessions or skill review. Ensure all trainees receive adequate hands-on practice with each aspect of production through careful group scheduling and task coordination.
- **Consider participant factors:** Account for participant needs and local conditions in scheduling. Factor in travel time, cultural practices such as prayer times, and local business patterns such as market days. Plan more challenging activities when participants are fresh and alert. Consider seasonal factors that might affect ingredient availability or training conditions. This attention to context helps ensure good attendance and engagement.

Training schedules should serve as flexible guidelines rather than rigid timetables. The key is to maintain a good balance between theory and practice while ensuring adequate time for skill development. Regular assessment of timing effectiveness helps refine planning for future sessions.

6.3 RESOURCE PLANNING AND PREPARATION

Adequate resources—both materials and personnel—must be in place for effective training delivery, especially in a technical, hands-on course such as baking with composite flour. Early planning helps ensure all necessary items are available when needed.

- **Training materials and equipment:** Inventory all physical items required for demonstrations and practical exercises. This includes ingredients (e.g., BCF, wheat flour, yeast, sugar, salt, improvers), baking equipment (e.g., ovens, mixers, proofing baskets, baking trays), and processing tools. Ensure quality and sufficient quantities so that all participants can practice adequately. If the training involves showing flour processing, prepare the needed tools such as graters. For baking sessions, secure functional ovens (charcoal- or wood-fired, gas, or electric as available) and backup fuel or power. Safety gear (e.g., aprons, gloves, hairnets, first-aid kit) must be included as part of the resource list. Plan for maintenance and repairs during training.
- **Documentation and teaching aids:** Prepare materials that support learning, especially for diverse learners. Have flip charts or whiteboards with markers for illustrating processes and noting key points. Provide participants with notebooks and pens for note-taking. Print handouts or manuals in advance—these might include recipes, process flow charts, equipment operating procedures, and quality checklists. Visual aids (e.g., posters or laminated diagrams of bread-making steps and ingredient quality criteria) can be displayed in the training venue. Simple job aids such as recipe cards or "dos and don'ts" charts make useful takeaways for trainees.
- **Human resources:** Plan for adequate training staff and support personnel. A lead trainer to present content may need co-trainers or assistants to help with demonstrations and coach participants during hands-on work. In baking training, when participants work in small groups to make dough or bake, multiple trainers circulating improves learning. For large groups, consider dividing into smaller groups for practical sessions. Identify any guest speakers or local experts (e.g., successful bakers who have adopted cassava flour) who can share experiences.
- **Budget and procurement:** Work out detailed costs early in planning. Include consumables (e.g., ingredients for all practice batches, fuel, stationery), equipment rental if needed, and participant support costs. Seek cost-effective options—for instance, sourcing BCF from a local processor at bulk rates, or borrowing equipment from local bakeries. If funds are limited, prioritize critical items that cannot be improvised. Plan transport logistics for moving equipment or accessing facilities.
- **Contingency resources:** Prepare backup plans for key resources. This might include alternative power sources if electricity is unreliable, spare equipment parts, or additional ingredients to replace spoilage. Consider how to adapt if certain resources become unavailable—for example, alternative mixing methods if electric mixers fail. Document contingency plans to help manage unexpected resource challenges.

A thorough resource plan supports smooth training delivery. Regular reviews during preparation help identify potential gaps before they impact training effectiveness.

6.4 TRAINING SPACE SETUP AND MANAGEMENT

The training environment significantly affects learning success. Choose and prepare spaces that support both theoretical and practical training while meeting safety and comfort needs.

- **Production area requirements:** Select a location that simulates a real bakery environment as closely as possible. An ideal venue is a bakery kitchen or production area equipped with basic bread-making facilities: reliable ovens or baking stoves, work tables or kneading surfaces, mixing equipment, ample clean water supply, and proper ventilation. If using an actual bakery, coordinate timing to avoid disrupting normal operations. The space must allow demonstration and practice of each production step—mixing, proofing, baking, and cooling. Consider workflow when arranging equipment and work areas.

- **Classroom facilities:** Ensure adequate space for instruction and discussion sessions. Provide proper seating and work surfaces for notetaking and reference materials. Lighting should be sufficient for viewing demonstrations and written materials. If possible, locate classroom space near production areas to facilitate movement between theory and practice. Consider acoustics—participants must be able to hear instructions over equipment noise.
- **Safety and hygiene setup:** Organize the space to support safe operation and good hygiene practices. Install handwashing stations and sanitizing facilities. Ensure clear access to emergency exits and firefighting equipment. Maintain adequate ventilation, especially around ovens and mixing areas where flour dust may be present. Post relevant safety signage and hygiene reminders. Set up first-aid stations in easily accessible locations.
- **Storage and utilities:** Arrange secure storage for ingredients, equipment, and participant belongings. Ensure a reliable water supply for recipe use and cleaning. Plan for an adequate electrical supply if using powered equipment. Consider refrigeration needs for perishable ingredients. Organize cleaning supplies and waste management systems. The space should support proper inventory management and hygiene maintenance.
- **Environmental controls:** Address factors affecting comfort and product quality. Plan ventilation to manage heat from ovens and humidity that may affect dough fermentation. Consider seasonal weather impacts when selecting and arranging spaces. Install fans or other cooling systems if needed. Control dust and maintain clean air quality. Good environmental management supports both learning and successful baking.

Training space preparation directly impacts program effectiveness. Regular monitoring helps maintain suitable conditions throughout the training period.

6.5 LOCAL ADAPTATION STRATEGIES

Successful training implementation requires careful adaptation to local conditions and resources. While Module 5 section 5.3 covers adapting teaching methods, this section focuses on planning and preparation strategies to ensure training is relevant and practical in the local context.

- **Resource assessment and planning:** Before training, evaluate available local materials and equipment. Identify which standard baking tools are available and what alternatives might be needed. Plan how to effectively demonstrate techniques using available resources—for instance, if electric mixers are scarce, include manual mixing demonstrations. Document required adaptations to recipes or procedures based on local ingredients and equipment. This preparation ensures training can be delivered effectively within local constraints.
- **Language and communication planning:** Determine language needs and arrange appropriate support. If training materials need translation, schedule this well ahead and verify technical terms are accurately conveyed. If interpreters will be needed, brief them on baking terminology and concepts. Plan for additional time in sessions to accommodate translation or explanation in multiple languages. Create visual aids that work across language barriers.
- **Integration of local knowledge:** Research local baking traditions and practices before training. Identify respected local bakers or food processors who might contribute valuable perspectives. Plan how to incorporate traditional techniques alongside new methods, showing respect for existing expertise while introducing improvements. This preparation helps establish the training's credibility and relevance.
- **Cultural context preparation:** Learn about local cultural norms that may affect training delivery. Consider factors such as appropriate training times (avoiding prayer times or market days), gender dynamics in food preparation, or local beliefs about certain ingredients. Plan seating arrangements, group activities, and practical sessions to align with cultural expectations. Document any sensitive topics or approaches to avoid.
- **Logistical adaptation:** Develop plans for managing training within local infrastructure limitations. Consider backup power sources if electricity is unreliable (e.g., charcoal or wood-fired ovens), alternative cooling methods if refrigeration is limited, or creative solutions for dough proofing in different climates. Plan session timing around local conditions—for example, scheduling baking during cooler hours in hot climates.

Thorough local adaptation in the planning stage helps ensure training delivery is practical and effective. By understanding and preparing for local conditions, trainers can create a program that works within community constraints while achieving technical learning objectives.

6.6 MONITORING AND EVALUATION SYSTEMS

A systematic approach to monitoring and evaluation supports training quality and helps demonstrate program impact. Clear systems help track progress and identify areas needing attention.

- **Evaluation framework development:** Establish clear criteria for measuring training effectiveness. Define specific indicators such as competency achievement rates, participant satisfaction scores, and post-training implementation success. Plan to collect both quantitative data (e.g., test scores, number of skills mastered) and

qualitative feedback (e.g., participant reflections, observer reports). Consider using established models such as Kirkpatrick's four levels to structure evaluation planning (USAID Advancing Nutrition 2023).

- **Documentation systems:** Create efficient methods for recording and organizing evaluation data. Develop standardized forms for tracking attendance, assessment results, and participant progress. Plan how to document observations during training and collect post-course feedback from participants. Establish procedures for maintaining training records that meet institutional requirements while being practical for trainers to implement.
- **Progress-tracking methods:** Monitor advancement of individual trainees and overall group progress. Use competency checklists to record skill development. Document participation in practical exercises and theoretical understanding. Track completion of key learning objectives. This information helps identify areas needing additional attention and supports individual learner success.
- **Quality assurance processes:** Implement systems for maintaining training quality across sessions. Plan for periodic review of training delivery against established standards. Create procedures for updating content based on evaluation findings. Include mechanisms for assessing trainer performance and for professional development. Quality focus helps ensure consistent, effective training delivery.
- **Impact assessment planning:** Develop strategies for evaluating longer-term training impact. Plan post-training surveys or visits to assess how trainees apply skills in their work. Consider methods for tracking broader impacts, such as changes in bakery practices or the adoption of composite flour technology. This information helps demonstrate program value and guide improvements.

Regular review of monitoring data helps maintain and enhance training effectiveness. Documentation provides evidence of program results and supports continuous improvement.

6.7 FOLLOW-UP SUPPORT PLANNING

Learning continues beyond the initial training period. Well-planned follow-up support helps ensure the successful implementation of new skills and broader program impact.

- **Post-training mentorship:** Arrange for ongoing support as trainees return to their workplaces. Plan periodic visits by trainers or local extension officers to trainees' bakeries, or establish remote check-in systems. The purpose is to coach trainees through implementation challenges—for example, troubleshooting production issues or advising on equipment modifications. Follow-up contact encourages application of training and helps maintain quality standards.
- **Refresher training arrangements:** Schedule follow-up workshops or refresher sessions after initial training. According to World Health Organization guidelines, an ideal time for refresher training is 1–3 months after initial sessions (WHO 2021). This allows trainees to practice independently, then receive additional guidance. Use these sessions to address common challenges, introduce advanced techniques, and reinforce key principles. Group refresher sessions also facilitate peer learning and experience-sharing.
- **Resource networks:** Help trainees access needed materials and technical support. Develop connections with suppliers, equipment services, and technical experts. Create directories of resource contacts. Share information about funding opportunities or business development services. Strong resource networks help sustain implementation after training.
- **Peer support facilitation:** Encourage formation of practitioner networks or communities of practice. Help establish communication channels (e.g., messaging groups) for trainees to share experiences and advice. Foster connections between experienced and new practitioners. Peer networks provide ongoing moral support and practical problem-solving assistance.
- **Progress monitoring:** Maintain contact with program alumni to track implementation success. Document adoption of new techniques and any adaptations made. Collect data on production volumes and quality achievements. This information helps to demonstrate program impact and identify needs for additional support.

Effective follow-up converts training into sustained practice improvement. Regular review of support effectiveness helps refine follow-up strategies.

MODULE 6 KEY TAKEAWAYS

Strategic planning elements

- Conduct systematic training needs analysis to identify participant profiles, skill gaps, and industry-aligned learning objectives
- Design integrated session plans balancing theoretical instruction with hands-on bread production timing
- Develop comprehensive resource management systems covering equipment, materials, personnel, and documentation needs.

Infrastructure and environment requirements

- Establish appropriate training spaces with dedicated areas for classroom instruction and practical sessions
- Maintain rigorous safety protocols and hygiene standards throughout training facilities
- Ensure reliable access to essential utilities, storage, and waste management systems.

Localization and adaptation framework

- Assess and document available local resources, equipment alternatives, and operational constraints
- Integrate cultural considerations, language requirements, and community practices into training delivery
- Leverage existing knowledge networks and traditional expertise to enhance program relevance.

Quality assurance systems

- Implement standardized competency tracking using structured assessment tools
- Monitor participant progress through systematic documentation and feedback collection
- Maintain continuous program evaluation to identify areas for improvement.

Post-training support structure

- Provide ongoing mentorship during initial implementation phase
- Schedule targeted refresher training after 1–3 months
- Establish resource networks and peer learning communities
- Track long-term adoption rates and practice changes.

Bibliography for Module 6

Afriqia HR Solutions (2021); Benor and Harrison (1977); CDAIS (2017); Franzel et al. (2014); Freudenberger (1995); Keller (2019); Khalid and Sherzad (2019); McCaslin and Tibezinda (1997); Oakley and Garforth (1985); Pereira (2017); Pretty and Vodouhê (1997); Sanni et al. (2007); Sasakawa Africa Association (undated); UNESCO (2005, 2007, 2009); USAID Advancing Nutrition (2023); WHO (2021).

BIBLIOGRAPHY

(Including normative references quoted)

Abass, A., E. Towo, H. Ngoyani, J. Baseka, M. Tsiriarjoa, M. Msangi, and W. Mengji. 2013. Cassava recipes for East and Southern Africa. International Institute of Tropical Agriculture, Ibadan. https://www.academia.edu/100786782/Cassava_recipes_for_east_and_southern_Africa

Abass, A.B., E.S. Asenge, E. Uzaribara, G.T. Nduruguru, R.M. Mulwa, and S. Apolot. 2014. Quality assurance manual for cassava processing: a training manual. Association for Strengthening Agricultural Research in Eastern and Central Africa, Entebbe, Uganda. https://biblio.iita.org/documents/S14ManAbassQualityNothomDev.pdf-3471ca207e0c08f13e8fb0fbd10ad84e.pdf

Abass, A.B., M. Bokanga, A. Dixon, and P. Bramel. 2011. Transiting cassava into an urban food and industrial commodity through agro-processing and market-driven approaches: lessons from Africa. Pages 305–352 in Innovative policies and institutions in support of agro-industries development, edited by C.A. da Silva and N. Mhlanga. Food and Agriculture Organization of the United Nations, Rome. https://biblio.iita.org/documents/S09ProcAbassTransitingNothomDev.pdf-1053e953ad32e620bd6a446465a2f514.pdf

Afriqia HR Solutions. 2021. Training needs assessment: Kono, Kailahun and Koinadugu / Falaba districts. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Freetown, Sierra Leone. https://www.giz.de/en/downloads/giz2022-en-training-needs-assessment.pdf.

ARSO. 2012. African Standard CD-ARS 471. Food grade salt—Specification, 2nd edition. https://archive.org/details/ars.471.2012/page/n1/mode/2up

ARSO. 2014a. African Standard CD-ARS [838]. Cassava flour—Specification, 1st edition.

ARSO. 2014b. African Standard CD-ARS 840. High quality cassava flour—Specification, 1st edition.

ARSO. 2014c. African Standard CD-ARS 853. Cassava bread—Specification, 1st edition.

Benor, D., and J.Q. Harrison. 1977. Agricultural extension: the training and visit system. World Bank, Washington, DC. https://documents1.worldbank.org/curated/pt/267901468765344268/pdf/multi0page.pdf

CDAIS. 2017. Trainer's manual: facilitating capacity needs assessment. Capacity Development for Agricultural Innovation Systems, Montpellier. https://www.tapipedia.org/content/trainers-manual-facilitating-capacity-needs-assessment.

Ciobanu, N.R. 2018. Active and participatory training methods. *European Journal of Education*, 1(2): 69–72. https://revistia.com/ejed/article/view/613.

Dziedzoave, N.T., A.B. Abass, W.K.A. Amoa-Awua, and M. Sablah. 2006. Quality management manual for production of high quality cassava flour. International Institute of Tropical Agriculture, Ibadan. https://www.academia.edu/73955548/Quality_management_manual_for_the_production_of_high_quality_cassava_flour

East African Community. 2001. East African Standard EAS 39: 2001. ICS 67.020. Hygiene in the food and drink manufacturing industry—Code of practice, 1st edition.

East African Community. 2010. East African Standard EAS 741:2010. ICS 67.080.20. Cassava wheat composite flour—Specification, 1st edition.

East African Community. 2011. East African Standard EAS 1:2011. ICS 67.060. Wheat flour—Specification, 2nd edition.

East African Community. 2018. Draft East African Standard DEAS 782: 2018. ICS 67.060. Composite flour—Specification, 2nd edition.

East African Community. 2021. Draft East African Standard DEAS 779:2021. ICS 67.230. High quality cassava flour—Specification.

Explore Psychology. 2025. Kinesthetic learning: definition and examples. Explore Psychology. https://www.explorepsychology.com/kinesthetic-learning/

FAO and WHO. 2023. Standard for wheat flour. CXS 152-1985. Codex Alimentarius. https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B152-1985%252FCXS_152e.pdf

FAOSTAT. https://www.fao.org/faostat/en/#data. Accessed 18 February 2025.

FICSI and E3. Undated. Participant handout: Perform skills—Training of Master Trainers program. Food Industry Capacity and Skills Initiative and E3 Consultancy and Services. https://pau.edu/coaet/content/pfedocs/Self%20Learning%20ToMT%20Platform%20Content.pdf.

Food and Agriculture Organization of the United Nations. 1994. Participatory learning techniques. *In* The group promoter's resource book. Rome. https://www.fao.org/4/T1965E/t1965e04.htm#ANNEX%201:%20Participatory%20learning%20techniques

Food and Agriculture Organization of the United Nations and World Health Organization. 2013. Codex pesticides residues in food online database. Codex Alimentarius [website]. https://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/en/

Food and Agriculture Organization of the United Nations and World Health Organization. 2023. General standard for contaminants and toxins in food and feed. CXS 193-1995. Codex Alimentarius. https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B193-1995%252FCXS_193e.pdf

Franzel, S., J. Sinja, and B. Simpson. 2014. Farmer-to-farmer extension in Kenya: the perspectives of organizations using the approach. ICRAF Working Paper No. 181. World Agroforestry Centre, Nairobi. http://dx.doi.org/10.5716/WP14380.PDF

Freudenberger, K.S. 1995. Tree and land tenure: using rapid rural appraisal to study natural resource management—a case study from Anivorano, Madagascar. Community Forestry Case Study 10. Food and Agriculture Organization of the United Nations, Rome. https://www.fao.org/4/v5595e/v5595e00.htm

Global Development Research Center. Undated. Participatory learning techniques. https://www.gdrc.org/icm/ppp/plt.html

Halim, A., and M.M. Ali. 1997. Training and professional development. Chapter 15 *in* Improving agricultural extension: a reference manual, edited by B.E. Burton, R.P. Bentz, and A.J. Sofranko. Food and Agriculture Organization of the United Nations, Rome. https://www.fao.org/4/w5830e/w5830e0h.htm#:~:text=change%20the%20action%2C%20belief%2C%20and,in%20extension%20training.

IITA, RBS, and UNBS. Undated. Summary of East African standards for cassava flour for processors. International Institute of Tropical Agriculture, Tanzania, Rwanda Bureau of Standards, and Uganda National Bureau of Standards.

International Organization for Standardization. 2018. Food safety management systems—requirements for any organization in the food chain, 2nd edition. ISO 22000:2018. Geneva: ISO. https://www.iso.org/standard/65464.html

International Organization for Standardization. 2003. Foodstuffs—Determination of aflatoxin B1, and the total content of aflatoxins B1, B2, G1 and G2 in cereals, nuts and derived products—High-performance liquid chromatographic method. ISO 16050:2003. Geneva: ISO. https://www.iso.org/standard/29628.html

Keller, S. 2019. Training follow-up. *In* Post training activities [website]. Sustainable Sanitation and Water Management (SSWM) Toolbox, Willisau, Switzerland. https://old2019.sswm.info/train-trainers/post-training-activities/training-follow-up.

Khalid, S.M.N., and S. Sherzad. 2019. Agricultural extension manual for extension workers. Food and Agriculture Organization of the United Nations Sub Regional office for the Pacific, Apia. https://openknowledge.fao.org/server/api/core/bitstreams/8d2286ce-2f04-4a4d-b559-d203fe57fe8e/content

Khisa, G. 2004. Farmers' field school—training of trainers manual. Food and Agriculture Organization of the United Nations, Rome. https://resources.peopleinneed.net/documents/356-fao-2007-farmers-field-school-methodology-training-of-trainers-manual.pdf.

Knowles, M. 1984. The adult learner: a neglected species, 3rd edition. Gulf Publishing, Houston.

McCaslin, N.L., and J.P. Tibezinda. 1997. Assessing target group needs. Chapter 5 in Improving agricultural extension: a reference manual, edited by B.E. Swanson, R.P. Bentz, and A.J. Sofranko. Food and Agriculture Organization of the United Nations, Rome. https://www.fao.org/4/w5830e/w5830e07.htm

Ministère de l'Industrie. 2020. Arrêté n° CAB.MIN/IND/OJA/012/12/2020 du 03 décembre 2020 portant adoption des Normes Nationales Congolaises dans le secteur de l'agroalimentaire [Order No. CAB.MIN/IND/OJA/012/12/2020 of 3 December 2020 adopting Congolese National Standards in the agri-food sector]. Journal Officiel de la République Démocratique du Congo, 3, 1 February 2021.

National Highway Institute. Undated. Principles of adult learning & instructional systems design. *In* NHI instructor development course. Vienna, VA, USA. https://www.nhi.fhwa.dot.gov/downloads/freebies/172/pr%20pre-course%20reading%20assignment.pdf

Norme Codex pour la Farine de Blé [Codex Standard for wheat flour] CODEX STAN 152-1985. 1995. (1-1995).

Norme Congolaise NCD ISO 004:2020. 2020. Norme Nationale Congolaise pour la Planification et la Pâtisserie [Congolese national standard for bread making and pastries]. Comité National de Normalisation.

NTEN. 2018. Using adult learning principles in technology trainings, August 14. Portland, OR, USA. https://www.nten.org/blog/using-adult-learning-principles-in-technology-trainings

Oakley, P., and C. Garforth. 1985. Guide to extension training. FAO training Series No. 11. Food and Agriculture Organization of the United Nations, Rome. https://openknowledge.fao.org/server/api/core/bitstreams/72985d26-76ff-4ecc-b0e7-c7607fc86408/content

OEC. Undated. Wheat in Democratic Republic of the Congo, [2022 data]. The Economic Complexity Observatory. https://oec.world/en/profile/bilateral-product/wheat/reporter/cod

Okafor, E.N., O.L. Erukainure, A.U. Ozumba, C.O. Adewale, F.O. Kayode, G.O. Asieba, O.I. Adesegha, and G.N. Elemo. 2017. Cassava flour substitution modulates glycemic responses and glycemic index of wheat breads in apparent healthy volunteers. *Journal of Dietary Supplements*, 14(4), 446–452. https://doi.org/10.1080/19390211.2016.1267061

Osuwatooyin, O.F., A.O. Williams, and I.B. Oluwalana. 2012. Prebiotic effects of cassava fibre as an ingredient in cracker-like products. *Food & Function*, 3, 159–163. https://doi.org/10.1039/C1FO10183H

Pereira, L.M. 2017. Cassava bread in Nigeria: the potential of "orphan crop" innovation for building more resilient food systems. *International Journal of Technology and Globalisation*, 8(2), 97–115. https://doi.org/10.1504/IJTG.2017.088958.

Pretty, J.N., and S.D. Vodouhê. 1997. Using rapid or participatory rural appraisal. Chapter 6 *in* Improving agricultural extension: a reference manual, edited by B.E. Swanson, R.P. Bentz, and A.J. Sofranko. Food and Agriculture Organization of the United Nations, Rome. https://www.fao.org/4/w5830e/w5830e08.htm

PRIA. 2002. Methods of participatory training. New Delhi. https://pria.org/knowledge_resource/Methods_of_Participatory_Training.pdf

Sanni, L., B. Maziya-Dixon, A.E. Okoruwa, B. Arowosafe, J. Lemchi, F. Ogbe, C. Ezedinma, R. Okechukwu, M. Akoroda, E. Okoro, P. Ilona, T. Babaleye, and A. Dixon. 2007. Cassava utilization training for bakers, caterers, and processors in south-south and southeast of Nigeria, July–August 2004 [workshop report]. International Institute of Tropical Agriculture, Ibadan. https://www.iita.org/wp-content/uploads/2016/06/Cassava_utilization_training_for_bakers_caterers_and_processors_in_the_south-south_and_southeast_of_Nigeria.pdf.

Sasakawa Africa Association. Undated. Uganda. https://www.saa-safe.org/www/uganda.html

TAAT Clearinghouse. 2022. Cassava processing technology toolkit catalogue. Clearinghouse Technical Report Series 013, Technologies for African Agricultural Transformation, Clearinghouse Office, IITA, Cotonou, Benin. https://taat-africa.org/wp-content/uploads/2022/06/Cassava-Processing-Catalogue_EN.pdf

UNESCO. 2005. Guidelines for inclusion: ensuring access to education for all. United Nations Educational, Scientific and Cultural Organization, Paris. https://unesdoc.unesco.org/ark:/48223/pf0000140224

UNESCO. 2007. Mother tongue matters: local language as a key to effective learning. United Nations Educational, Scientific and Cultural Organization, Paris. https://www.unesco.org/en/articles/mother-tongue-matters-local-language-key-effective-learning

UNESCO. 2009. Policy guidelines on inclusion in education. United Nations Educational, Scientific and Cultural Organization, Paris. https://unesdoc.unesco.org/ark:/48223/pf0000177849

University of Wisconsin Green Bay. Undated. Creating trainings using adult learning principles. https://www.uwgb.edu/UWGBCMS/media/Continueing-Professional-Education/files/Handout-0-Master-Handout-Adult-Learning-Principles-Participant-Handout.pdf

USAID Advancing Nutrition. 2023. Effectively measuring training: building knowledge and skills for nutrition programs. Capacity Strengthening Measurement Brief. United States Agency for International Development, Washington, DC. https://www.advancingnutrition.org/sites/default/files/2023-09/usaid_an_capacity_measurement_training_2023_1.pdf.

WHO. 2021. Web annex A. Guidelines for follow-up after training. *In* Infant and young child counselling: an integrated course. Trainer's guide, 2nd edition. (WHO/HEP/NFS/21.42). World Health Organization, Geneva. https://iris.who.int/handle/10665/346563

WHO Africa. Undated. Five keys to safer food. World Health Organization, South Africa. https://www.afro.who.int/node/9306.

Williams, R.J. 2019. Participatory training for adult learners: activities and examples for trainers in livestock systems. Feed the Future Innovation Lab for Livestock. University of Florida, Gainesville. https://livestocklab.ifas.ufl.edu/media/livestocklabifasufledu/pdf-/MANUAL-Williams_UF_Participatory_Training_for_Adult_Learners_published_2020_03_18.pdf.

APPENDIX: PRACTICAL EXPERIENCE OF SOME BAKERS USING WHEAT–CASSAVA COMPOSITE FLOUR (10% WHEAT SUBSTITUTION) FOR BREAD

Parameter	Baker 1	Baker 2	Baker 3	Baker 4	Baker 5	Baker 6	Baker 7	Baker 8	Baker 9	Baker 10	Baker 11	Baker 12
Wheat flour (kg)	40.0	4.5	2.7	22.5	4.5	9.0	2.7	2.7	9.0	40.5	40.5	20.3
HQCF (kg)	4.5	0.5	0.3	2.5	0.5	1.0	0.3	0.3	1.0	4.5	4.5	2.25
Salt (g)	550	54.0	29.0	273.0	88.0	101.0	40	45.0	103.0	450	560.0	302.0
Yeast (g)	283.0	63.0	24.0	129.0	100.0	104.0	30.0	39.0	92.0	305.0	370.0	186.0
Water (L)	25.0	2.0	1.1	14.0	2.7	5.5	0.7	0.7	7.0	27.0	30.0	15.0
Mixer type	By hand in a wooden box	By hand in a wooden box	By hand in a wooden box	By hand in a wooden box	Kneader	By hand in a wooden box	By hand in a wooden box	By hand in a wooden box	By hand in a wooden box	By hand in a wooden box	Kneader	By hand in a wooden box
Fermentation time	2 h	1 h 30 min	1 h	1 h 30 min	2 h 10 min	1 h 5 min	2 h	1 h 30 min	1 h 18 min	2 h 20 min	1 h 40 min	1 h
Oven type	Artisanal (wood-fired brick) oven											
Fermentation temperature	Managed by experience											
Baking temperature	Managed by experience											
Quantity of raw dough (g)	51 692	7 584	3 744	41 688	8 221	14 880	6 562	6 372	15 264	57 514	54 864	32 960
Dough cut sizes for bread category	500 FC bread: 148 g; 1000 FC bread: 253 g	500 FC bread: 158 g,	500 FC bread: 234 g	300 FC bread: 86 g; 500 FC bread: 179 g; 700 FC bread: 244 g; 1000 FC bread: 354 g	300 FC bread: 97 g; 500 FC bread: 176 g; 1000 FC bread: 366 g	500 FC bread: 155 g	500 FC bread: 193 g	500 FC bread: 177 g	500 FC bread: 159 g	300 FC bread: 90 g; 500 FC bread: 122 g	500 FC bread: 127 g	500 FC bread: 160 g

Bread quantity per price (size)	192 loaves 500 FC (129 g); 92 loaves 1000 FC (240 g)	48 loaves 500 FC (138 g)	16 loaves 500 FC (197 g)	66 loaves 300 FC (82 g); 148 loaves 500 FC (154 g); 10 loaves 700 FC (228 g); 20 loaves 1000 FC (332 g)	19 loaves 300 FC (87 g); 30 loaves 500 FC (161 g); 3 loaves 1000 FC (312 g)	96 loaves 500 FC (145 g)	34 loaves 500 FC (160 g)	36 loaves 500 FC (131 g)	96 loaves 500 FC (136 g)	433 loaves 300 FC (80 g); 152 loaves 500 FC (115 g)	500 loaves 500 FC (117 g)	206 loaves 500 FC (132 g)
Comments	Good taste; Considerable weight; All sold	Good taste; Considerable weight; Good texture; All sold	Good taste Poor management of the fermentation; loaf weight appreciated; Motivated to use the flour if point of sale is close to the bakery; All sold	Good taste; Considerable weight	Value-added on weight	Good taste; Production successful; All sold	Good taste; Considerable weight; All sold	Good taste; Considerable weight; All sold	Good taste; Production successful; All sold	Good taste	Taste; Texture; Weight — all appreciated	Good bread; Color; Taste; Weight — all appreciated; Bread shrank
2022 exchange rate: US$ 1 = 2001 CF.												

IITA

Transforming African Agriculture