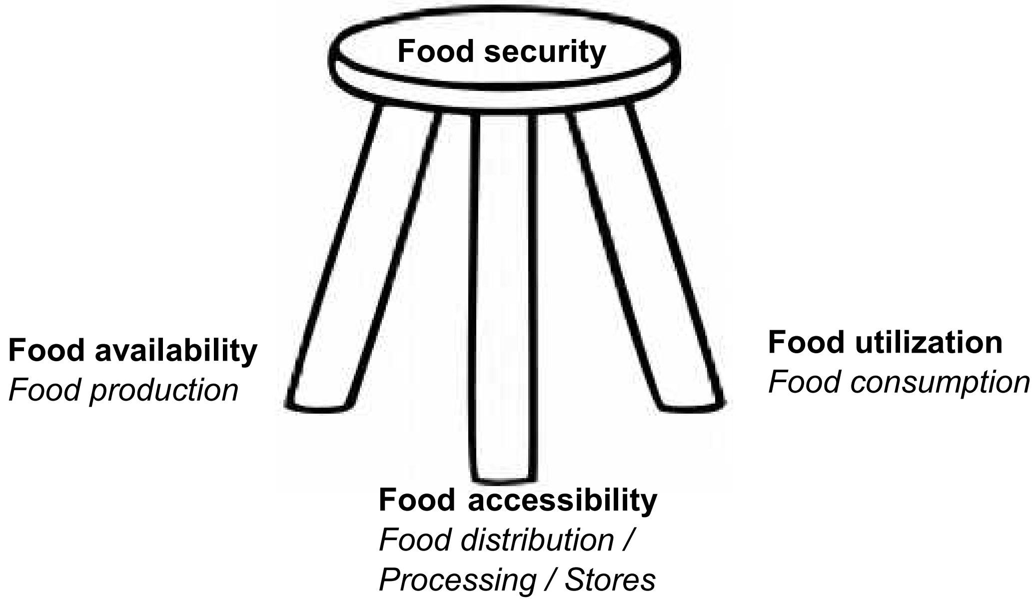
Unit 2 Improve food storage and processing practices for food stability

Introduction

Food production, food distribution of processed food and food consumption act like a three legged stool. If one leg breaks the stool will fall or else one will need a fine balancing act to sit on the stool and will not be able to do so for a long period of time. Food production, food processing and food storage all together provide stability to household food security.



At the different levels of household, community, provincial and national, food security has a strong linkage between food availability (production), food accessibility (distribution) and food utilization (consumption). In simple terms we can compare these linkages in the household with the three legs of food production, food distributions and food consumption. In this unit we will learn about:

2.1 Linkage between food stability and the food system

2.2 Indigenous knowledge and appropriate food processing

2.3 Food processing to extend food storage and shelf life

Specific Outcome

The information in this table is like a good road map for your learning journey. It gives you a clear idea of what you are expected to know and do at the end of Unit 2.

Determine household and consumer practices in relation to the allocation of resources to food related processes and activities.

Learning outcomes	Assessment activities	Actual time spent
	Workbook activities	
2.1 Linkage between food stability and the food system		
2.2 Indigenous knowledge and appropriate food processing	2.1 Applying food processing techniques	
2.3 Food processing to extend food storage and shelf life	2.2 Commercially available food and packaging	
	Portfolio Activity 2.1 Analyse food processing practices used (3 hours)	
	Assignment 1 You can find information on this assignment in Tutorial Letter 101 (2 hours)	

Key concepts

Food systems Local food system Food path Food kilometres Food stores Food storage Food flow Indigenous knowledge Traditional knowledge African foods Value chain	Food processing Food preservation Micro-organisms Enzymes Refrigeration Food preparation Hazard zone Food packaging First-in-first-out Food budget

2.1 The linkage between food stability and the food system

We have referred to the systems approach many times and we know its whole is bigger than the parts, because of the relationships and the integration between the parts. Therefore the food system is bigger than its parts as it constitutes food availability, food accessibility, utilization and stability of food supplies.

2.1.1 What is the food system

I think that it is really important at this point to remind ourselves, that the foods we consume and the foods that we feed to our livestock and pets are part of a natural system. When we begin to control one part of the system, this influences the other parts. In this module, you will be looking at the technology and knowledge required to maximise food production(in a natural system) by extending its supplies for all year round availability.

In the picture below the artist has shown the very close link that exists between the rural and urban area. You will notice that the land available for grazing and planting is in the rural area. Water reserves are also found mainly in the rural area. The two very most important tangible components of this system are ***man*** with his associated values and beliefs who is the ultimate consumer, and the ***natural resource base*** consisting of land, water and the biodiversity of plants and animals. The two not so obvious parts of the system are the ***relationship*** between the humans and the environment and ***the integration*** of activities needed for the system to remain sustainable. The system concept itself always has an **input**, **throughput**, **output**, **feedback** and **boundary**. You have been introduced to these concepts in previous work. How people nurture their natural resource base and what they demand from it determines the sustainability of all human life. Most important to know is that these systems are always changing with shifts in humans' rural-urban patterns of living and thus their dependency on the natural resource base.

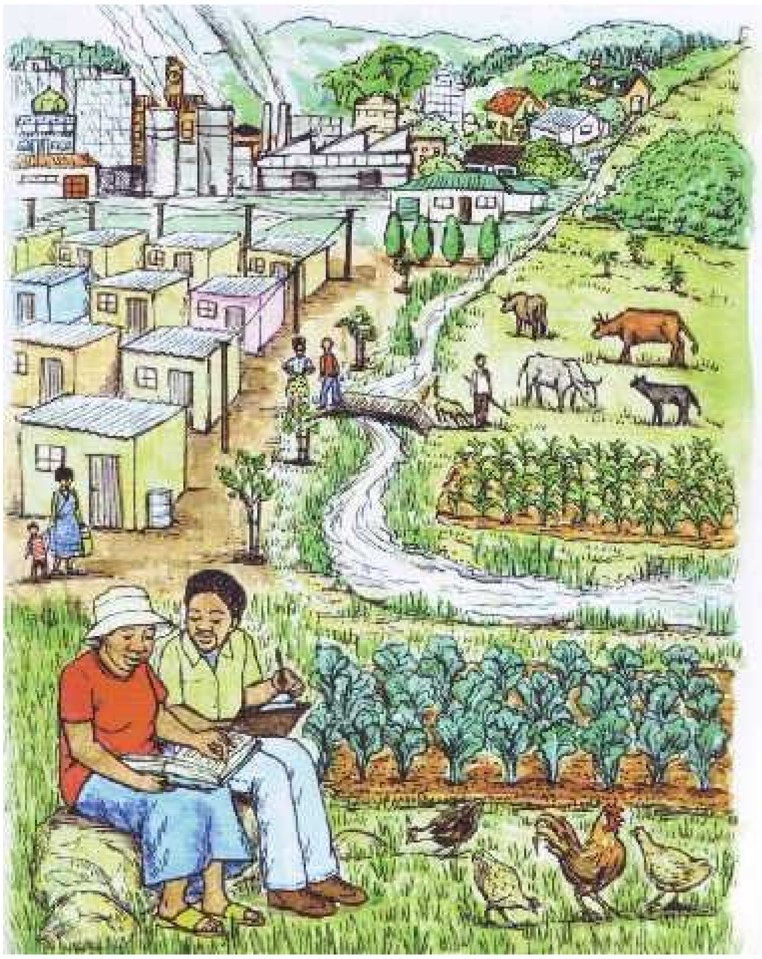


Figure 2.1 Farmer Support: Making land work for rural people (painted by Arbuckle, K, 2005).

For people who grow food, herbs and ornamental flowers, rain is very important that we often forget that the purity of water reservoirs (which include ground water) needs caring for as part of our natural resource base. Land provides the soil for food production that also supports filtration of ground water.

When we look at the relationship between rural resources and the consumption demands in the cities we begin to see the potential we have to meet those demands in mutually beneficial ways. The values and beliefs that determine how we link the use of land to our livelihood goals and opportunities is an important aspect of sustainability. Do we believe that resources are unlimited? Do we believe that production is a process that **exploits** a resource or is production a process that nurtures a resource into repetitive cycles of productivity? Exploitation refers to the taking advantage of a situation or resource at the expense of other people.

Without a sustainable food system we cannot have stability in food security on any level –nor on community level and down to household food security on the micro level.

2.1.2 The food system, food stability and household food security

Can you remember the four dimensions of household food security: *food availability, food accessibility, food utilization* and food *stability?* In this unit we have to bring in the food system and link it also to livelihoods of households. These linkages describe the flow of food and resources needed to acquire food. In order to be functional all systems need to be stable otherwise they will not function well and can be destroyed.

In Unit 1we discussed the CARE household livelihood security model. We observed that assets are an important part of the livelihood system. The livelihood strategies, *production, processing* and *consumption* activities are part of the livelihood strategies which households are active in, or should be active, for healthy well-being and sustainable livelihoods.

A food system also includes all the activities related to the production, distribution and consumption of food that affect human nutrition and health. In the bigger picture of the food system, one can also include the activities occurring at the micro-level of the smaller farm household food system and this involves:

- **food production** comprises such factors land use and tenure, soil management, crop breeding and selection, crop management, livestock breeding and management and harvesting for increasing food harvests and post-harvest processes.
- **food distribution** involves a series of post-harvest activities such as food processing transportation, storage, packaging and marketing of food. It also includes activities on the household level such as household buying (purchasing power), traditions of food use (including child feeding practices), food exchanges, gift giving, food gathering, and public food distribution better known as the food safety net (food parcels, soup kitchens, food banks).
- **food consumption** (utilization) includes activities such as preparation, processing and cooking of food at both the home and community or commercial levels. It also includes household level decision-making regarding food, household food distribution practices, cultural and individual food choices and access to health care, sanitation and knowledge (FAO, 1997).

The food system and household food security do have linkages and the system refers to the real processes involved with how food moves through the system.

You will recognise that in real life these activities actually cannot be grouped in clear cut groups like they are mentioned above. Among the different system components there are overlaps such as food processing that can also include food preparation at household level, communication and education. Other examples from above are household decision-making behaviour with regard to food which is influenced by nutrition knowledge and by cultural practices with regard to food allocation within the household and the household' buying (purchasing) power.

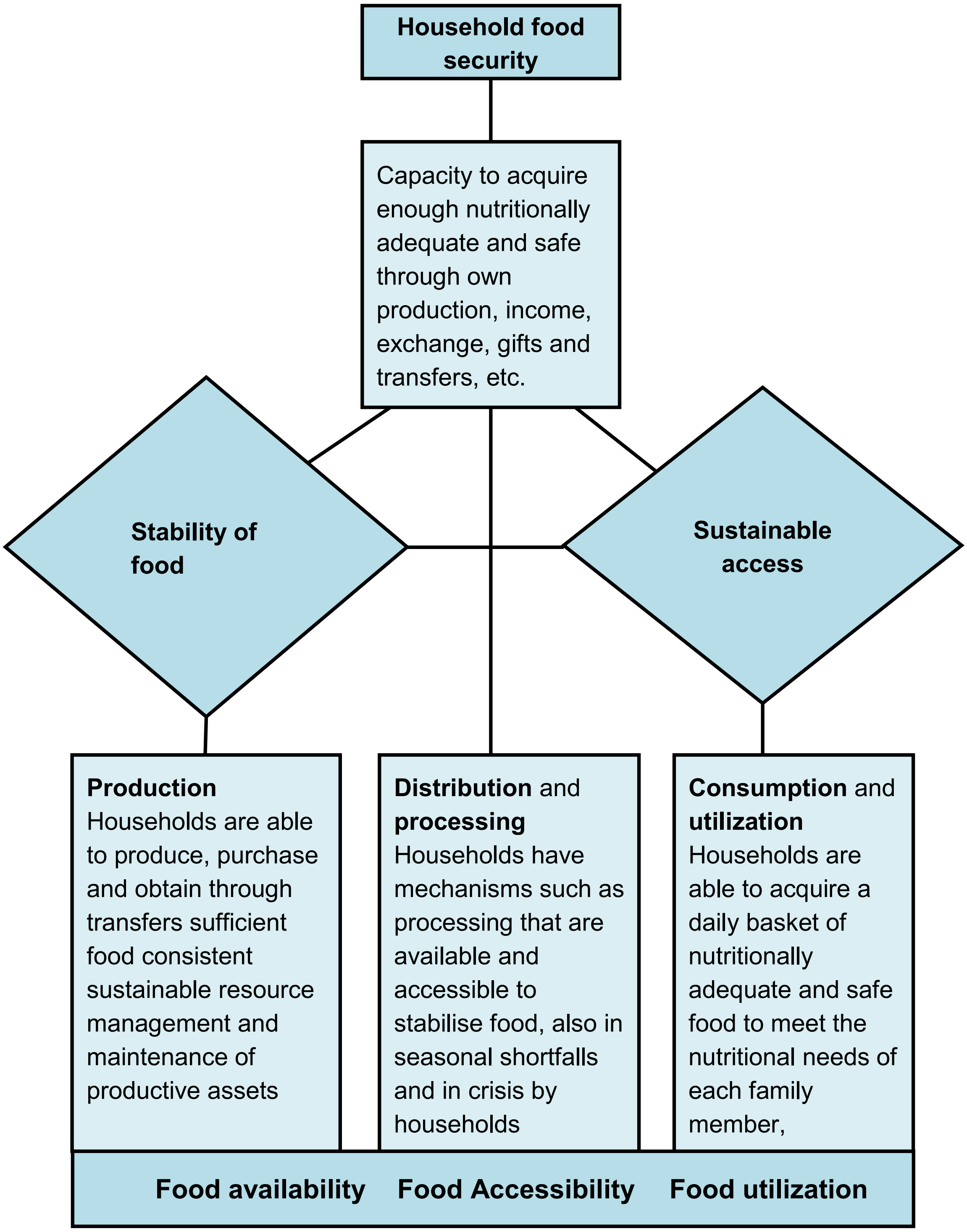


Figure 2.2 Household food security, stability and the components of the food system (Adapted from Frankenberger*et al, 1993).*

So for each household to have food security, the household needs to function as a micro-food system within a stable food system that includes indigenous creativity and commercial components. The path most of us in modern society know is the commercial path, through which most cash consumers acquire food.

2.1.3. The food system and food pathway

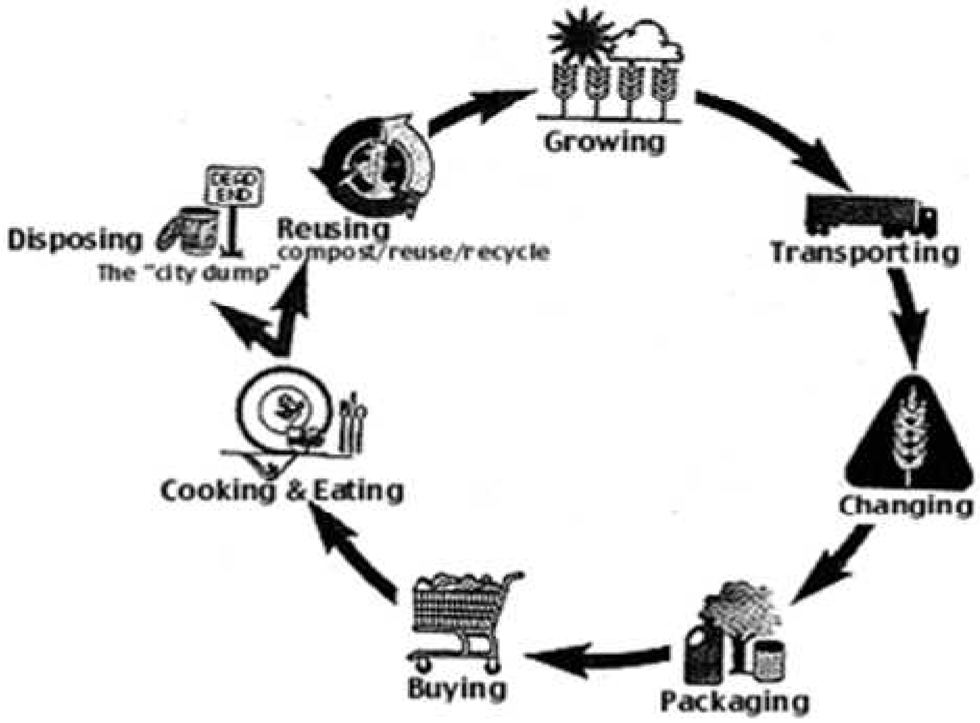


Figure 2.3 The commercial food pathway

We can use the concept of food pathways, meaning the way food moves along pathways in the food system to reach the household and consumer. In a food system the food present represents a series of activities where food as raw material is built up of energy and nutrients and at the end is consumed to provide energy and nutrients. The foods and waste products that we don't eat go back into the soil as energy and nutrients.

The path in between is sometimes short as in a household, or long as in the case of the commercial production for the food market of food, wholesalers and retail shops. Governments make sure enough food is nationally available or imported.

We also refer to the concept of a *food value chain*. At each stage of the food pathway value maybe added to the food products to increase the value and price of the products. This refers to a food pathway with several stages. At each stage of the value chain process, value adding activities are done by another person, agent or enterprise until the food products reach the end consumer. We will refer to the food value chain again in Unit 3 again and discuss its possibilities for household food security intervention.

What does the term *food kilometres* mean? It refers to how far food travels before it can be served on your table for a meal. The further it travels, and the more it is processed, the more expensive the food is. The price you pay is money that leaves the community and has to come back as wages. However, we know that unemployment is a problem and that commercial processed and packaged foods are not always the best answer for the food security of a poor household that cannot really afford to buy these products.

The food we as people eat comes from many places. Food is not necessarily produced any more by household themselves, like in the days when households were often dependent on their own subsistence produce. Food may now be distributed as stored, processed and packaged food ready for consumption in large quantities. Food is then bought with money or we may produce and process some of our own fresh foods. If everyone is to have enough food many sorts of food must move along different food paths. Therefore it is important that in a household, community and local area:

- enough food must be *produced*
- enough food must be *stored*
- enough food must *get to places where it is needed*.
- families must have *enough money to buy foods* which they cannot produce
- each person in the family must *eat enough food*.

Some writers also use the term *pipeline* for a *pathway*. This can be most easily pictured as a pipeline with producers of food products at one end and consumers at the other.

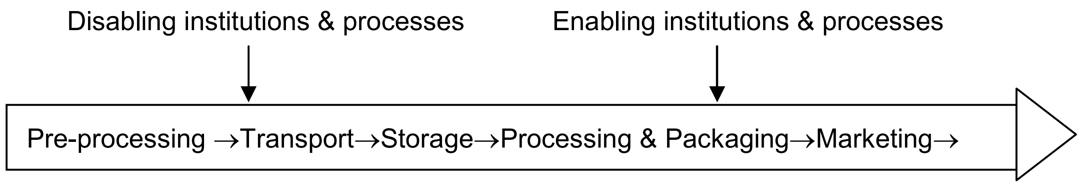


Figure 2.4 Food path or food pipeline.

But there is always a feedback completing the circle with consumers demanding more and better or cheaper food from the producer and processor. The pre-processing, transport and storage processes can be disabling factors for households and small farmers. While if a household have the knowledge and skills to process, package and market food or exchange food it could be beneficial for both local producers and local consumers.

2.2 Indigenous knowledge and appropriate food processing

Many modern food processing technologies are either hard to acquire for economic or financial reasons or are unsuitable to the socio-cultural African context, specifically vulnerable households. Moreover, foreign technologies simply do not exist for either solving some of the specific African problems or meeting the whole spectrum of technological needs.

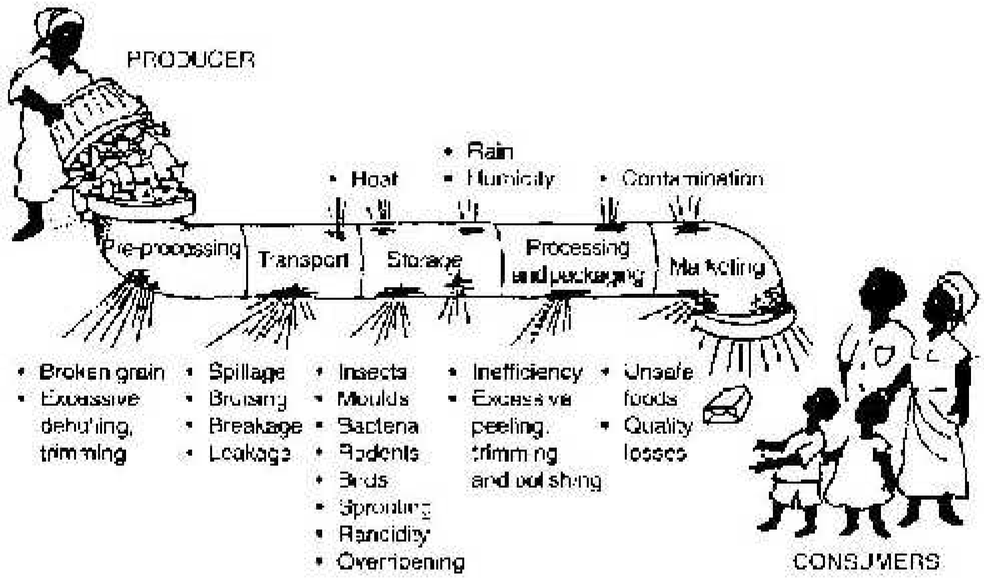


Figure 2.5 The African food pathway illustrated as a food pipeline

As can be seen from Figure 2.5 a lot of food can be wasted (in quantity and quality) at all the different processing stages due to a number of reasons such as spillage, poor storage, inefficient processing, contamination etc. Processing methods and applications that rely on indigenous knowledge and technologies are therefore an important part of any real solution to the problem of food insecurity in Africa.

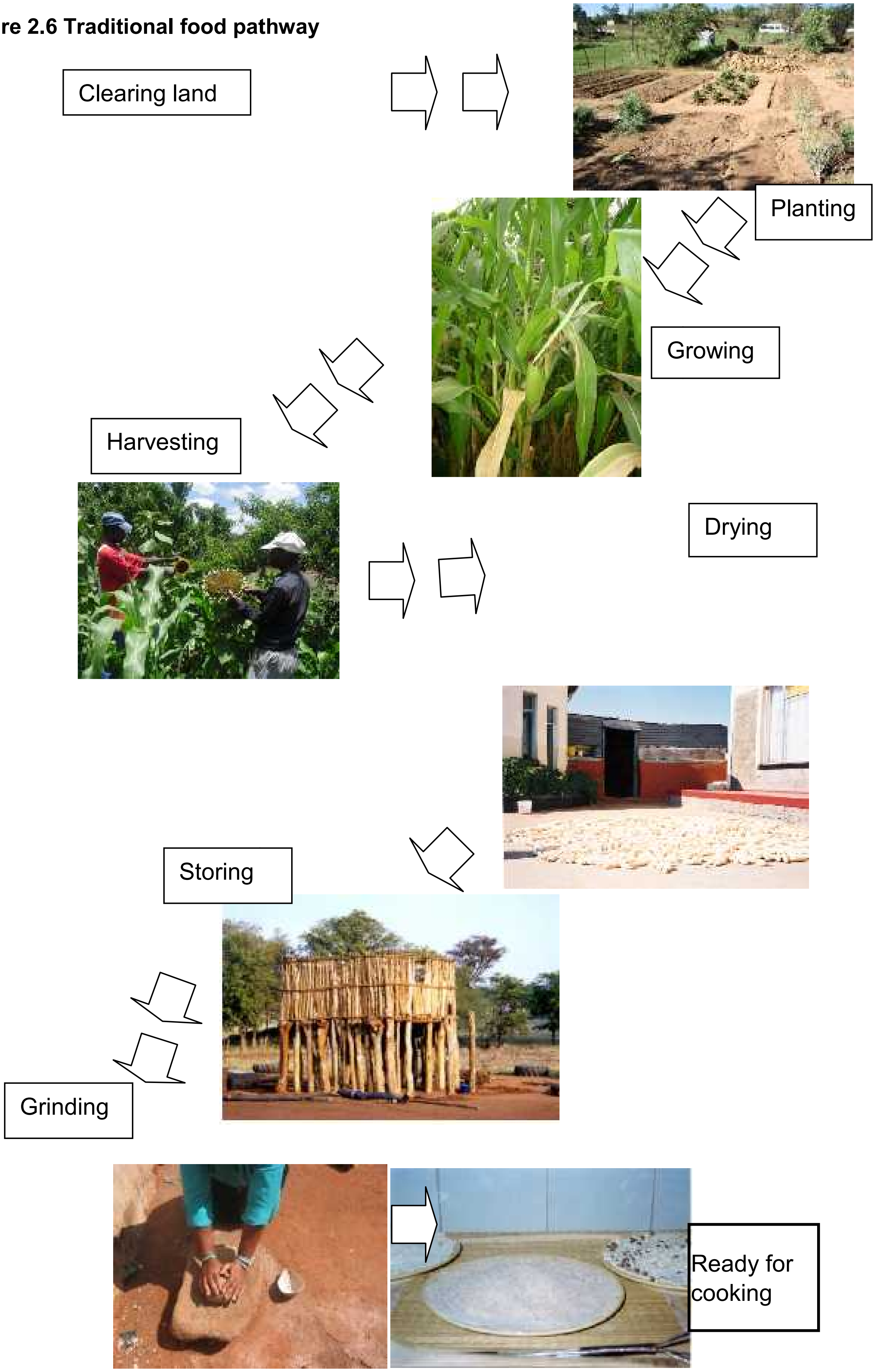
Often in literature we hear the term ‘indigenous knowledge’. What is being referred to is the collective skills, experiences and insights of people that are applied in maintaining and improving their livelihoods. Before mechanisation, indigenous farming systems utilized indigenous knowledge and practices of food production and preservation that were sustainable within their social and natural environments.

Tradition: Is a ritual, belief or object passed down within a society and is still maintained in the present with origins in the past. So the main idea is that people must have accepted it, believed in it and made it a part of their lives that make it tradition, it does not matter where it originally came from.

Communities are different, households and individuals are different. The age-old institution of a family unit or households has always been the unit for learning life-skills. With the changes in society the household lost some of its indigenous or traditional capacity to cope with many responsibilities, risks and vulnerability. However, learning to survive and acquire food takes place where there is interaction between people.

In every region and country there are distinctive traditional processed foods that are well suited to the local climatic and socio-economic conditions. Kept alive by pockets of people, these systems in their original form are sustaining food security and can be found in some

Figure 2.6 Traditional food pathway



Linking production to consumption in innovative ways to ensure maximum retention of nutrient value as well as sustainable use of resources is the main challenge of community and regional, food security initiatives. Post-harvest technologies in critical areas such as food storage, processing, preparation, preservation and packaging play a significant role in ensuring effective links and preventing losses in terms of quantity and quality. Any development process interacts with indigenous knowledge and therefore typical strategies for development will either:

- rely entirely or substantially on indigenous knowledge,
- override indigenous knowledge or,
- incorporate indigenous knowledge.

In this unit, we adopt the attitude that to build capacity, the student must recognize the value and contribution towards sustainable practice of both indigenous and scientific knowledge in the management of food resources. This capacity will enable you (the household food security facilitator) to assist community members to select the most appropriate combination of indigenous and foreign technologies for the management of food related resources.

Microorganisms will always try to maintain a life supporting environment. When we use multiple methods for disturbing their optimum conditions such as heating, removing water, drying and storing in air tight containers, simple but effective preservation technologies and processes are developed. Indigenous technologies have developed ways of combining methods, processes or barriers that are reliable and simple. In the following extract taken from a case study, note the multiple methods of preservation and the integration of livelihood strategies and capabilities.

…In February the women and young girls started to pick melons, cowpeas and also preserved their leaves by drying them. These foods were then stored away in big clay pots and sealed with fresh cow dung to prevent pest encroachment…

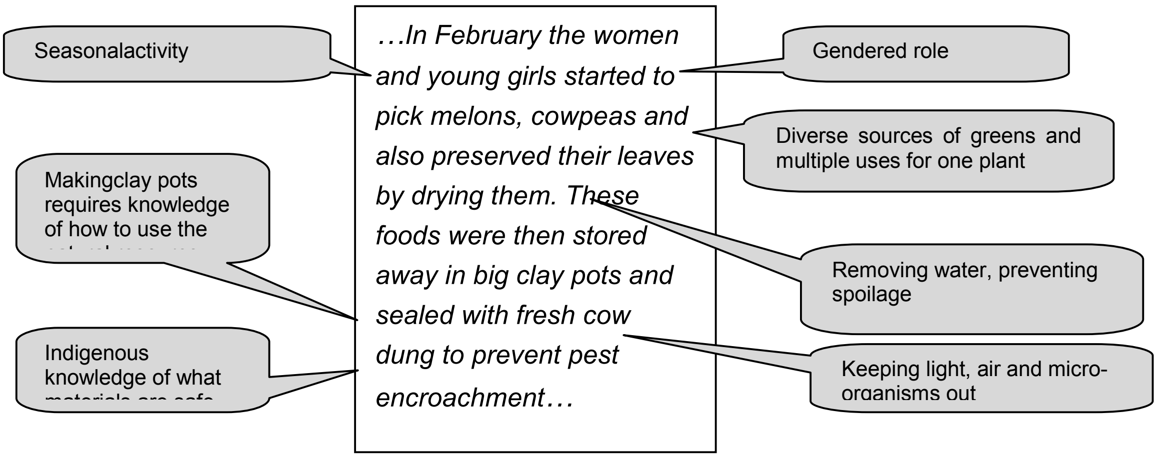


Figure 2.7 A rural livelihood strategy drying leaves improving food security (source ?)

Our ancestors learned these techniques – not from books or the internet, but by interacting with and being sensitive to changes in their environment. Okay – sometimes they may have learned by accident! However they learned it, they have passed on this technology from generation to generation by using it and by demonstrating it to the next generation. Today, there exists in people's heads, in libraries and on the internet, a vast amount of information available to us – from simple low cost traditional technologies that create diversity and are part of managing household's food resources from the household food processing to the hi-tech food industry where foods are a business commodity.

To prevent food spoilage from happening at all, numerous ways to preserve foods at household level or for a small scale food industry have been developed over time. These include processes that slow down spoilage, such as heating, drying, curing, salting, adding sugar, adding spices, adding chemical preservatives, making things more acidic, fermentation, smoking, refrigeration and freezing (See Table 3.3).

2.3 Food processing to extend food storage and shelf-life

Food processing uses science together with the creative imagination of the processor to change the eating quality of foods and provide people with interesting variety in their diets (as seen by the variety on the home industries and supermarket shelves).

Peoples' experiences in development projects around the world have shown that increasing the awareness of the value of processing foods is an important method for improving the livelihoods of both rural and urban populations. This is because food processing can contribute to food security through:

- Improved storage of fresh produce minimising losses;
- Preserving seasonal excess which would otherwise be wasted.
- Improved nutritional status through consumption of preserved or stored fruits and vegetables throughout the year (as opposed to consumption only in season);
- Increased income for the sale of processed fruits and vegetables (value adding).

Many normal diets throughout the world rely on a cereal (such as wheat, sorghum, maize, barley, rice, oats) or root crops (such as potato, amadumbe, cassava) as their staple food. These foods are generally simple to store for long periods and provide an economical source of energy in the form of carbohydrates. To supply our bodies with protein: meat, milk, fish, and legumes (e.g. beans, lentils, and dhal) are consumed with these staple energy foods. Fat from seeds and nuts are a source of fatty acids essential for our bodies. They also provide concentrated energy along with the fats found in many protein foods. Vitamins and minerals are provided by leafy vegetables, fruits, seeds and nuts which in traditional meal patterns are often made into strong tasting relishes to accompany the relatively bland staple foods.

But because most crops are seasonal, there are times of the year when either there is too much to eat or none at all if adequate measures are not taken to preserve and store the foods. Most foods need some sort of preparation and processing to make them more attractive to eat. If you think of grains, vegetables, meats and fish, you tend to think of them in cooked forms.

There are problems in processing some foods. Some foods e.g. cassava and *amadumbe* are dangerous until they are cooked – they cannot be eaten raw. Even foods that we are happy to eat raw like nuts, milk and fruits can benefit from processing into a wide variety of other products which add variety and nutrient value to our food intake. For example, when we eat a fresh peach, we think of it as ‘fruit’, but when we serve tinned peaches, we think of it as ‘pudding’ and will often add cream or ice-cream for a completely different food experience. In another example, it is well known that many people around the world have digestive systems that reject fresh milk but these same people can tolerate yoghurt or *amaasi.* The reason for this is that fermenting (a type of preservation) the milk makes it more digestible.

These benefits directly affect individuals and households who participate in food processing activities. Establishing local food systems distributes and retains the value of these foods close to the source of production. Indirect effects are that as a result of increasing expertise and utilisation in processing and marketing, more raw materials may be required. This stimulates farmers to improve the amount, quality and variety of fruits and vegetables which are grown. When environmentally sustainable farming methods are used, the care exerted maximises soil health and water utilisation. Incomes to farmers improve from the volumes sold, and also from the ability to store crops which can then be sold out of season (for better prices). Farming activities and food processing activities also increase the demand for packaging, equipment, and services (e.g. mechanics) and infrastructure. These indirectly stimulate the development of associated industries and services.

There are many benefits of processing and preserving food. In communities and households, food preparation and processing can:

- Increase the variety of foods in the diet;
- Create special foods for cultural or religious occasions, thus reinforcing cultural identities;
- Create opportunities for sales and income generation.

Food processing is a scientific activity that covers a broader area than food preparation and cooking. It involves the application of scientific principles to slow down or stop the natural process of food decay caused by micro-organisms, enzymes in foods, or environmental factors such as heat and sunlight, and also factors involved in the preservation of foods. All foods are biological materials that begin to decay as soon as they are harvested or slaughtered. Processing slows down or stops this deterioration and thus allows foods to be preserved for extended periods.

The benefits to a household then are that it enables food to be stored as a reserve against times of shortage, ensures a distribution of essential nutrients throughout the year, and creates the possibility of selling a crop ‘out of season’ for a higher price (at harvest time everyone is selling the same thing triggering lower prices). If land is available, growing staple crops can save on household incomes. By growing variety, households can increase the diversity and satisfaction of their diet with preferred foods that would be too expensive or inaccessible because there is no market available.

2.3.1 Food processing practiced on different scales

There are three broad categories of food preparation and processing and these can take place at any scale from a single person to many employees in a large processing plant. When foods are intended for household consumption, or small-scale processing they are usually processed by individual families or small groups of people working together. These processes may happen seasonally or be based on the availability of labour, and or demand for the product.

Primary Processing: This refers to the stabilization of food after harvesting. The objective is to extend the shelf life of a raw or untreated commodity using appropriate post-harvest handling and storage practices. This includes processes that slow or prevent spoilage and make the foods more convenient to store and transport while allowing them to be marketed in a fresh or fresh-like state or form. Examples include slaughtering and portioning, cleaning, classifying or grading, de-hulling, pounding, grinding, soaking, winnowing, sieving, drying, chilling, milling, extracting oils from seeds, and simple packaging.

Secondary Processing: many foods can be preserved to increase their stability or they can be converted into other forms which essentially produce a new food or food product. When we use processes to increase the stability of a food we call this *preservation.* When we convert the food into another form or more complex combination of foods, we call this *processing*. Some examples of these processes are mixing, cooking, moulding, cutting, extruding and puffing. Food processing in the food industry involves understanding the science of living food and then applying science to stop the natural process of decay (spoilage) or to change the physical structures of the foods to recombine them in different forms. In both processes, we are trying to extend the **shelf life** or alter the eating quality of the foods.

Tertiary Processing: This category is what we used in the household to cook food. Food can be boiled, steamed, fried and baked. The processes are fairly simple and do not need special equipment and processes except for heat or cold temperatures.

2.3.2 Mechanisms of food spoilage and loss of food supplies

If you remember back to Figure 2.3 in Unit 2, we depicted the flow of food from producer to consumer as a pipeline. The usefulness of farm produce can be lost through **spoilage** or **deterioration** at any stage of the pipeline. Direct loss comes from spillage (out of packaging) or pests which actually consume (food loss) or destroy the nutritional value of the products while in the pipeline. When foods spoil, they undergo chemical and physical changes that may render the food inedible. There are a number of ways that spoilage and deterioration can occur. In this unit we look at the four most relevant mechanisms that we can control with food preservation and processing at household level: Infestation by macro-organisms such as insects and rodents, microbiological spoilage, chemical and/or biochemical spoilage, and physical damage.

Infestation by macro-organisms

Insects, parasites and rodents and birds can cause major losses in fresh produce. They infect the foods in a myriad of ways both before harvest, during and after harvest, and even after processing through careless packaging and storage. These macro-organisms such as mice and rats can cause much damaged to stored food. The use of rat poison is very dangerous to man band yet itis a problem to control such rodents without using poison. In some countries rodents and some insects are regarded as culturally acceptable foods. Very creative methods have been developed to catch to hunt and harvest those insects and rodents regarded as food.

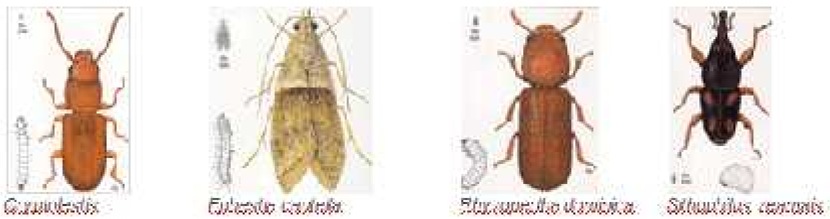


Figure 2.8 Different grain borers (ARC)

Grain borers also cause a lot of damage to improperly stored grains. Traditionally harvests of grains and legumes have been stored in baskets above or underground. In smaller containers Aloe ash has been mixed in to kill borers. Lately farm households are encouraged to use tanks that can store large quantities of harvested grain. In certain areas the harvest is collected by milling companies with grain silos in exchange for milled meal, flour or cash.

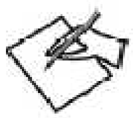
Microbiological deterioration

Micro-organisms are living organisms that are too small to be clearly seen by the human eye. We can only see them if we use a microscope. They are found everywhere: in the air, in soil, in water, on the human body as well as in foods and the equipment that we use to prepare foods. We come into contact with them through animals, insects, birds, packaging materials, equipment, poor personal hygiene of food handlers, and cross-contamination from raw materials to cooked and ready to eat foods.

Microbial spoilage of food arises from the rapid growth of vegetative forms of micro-organisms. Under **optimal** conditions, the rate of growth of micro-organisms may be less than 20 minutes. These organisms use the nutrients in the food for growth, which leads to the breakdown of the foods. For example, fungus (such as Rhizopus- also known as bread mould) grows on bread causing the starches to break down, making the bread have an unpalatable taste. The bacteria which grow in meat, causing the meat to go “off” make the meat taste terrible, and can make you sick. There are three basic principles that have been followed by mankind for centuries for dealing with micro-organisms.

- ***Keep out***: Restrict the access of micro-organisms and pests to food in the first place to minimize contamination. We do this through the use of appropriate packaging materials and storage containers.
- ***Kill them***: Inactivate or destroy micro-organisms that have made it past the ‘keep out’ process and gained access to the food. The most appropriate of these technologies at household level is applying high temperatures (heat) beyond which the micro-organisms can survive. Enzymes are proteins and heat denatures proteins. In other words it makes them unable to act on food. The micro-organisms die because the heat destroys the enzymes which control their metabolic processes and they are not then able to grow or replicate.
- ***Keep them from growing***: Slowing down or inhibiting the growth of the microbes in the event that they have not been kept out or killed.

Activity 2.1 Applying Preservation techniques



Complete this activity on your own or in groups in your workbook

Aim: To gain practical experience in understanding the process and benefits of preserving by applying a food preservation technique

Time: 45 min hour

What you must do:

1. Preserving with sugar: preventing the growth of mould and bacteria

Jams, syrups and jellies

Any fruit except avocado can be made into **jam** (from the juice and the flesh of the fruit) or **jelly** (made from the juice of fruit only). When citrus fruits are used for jam – these are called **marmalade**s. When moulds and yeasts do sometimes form on the surface, remove them with a clean spoon because the jam is underneath is safe to eat.

To make jam: choose firm fruit, discard or remove any brown parts. Wash and peel the fruit. Remove seeds if they are large like in apples or peaches, or mangoes. Small seeds such as in berries like mulberries are too small to worry about. Cut the fruit into small pieces. Put the fruit into a cooking pot and just barely cover with clean water. Allow to stand for a few hours or overnight to extract the juice from the fruit. Bring to the boil and cook gently until the fruit is tender (this is when you can cut it with the side of a fork or spoon). Measure how many cups of juice/fruit you have now in your mixture. In general, you add 1 cup of sugar and ½ cup of freshly squeezed or bottled lemon juice to every cup of juice/fruit. (If you can let this mixture soak overnight, your jam will have a better flavour and will set (become firm) with less cooking). Stir the jam over a gentle heat until the sugar is dissolved, then bring to a fast boil and continue boiling uncovered until the jam is set (be careful – the mixture may boil up over the sides of your pot). You can add a large teaspoon of margarine to the boiling jam to help stop it from boiling over. To test for setting, stir the jam well, then use a spoon to put a small amount (less than a spoonful) on a clean cool saucer. When it is cool push the drop of jam gently with your finger, if it crinkles, the setting point has been reached. Set the pan aside to cool slightly. Ladle the jam into clean hot jars (up to 0.5 cm from top), cover with an airtight later of thin plastic cut from a clean sugar bag and screw on the lids. You can also melt candles in a clean tin can and pour a layer of this wax on top. When cool, you can screw on the lids. This makes an airtight seal. The wax can be removed when you open the bottle, washed and used again next time you make jam. – When your bottles of jam are cool, wipe them clean, label with a name and date and store them in a cool dark place.

Note: Any bottles that you can wash in boiling water are suitable. Wash and then boil the bottles as well as the lids in clean water for 10 minutes. Turn upside them down to drain and dry. It is best to keep the bottles hot by placing them in your oven if you have one. If you cannot keep the bottles hot, be very careful with your hot jam – put it in carefully to prevent the bottles from cracking. If you are not able to sterilise your jars by boiling and keeping them hot – then you must wash the bottles in very hot water and understand that your jam will not keep as long as it would if your bottles had been sterile.

Here is a question: *How effective is solar energy for sterilizing bottles?* If you want to find out then you can experiment by constructing a solar heater that could sterilize bottles with water or heat.

2. Make at least one of the recipes in Annexure C:

Answer the following questions (refer to your notes in the text and in the Annexures):

Why do you think that it is important to wipe the jars clean after filling and sealing, before you store your bottled product?

....

....

....
....
....
....

In the recipe you used, what ingredients were used to prevent the growth of moulds and yeasts?

....
....
....
....
....
....

What role did the cooking play?

....
....
....
....
....
....

What role does the wax or the tightly screwed on lid play in preserving the contents of the bottle?

....
....
....
....
....
....

What role does the bottle play in preserving the ingredients?

....
....
....
....
....
....

Think about the need for bottles if you were to make jams and chutneys more regularly. Suggest strategies for how you could obtain the bottles, you would need from your neighbours, colleagues and friends without buying them from a store.

....
....
....
....
....

The micro-organisms that cause food spoilage are **bacteria** and **fungi** in the form of ***moulds*** and ***yeasts.*** These organisms multiply rapidly and cause changes to taste, texture, smell and appearance of foods. When they break down the proteins in foods, they can cause really offensive odours. The most common food-related illnesses result from the growth of microbes and/or toxins produced by certain microbes in foods. Because of this hazard to human health, it is important to know how these microbes contribute to spoilage and loss of our food resources.

All microorganisms have conditions within which they thrive.In general, micro-organisms are affected by:

- The temperature of the food: most microorganisms are 'mesophiles' meaning that they grow best between 30-34 ^{o}C.
- The presence of oxygen: If they need oxygen to grow they are aerobic (with oxygen) or if they grow without oxygen, they are anaerobic (without oxygen).
- The acidity of the environment: this can be acidic, neutral or alkaline. Most microorganisms prefer to grow in a neutral environment.
- Availability of water: all micro-organisms require water to grow.
- The presence of sugar, salts, acids.
- Sufficient quantities of substrate (the nutrients which they require to grow) to support growth.

Yeasts

Yeasts are unicellular (one-celled) forms of fungi that are microscopic. Yeasts grow best with a generous supply of moisture (water) and can grow in the presence of greater concentrations of sugar than do most bacteria. Growth of yeasts is favoured by an acidic environment (pH 4.0- 4.5). They also grow best in the presence of oxygen. For example yeasts thrive particularly in acidic fruit juices, where they can ferment the sugar, producing alcohol. The optimum range of temperature for growth is similar to moulds and is (25-30ºC), therefore, growth is inhibited (slowed down or prevented altogether) at low (cold) temperatures. Very high temperatures kill them.

Moulds

Moulds are multi-cellular fungi that appear fuzzy or cotton like when they grow on the surface of foods. These microbes have filamentous like (string-like) shapes (see Figure 3.2). The growth may be white, dark or various colours, such as green or orange. Mould spores, by which moulds can reproduce, are small, light, and resistant to drying. They easily spread through the air and can contaminate any food on which they settle. Moulds grow readily on relatively dry foods such as bread, stored cereal grains, dried fruit and vegetables. They thrive at ordinary room temperatures, require oxygen and can grow within a wide pH range of 2.0-8.5. Given sufficient time, moulds can also grow under cool conditions in refrigerators. Some moulds can grow even at relatively high temperatures. Because moulds are adaptable to many conditions of acidity and temperature they are commonly involved in the spoilage of food.

Yeasts and moulds are forms of fungi which we often see growing on the surface of fruit, cheese and bread. What we see is the grouping (colonies) of millions and millions of these organisms growing together (Figure 2.9).

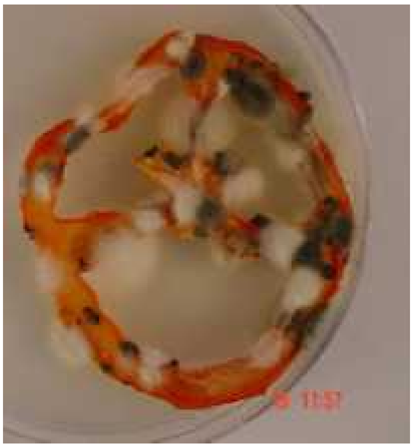


Figure 2.9 Moulds growing on

a) sun dried tomato (Caister 2003)

b) fresh nectarines http://en.wikipedia.org/wiki/Mould

Bacteria

Bacteria are one-celled microbes smaller even than either moulds or yeasts. They can exist either as a spore (a package of genetic material) or a vegetative cell (growing cells). Vegetative cells represent the active form of bacterial life while spores are a dormant or resting state of a bacterial cell and do not show any signs of metabolic activity. Under conditions that favour growth, spores germinate and become vegetative cells. Spores themselves are highly resistant to heat, acid, or other conditions that would normally prevent growth or even kill vegetative cells. This means that they are very difficult to destroy or inactivate.

The bacteria spores that cause food poisoning release toxins. Some of these spores require an anaerobic environment (no oxygen!). The spores are found on all fresh foods but are harmless. However, when oxygen is removed during canning (e.g. tinned tomatoes, tinned beans or peas) they are able to grow. What prevents their growth is the addition of salt or acid to the contents of the tin and heating the sealed tins to very high temperatures to ensure that the bacterial spores are killed.

Bacteria come in different shapes (Figure 2.10). The shapes are important because shapes determine how bacteria are identified when we are dealing with animal and human illnesses. In addition to their different shapes, their cell arrangement varies. For example, some cocci are always grouped in pairs (diplococci). Others are arranged in chains (streptococci). Still others are bunched (staphylococci). Diplococci are the kinds which cause pneumonia. Streptococci are often associated with "strep throat." Staphylococci are familiar to many because of their role in "staph infections" and some types of food poisoning (Schuler 2008).

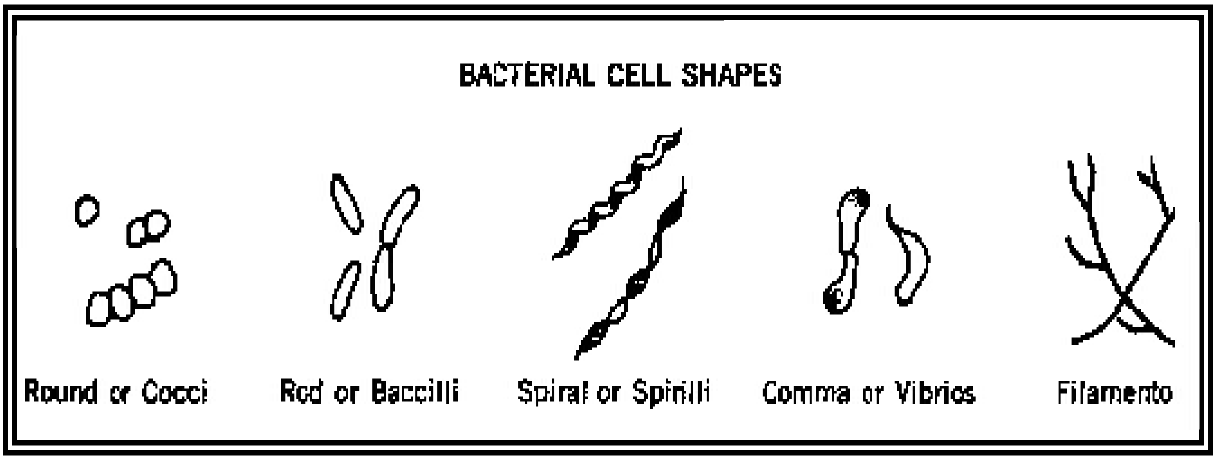


Figure 2.10 Different shapes of cells (Schuler 2008)

There are many different families of bacteria involved in food spoilage and food poisoning. Generally, bacteria require more moisture (approximately 20-30%) than either moulds or yeasts; they grow best where concentrations of sugar or salt are low and where the pH is about neutral. Some bacteria like cold conditions (**psychrophilic**) and thrive at refrigerator temperatures. Other are heat loving (**thermophilic**) and will affect cooked foods. Others like moderate temperatures and are called **mesophilic**. In general, heat in the presence of acid is highly destructive to bacteria. Non-acidic foods (low acid content where pH >5) are very difficult to preserve.

Food Poisoning

When microorganisms are able to make a person or animal ill – we say that they are 'pathogenic'. Pathogenic bacteria are the most notorious micro-organisms guilty of causing diarrhoea and vomiting after eating spoiled foods. Bacteria prefer foods with protein and usually spoil fresh foods such as meat, fish, milk, beans and legumes. Pathogenic moulds are best known for producing aflatoxins. These toxins are produced by the mould as it grows. They are poisonous to humans and livestock –potentially causing cancer. Food products susceptible to aflatoxin contamination are:

- Cereals: maize, sorghum, pearl millet, rice, wheat
- Oilseeds: groundnut, soybean, sunflower, cotton
- Spices: chilli, black pepper, turmeric, coriander and ginger
- Nuts: almond, pistachio, walnut, coconut
- Milk and milk products

There are two ways in which pathogenic microorganisms can cause illness: *Food intoxication* and *food infection*.

Food Intoxication: Occurs when pathogenic micro-organisms have grown and produced a toxin in food, and the toxin-laden food is consumed. The toxin produces the illness.

Food infection resulting from infestation of live pathogenic micro-organisms in food, which are then ingested and then grow in the gastrointestinal tract and which can then cause illness

Table 2.1 Examples of food intoxication and food borne infection

Food intoxication	**Health hazard**	**Frequency**
Clostridium botulinum	Severe poisoning, fatal toxin is heat labile (changeable)	Very rare
Clostridium perfringes	Diarrhoea, cramps, little toxin produced	Very common
Staphylococcus aureus	Stomach cramps, vomiting, diarrhoea, toxin is heat stable	common

Food borne infection	**Health hazard**	**Frequency**
Salmonella	Fever, diarrhoea, vomiting, occasionally fatal	Very common
Campylobacter jejuni	Abdominal pain, bloody diarrhoea, fever	rare
Yersinia enterocolitica	Diarrhoea or inflammation of intestinal lymph nodes, can be fatal	Rare
Listeria monocytogenes	Meningitis, septicaemia, miscarriage	Increasingly common in pregnant or immunity challenged individuals i.e: transplants, AIDS, cancer

When we monitor the safety of foods and water, we test for *Escherichia coli (E.coli)*. Because *E.coli* occurs naturally in the gastrointestinal tracts of humans and animals, their presence in our food and water indicates that food is not being handled in a sanitary or clean way. We then assume that the people working with the food are not following sanitary practices like washing their hands, or there are animals like birds and rodents that are infesting stored foods and leaving their feces. You learned about good hygiene practices for preparing food in the nutrition module.

2.3.3 Parameters affecting the health and growth of microorganisms

To be effective in preventing foods from spoiling we need to understand that the micro-organisms (like human beings) are dependent on their environment. When we control the environment, we are able to exert some control over food spoilage. By removing the things they need from the environment, micro-organisms cannot survive and thus are not able to threaten our food supplies. What micro-organisms need are an adequate but varying amount of water, a source of energy (e.g. carbohydrates), a nitrogen source (e.g. amino acids from proteins) and vitamins and related growth factors and minerals. Because moulds have the simplest nutrient requirements they cause spoilage much more often than bacteria.

Oxygen

Microorganisms, including bacteria, can also be grouped according to their requirement for oxygen. Some grow only in the presence of oxygen (aerobes). Others grow only in the absence of oxygen (anaerobes). Some are able to grow with or without oxygen (facultative anaerobes).Under natural conditions, anaerobes grow only in places protected from the air, such as deep in the soil or under water. They can also grow under man-made anaerobic conditions, such as in canned or vacuum packed foods which have not been processed or handled properly. Therefore one always aims to seal products so as to leave none or as little oxygen as possible.

Acidity of foods (pH)

The acidity or alkalinity of foods is measured by measuring the pH of the foods. The pH of a substance simply means the amount of reactive hydrogen molecules (H^+) there are in that substance. The amount (concentration) of reactive hydrogen in a substance is measured using a complicated mathematical formula. This calculation always produces a number somewhere between 1 and 14. This number represents the concentration of hydrogen molecules available for chemical reactions. Fortunately for us, we do not have to be able to do the calculations to measure the concentration. We only have to understand what the results (the numbers from 1-14) of those calculations mean.

We create meaning by measuring the acidity or alkalinity of our food substance to the pH scale of 1 to 14 (Figure 2.3). If the pH is low the number is also low and we say that the substance is *acidic*. If the pH is high the number is also high and the substance is considered very *alkaline* or *basic*. Obviously, 1 is a measure of the most acidic substance and 14 is the measure for the most alkaline substance.

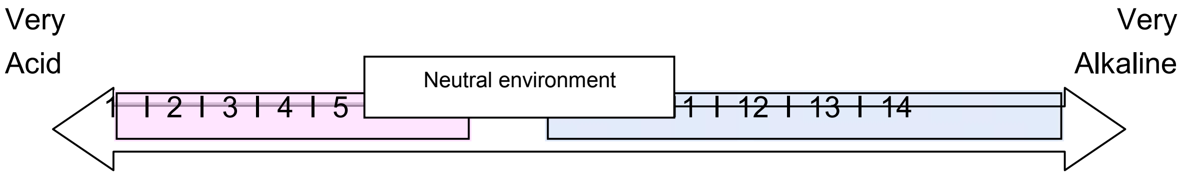


Figure 2.11 Values representing the pH [concentration of hydrogen (H^+)] in liquids and solids

In dealing with every day decisions, it is nice to know that we can change the acidic or basic nature of a substance. For example, if our soil is acidic, we can add agricultural lime (alkaline in nature) to move the pH of the soil towards a more neutral state. If we have been stung by a bee or a wasp, we rub a raw onion or dab some ammonia on the bite – both of these 'treatments' are alkaline and they neutralize the acidic poison from the sting!

Lowering the pH of foods (in other words, making them more acidic) will contribute to the microbiological stability of the food. Pathogens do not grow or multiply when the acid levels are high. However, foods with a low pH (or ones that are alkaline) may spoil more easily because yeasts, moulds and some bacteria thrive quite happily in this environment. So you may not get sick, but you still might end up with mouldy orange juice if you don't drink it within 3-4 days!

Most micro-organisms prefer to live in a neutral environment between a pH range of 5 to 9. Neutral, which means being neither acidic nor alkaline (basic) is exactly pH7.

Availability of water

The deterioration of foods by micro-organisms can take place rapidly, whereas enzymatic and chemical reactions take place more slowly during storage, in either case, water is the single most important factor controlling the rate of deterioration.

All living organisms need water to grow. Each micro-organism has a specific amount of water that is optimal – in other words, the amount of moisture available for maximum growth. What this means then, is that we could theoretically control the ability of any particular micro-organism to survive simply by adding or removing the amount of water available to the cells. In general, bacteria require more free or available water than yeasts and moulds. Examples of how we reduce the water available to micro-organisms are: by binding water to sugar and pectin gels (as in jams) or by freezing where the water is caught up in the ice crystals.

We can also physically remove water by evaporating some of the water away. We evaporate some water when we make cordials or concentrated fruit syrups. We evaporate most of the water when we dry foods such as biltong and fruit, by removing almost all the water. The water that remains is attached to sugar (in the case of dried fruit) or salt (in the case of biltong). The scientific term for this in English is dehydrating. The 'de' means to ‘remove’ and hydrate means ‘to water’. Therefore we ‘remove the water’.

Temperature

Temperature is a very important factor for micro-organisms to grow on food. Therefore food must not be kept at room temperature for more than two hours. Food should be kept cold or heated to very hot. This zone of at risk temperatures is called the hazardous or danger zone.

2.3.4 Chemical or Biochemical deterioration

In addition to nutritious elements such as water, vitamins, carbohydrates, fats and proteins, foods also contain enzymes that promote chemical interactions inside the foods. Enzymes are present in all living tissues and control the growth and development of the plant or animal. Micro-organisms also produce enzymes, adding to the problem when food is not protected.

Action of Enzymes in food

In active living tissue, complex enzyme-catalysed biochemical reactions take place, which are carefully controlled by the cell. These enzymes are naturally occurring and normally aid in the ripening of fruit and vegetables. However, in raw, unpreserved food (the cells are not living anymore), the cellular structure breaks down and these enzyme reactions become uncontrollable, modifying the appearance, taste, texture and safety of foods. For example, in bruised fruit and vegetables, the breakdown of the tissue by the enzymes leads to the formation of acetaldehyde and ethanol, which taste unpleasant. Fruit and vegetables which, have been left too long, go soft because of the breakdown of pectin. Humans generally do not find these overripe fruits or vegetables edible.

Heating the food to denature the enzymes can control damage caused by enzyme activity. Boiling, frying, pasteurization and canning are all heating methods that reduce enzyme activity. Blanching of vegetables and fruits is used before carrying out other forms of processing such as drying or freezing, which do not heat the food sufficiently to destroy the enzymes. Blanching is a cooking process which is intended to enhance the color, flavor, and texture of vegetable. Blanched vegetables are quickly cooked in boiling water or steamed before being plunged into very cold water which stops the cooking process.Enzyme activity can also be inhibited by changing the level of acidity, excluding air (removes oxygen), or reducing the moisture available in some foods.

Non-enzymatic reactions in foods

Food can also spoil from non-enzymatic reactions, such as oxidation (from the contact of cut or broken surfaces with oxygen). Examples are the browning of apple slices or rancidity in unrefined fats and oils.

The fats in plants and animal tissues (i.e. oils extracted from seeds, peanuts) break down when exposed to oxygen in a process called oxidative rancidity. In English we say 'the fats have become rancid'. The most common experience that we have is when milk or butter is exposed to light and air. Within a very short time, there is a difference in flavour – these flavours are the result of the oxidative rancidity. This is why luxury foods that contain cream like imported cheese, and butter are wrapped in foil and or opaque containers that do not let the light through to prevent exposure of the contents to light and air. NikNaks, potato chips and other fried or baked snacks are also usually packaged in foil they have a high fat content which has already been exposed to heat and are very susceptible to becoming rancid. The packaging is not permeable to air (air cannot go through the foil and plastic layers) and the foil blocks the light from causing damage.

Physical Damage:

Very occasionally we experience a flat coke or beer with no fizz because there is a flaw in the tin or bottle which allows carbon dioxide to release slowly over time. Even though nature often packages food in the most creative of ways (e.g. egg shells, banana peels, nut shells), raw foods, especially fruit and vegetables, are very susceptible to physical damage. Poor handling at harvest or during transport leads to cuts and bruises, thereby, damaging the tissues. These foods are then more susceptible to biochemical changes, invasion by insects and spoilage by microorganisms.

Careful post-harvest handling and storage, and the use of containers instead of dumping fragile foods in piles can reduce physical damage You could pile pumpkins or cabbages into the back of a bakkie without doing serious damage, but if you packed them into a lorry without putting them in crates the pumpkins or cabbages at the bottom are likely to be damaged. It is a matter of knowing what the potential problems are and choosing an appropriate method with the resources that you have available to prevent those problems.

In very humid conditions, dry goods such as biscuits can easily gain moisture if not packaged effectively –e.g. soggy (soft) biscuits. In fact, if you bake a lot, you may have noticed that sometimes the ratio of liquid to flour in a recipe changes and your dough comes out stickier than you expected and you have to add more flour than normal. One reason for this is because even though they may still feel dry, flours (and other milled grains) easily absorb moisture from the air.

Sometimes bulk foods which have been physically damaged – for example grains that are broken or allowed to get dirty, fruits and veggies that are overripe or bruised, mealie meal that has fermented slightly may be used as animal feed thus salvaging some part of the loss. We have spent quite a bit of time outlining how foods deteriorate. Now we need to look at how to stop the deterioration.

2.4 Food processing practices for value-adding for food resources

We have been learning about what causes food spoilage and you should now be able to understand that foods deteriorate from microbial activity, chemical reactions (including enzyme action) and physical damage. We also learned that oxygen, water and the acidity of an environment determine the type of spoilage and how rapidly it will occur.

Now we come to a great turn around in our learning! Some of the very same factors that cause deterioration in food can also be used to preserve and add value to food. Many bacteria, yeasts and moulds are actually used in traditional food processing processes and in the modern food industry to achieve desired flavours, textures and even to help preserve foods.

For example, the different flavours and characteristic textures of a variety of cheeses result from the activity of various bacteria or moulds. Sauerkraut, pickles, maas, yoghurt and sourdough or salt fermented breads are made by using *bacterial fermentation*. The yeast in bread provides leavening and flavour to baked goods and is important in the production of foods such as beer, vinegar and wine. Many Oriental foods such as Miso, and Tempeh are made with the help of moulds.

2.4.1 Traditional low-input technologies for increasing shelf life

We call foods that can be stored without refrigeration at normal (ambient) temperatures shelf-stable. These are of special interest to rural communities especially if refrigeration is costly or unavailable. The most common traditional technologies and which are still used today are given in the table below.

Table 2.2 Appropriate food processing technologies used in Africa and other parts of the world

Principle	Method	Technology used	Examples of use in food products
Inactivate microorganisms and enzymes	Heat	Cooking(boiling, roasting, grilling) Baking Pasteurization Heat sterilization (bottling/canning)	Porridges, root crops, vegetables, meat and legumes Injera (sour bread leavened by fermentation) Milk, fruit juice Canned or bottled fruits, vegetables, legumes,
Slowing down or inhibition of microbial growth	Reduce available water Lowering pH	Drying foods, concentrating Salting Salting and curing with smoke Smoking Addition of sugar	Dried fruits, vegetables & herbs, roots, nuts, pulses, saps from plants, insects (mopani worms) Fish (e.g.kapenta), meat (e.g. biltong), pickles meat (e.g. ham & bacon), fish, various fruits (kwakwa), seeds (mealies for planting) konfyte, jams, syrups, bottling & canning, drying fruits
		Addition of acid (vinegar, citric acid, lemon juice)	Pickled meats, fruits, vegetables, herbs
		Lactic acid fermentation	Fermented fruits (Mango 'atchar'), Fermented porridges & beverages (Mahewu) Fermented milk products (maas, yoghurt) Fermented legumes (dawadawa, soya sauce, miso),
	Production of alcohol and carbon dioxide	Brewing	Sorghum or millet beer, fruit wines
	Chemical preservatives	Natural chemicals Artificial chemicals	Spices (chillies, ginger, garlic mustard, cloves), wild leaves & herbs known to local peoples Sulphiting (soaking fruits in sulpher solution before drying) Sodium benzoate (in juices, cordials and squashes)
Restrict access of microorganisms	Decontamination	Fumigation of raw materials with ethylene oxide	Cereal grains stored in containers

We need to understand that for improving food security, simple methods of processing and storage based on traditional knowledge have the greatest chance of being successfully introduced. Preservation techniques used in rural communities should be effective and reliable but simple and inexpensive to implement. Improving existing practices is more likely to succeed than introducing completely new technologies. This is because the 'known' is familiar, matches available resources to objectives, and is suited to local environmental conditions.

In this course we cannot teach you everything you need to know to become skilled in preserving foods, but we can expose you to the potential of household based preservation and how this may contribute to food security. Perhaps by doing so, we will encourage you to search for additional training and capacity building both for yourself and the communities that you work in.

Drying

Drying is one of the most accessible and therefore widespread food processing technologies. When combined with improved food stores, it can lead to significant improvements in food security. Legumes, field maize, and important dried fruits and vegetables okra, cabbage, spinach and wild *imfinos* (herbs), fruit slices and leathers, garlic, chillies and other flavourings which are stored for use in daily cooking.

Figure 2.12 Peaches slices to be dried in the sun covered in dryer (FAO, 1997 Photos X5040E1h / X5040E05)

Figure 2.13 Sorting and drying of dark green leaves as vegetable(*imfino* or *morogo*)(Photos: FM Ferreira and adapted from Northern Province DFID)

Figure 2.14 Fresh bambara nuts to dry (*dithlo*) cowpeas and peanuts right(Photos: MR Masekoameng, FM Ferreira)

When assisting people to improve their sun drying methods; encourage households to look for ways to reduce contamination by dust, crawling insects or rodents. Netting helps to keep out birds and flying insects. In covering foods with netting make sure that households don't use their mosquito netting for drying food leaving children vulnerable to malaria. Cutting fruits and vegetables into smaller pieces so that they dry faster and blanching vegetables helps retain more appetizing colours and kills some enzymes. It may also be possible to introduce crop varieties that are better suited to drying than traditional types.

Concentration by boiling

Boiling for long periods of time consumes fuel which is a major cost in terms of labour, time or cash in rural communities. But sometimes a food is important enough to warrant the cost. Tomato paste, extracts from wild plants such as baobab fruit, chutneys, and syrups made from fruits or saps and of course fruitjams, konfyte and other preserves are a very useful way of extending the season's supply and adding variety and micronutrients to any normal food intake.

Figure 2.15 Cutting a cross in the peel of marula fruit; for ease of boiling them to extract juice and to preserve the fruit; that is then canned. (Photos: FM Ferreira)

For example, if the area contains *amarula* trees. Juice from the fruit can be extracted and combined with equal amounts of sugar and concentrated into syrups, jellies (clear jams) or even fruit squares. The main requirement to improve processing of these products is to control the rate of heating to prevent localized burning of the product, particularly when it has become thickened towards the end of boiling.

Figure 2.16 Using wild fruit such as guava cherries to make jam or jelly (Photos: FM Ferreira).

Fermentation & Pickling

For thousands of years, fermentation has been used in villages for preserving foods. It is inexpensive and manageable for rural people because it makes no demands from external inputs and is adaptable to local climate and agricultural products.

Figure 2.17 Drying sorghum and other legumes (on left) and fermenting (in the middle)and drinking sorghum beer (on the right) (Photos: FM Ferreira)

Fermentation contributes to food security because it increases the range of raw materials which can be used in the production of edible products and improves the digestibility of proteins and carbohydrates thereby making nutrients in food more available to the human body. It is important for food security that during economic and cultural change i.e. development that the practice of these processes and the indigenous knowledge supporting them is not lost. Fermentation is a way of adding value to agricultural raw materials and by improving the safety, yields and quality of these indigenous products, an extended shelf life, income and employment may be generated.

Figure 2.18 Extracting the juice of marula fruit to ferment for making beer
(Photos: FM Ferreira)

The process of fermentation produces antimicrobial factors such as changes in pH (lactic acid), hydrogen peroxide, carbon dioxide, and ethanol which pathogenic micro-organisms do not like. In other words, it changes the environment so that pathogenic micro-organisms cannot function. A wide variety of flavours, textures and aromas can be produced through fermentation.

Figure 2.19 Smoked and fermented polonies and pickled sosaties in brine and dried biltong with dry salt and spices (Photos: FM Ferreira)

The difference between pickling and fermenting is that the acid is added as a preservative, rather than produced as part of the preservation process. Some fermentation may occur over time, but this is contributes more to flavor development than to preservation. Quick pickling is accomplished by soaking vegetables in brine (salt water) draining and then covering them with vinegar (acid). When you purchase or make dill pickles made out of cucumbers, this is the method generally used.

Production of fruit wines is a common form of home fermentation. A wide range of fruits can be used including pineapple, melons, pawpaw and indigenous fruits such as *malala* palm, *amarula*, berries and grains. In these fermentations, the yeasts (naturally found in the foods or added to encourage more efficient results) feed on the carbohydrate sugars to form lactic acid in the presence of oxgyen. This gives the products various intensities of sour flavours. When the food combinations are sealed in air tight (aneraobic conditions) containers, the yeasts produce alcohol and carbon dioxide (bubbles) instead of lactic acid.

Vegetables and fruits like hard pawpaw and mango can also be mixed with spices and held in closed containers such as glazed clay pots, porcelain containers and glass bottles. For example, **any** vegetable can be fermented using the method in Box 2.1.

BOX 2.1 Preserving Vegetables in Brine

Abrine using a weight of salt that is 10% of the weight of the water needed to cover the vegetables in the container. A convenient way to remember this proportion is 1 measure of salt to 16 measures of clean water. The vegetables are cleaned by washing and peeling if desired, sliced (e.g. carrots and beans and onions) or shredded (sliced thinly as in cabbage). Spices are added such as garlic, chillies, or whole pickling spice (see recipe in Annexure) and then the whole lot is kept covered in the prepared brine. It is important that the vegetables are always kept under the brine to prevent air from drying the vegetables or oxygen supporting the growth of moulds and yeasts on the vegetable mix. Bacteria ferment the sugars in the vegetables thereby changing the texture and flavor of the veggies. Problems can arise if the vegetables are not cleaned properly (introducing moulds and yeasts). High summer temperatures can also prevent lactic acid bacteria from fermenting and the whole lot spoils because no lactic acid is produced to assist in preservation. This method can be used whether trying to cope with an excess of a crop (like lots of cabbage) or when you have a variety of small quantities that are too small on their own to be worth the effort to preserve, but when combined make a substantial substrate for preservation by fermentation.

Smoking

To smoke food, obviously one needs smoke from fire. This requires fuel. Practice of this technology is widely found in climates where exposure to the sun is not sufficient to dry foods adequately. Fires produce heat, but also as the wood burns, fat and water-soluble molecules, steam and other particles are released from the burning wood. These settle on the food and are absorbed by them, contributing to the flavour of the final product. The heat and smoke dries out the food by removing moisture which helps to concentrate food flavours as well as prevent microbial growth.

There are two smoking methods these are cold smoking and cooking with smoke. Cold smoking is the oldest process. Foods, in particular animal proteins such as fish, livestock, game meat and poultry were prepared and hung over fires in the path of the smoke. Combining preservation methods occurred when salt was available and assisted in preventing mould and yeast growth. Meats could be soaked in brine before being placed above smoking fires or hung inside 'smoke houses'. Smoke houses were any structure which would keep the smoke from escaping before penetration of the foods had occurred.

Indigenous fruits, fish, pork, poultry are common smoked items. Cheeses are also smoked for flavour development rather than for a preservative effect. People living in the low veldt areas of Southern Africa smoke the fruit of *Strychnosmadagascariensis* or the Shiny-leaved *mukwakwa* which is also called Swartklapper in Afrikaans. Smoking does not actually cook food but rather dries it out slowly over a period of days.

Cooking with smoke uses heat and smoke, mainly to flavour foods and is often used today in combination with chilling and freezing as preservation methods for items not eaten immediately. Smokers are made out of any container which can hold a source of heat (like a heating element or fire from the bottom). Food is held on racks or hooks. The fire is fed with wood that gives off desired flavouring as the smoke penetrates the tissues. In the meantime, the heat generated cooks the meat.

Preserving with sugar

Preserving with sugar is not a traditional process for African groups in South Africa. It is mostly a traditional process for the European groups. Any women with limited experience wanting to pursue preserving with sugar, and is interested in utilizing fruits and vegetables can contact organizations, agriculture extension officers, farmers forums & cooperatives, farmer's wives, knowledgeable men and women in the community and NGO contacts that may be drawn upon to assist with developing technology or ingredient combinations. Churches and women's institutes have a wealth of knowledge available and attract people looking for ways to help others. Otherwise one can search for information in the local library or the internet.

Figure 2.20 Sugar has been added to the extracted juice with pectin and boiled to make canned marula and marula jelly (Photos: FM Ferreira)

Fruits are usually preserved with sugar. When a high concentration of sugar is mixed with fruit pulp or juice (marula itself is acidic -low Ph - or acidify by lemon juice) the water activity is so diminished that moulds and yeasts find it difficult to grow. Examples of products that can be made are:

Jams and jellies:

In these products acidified fruit pulp is boiled with sugar until the pectins from the cells of the fruit form a gel. The different types of fruit give the products their unique flavor and colour. All fruits contain some pectin even if just a little bit.

Figure 2.21 Using natural resources to sterilize bottles, boil fruit juice, and pour jam in clean bottles (FAO, 1997-X5040E00).

Pectins are substances (known as soluble fiber) in fruits that form a gel when they are combined in the correct proportion with acid (fruit acid) and sugar. Generally, lemon juice is added to ensure that the mixture is acidic enough to form a good gel. It is possible to purchase pure pectin in a powdered form that has been extracted from apples or citrus peel. Adding pectin means that you can add less sugar and not cook the product quite as long. Modified pectins are available that produce gels with even less sugar. These are used in 'diabetic' jams and preserves.

However, pectin gets less and less as the fruits ripen. Generally, one must ensure that at least one fourth of the fruit used to make jams is slightly green or is a fruit very high in pectin. Unless the fruit contains a lot of pectin the usual proportions are one measure of sugar to one measure of fruit juice or pulp this is a relationship (ratio) of 50%sugar to 50% pulp. The final product usually contains approximately 60% or almost two thirds ($2/3^{rds}$) sugar because boiling the mixture evaporates some of the liquid. When ready, the cooked jams or jellies are poured into sterilized jars and sealed while hot to create a vacuum in the top. Vacuum means that the oxygen has been expelled. The sealed lids prevent any further contamination during storage.

Jams and jellies can also be made without sugar for diabetics. The simplest of these are generally made at home by mixing the fruit pulp or juice with gelatin (unflavored gelatin powder). Artificial sweeteners are added to taste and then the mixtures are kept in the refrigerator. Because there is no heat, acidification or sugar to destroy the environment for bacterial growth, the only deterrent is the cool temperature from the fridge. For this reason the shelf life of diabetic jams and jellies is very short (approximately one month).

Konfyte refers to whole fruits or large chunks of fruit suspended in clear thick gelled sugar syrup. **Marmalades** are soft, but have small to large pieces of fruit or citrus peel evenly suspended in a transparent jelly. **Fruit Butters** are made from fruit pulp cooked with sugar until thickened to a spreadable consistency.

Figure 2.22 Boiling fruit juice with sugar and spooning layers in flat containers to dry. Fruit leather strips cut into blocks and wrapped.(Adapted from FAO, 1997 - X5040E0f, X5040E0j)

Fruit cheeses or **fruit leather** are made by cooking and mashing fruit which is then forced through a sieve to remove lumps. The pulp is mixed with equal measures of sugar (1 weight pulp to 1 weight of sugar). The mixture is heated to remove most of the water through evaporation. It is then spread on trays to cool and dry, cut into cubes and stored in airtight containers (See Figure 2.23)

Fruit drink concentrates: The juice is extracted from heated fruit pulp and made into syrup with a high sugar concentration. The squash or syrup is put into sterilized bottles which are then heated in a hot water bath to kill mould and yeasts before sealing to prevent recontamination. Others with less shelf life are acidified by adding citric acid and stored in the refrigerator or used within several days of making.

Storing food - Keeping cold: Many methods have been developed to keep food cold traditionally. Africans buried grain baskets in the kraal. Europeans built cooler rooms with charcoal walls and flowing water to cool food. The Zeer pot fridge was initially designed as two clay pots fitting the one into the other with sand filled in between the two pots. The sand is wet with water, the fruit vegetables are put in the inside pot and covered with a wet cloth. The food stays 2 to 5 degrees colder than the outside temperature. This technology does not require electricity!

Figure 2.23 Zeerpot refrigerator (ITDG, FAO, 1997 X5040E1t)

Figure 2.24 Traditional root cellars used by Europeans (Internet)

2.3.7 Nutrition in processing

When we ingest and utilize an adequate mixture of high quality foods we get an adequate supply of nutrients in our diets.

The importance of nutrient losses during processing depends on the nutritional value of a particular food in the diet. Is the food an important source of energy and fibre (like pulses/bread/rice/maize)? Or is it a source of vitamins and minerals (like fruits and vegetables)? The extent to which nutrients are lost during processing will vary with the fruit or vegetable and with the process that is used. It should also be noted that growth conditions, or handling and preparation procedures prior to processing, also cause substantial variation in nutrient loss. This reinforces the knowledge that whether foods are being eaten fresh or destined for processing, the quality of foods must be carefully promoted from the health of the soil they grow in to the final cooking before serving to household members.

When foods are processed either by indigenous methods or high tech commercial processes, heat, exposure to sun and fluorescent light (ultraviolet light), oxygen and enzyme activity can cause deterioration of the nutritional quality. This occurs when foods are cleaned, sliced (exposing greater surface areas to oxygen and light), heated, treated by chemicals and stored on shelves. Dark green and yellow foods should not be exposed for too long to direct sunlight as sunlight also destroys Vitamin A. Such foods should be packaged when dry. However, drying cabbage is of little nutritional value but uncooked cabbage is rich in Vitamin C and minerals (See Module on nutrition)

Table2.4 Stability of vitamins in processed food (Fellows 1990, p. 34).

Vit. A	Vit. D	Vit. E	Vit. K	Vit. C	Vit. B complex and pantothenic acid
Destroyed by ultraviolet light and air	Increase in ultraviolet light	Destroyed by rancid fat	Very stable	Destroyed by air, enzymes, ultraviolet light, iron and copper	-
				Unstable to heat	More heat stable
Stable to heat, not normally affected by heat processing				Leached out, destroyed by alkalis, but are stable in acid	

Even though there is some deterioration, the benefits of having a variety of foods out of season cannot be dismissed. These foods not only bring nutrients into the diet, they provide variety and expression of personal or cultural preferences throughout the year.

2.3.8 Food labels & packaging

Household labeling and packaging

Food stores of home processed or food packaged from the shops need to be properly packed, in appropriate containers that can seal airtight or bags that can be closed and both keeping food dry and moisture out. Traditional aloe ash was used in dried foods to keep insects out. To be able to manage food stores one has to make sure that food packaged, processed and bottled at some are marked with the name of the product, the recipe used and date.

Figure 2.25 Home-made labels with dates on them

Box 3.2 below outlines the requirements for the labeling of foods.

Box 2.1. Information which must be found on food labels (Steenkamp 2007)

- **Name and address of the manufacturer or importer or distributor**
- **Instructions for use**
- **Net contents**
- **Country of origin**
- **Batch identification**
- **Use by date**
- **Table with Nutrient analysis per 100g or 100ml.**
- **All allergens must be identified in the prescribed format**

If no nutritional claims (such as ‘sugar free’, ‘Low Sodium’) are made, ingredients must be listed in order of descending mass (not volume) i.e. the ingredient weighing the most will be listed first and the ingredient weighing the least will be listed last.

Commercial labelling and packaging for the consumer

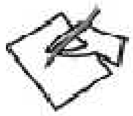
The way a food is contained for storage helps to control its shelf life by preventing light or air or pests to access the processed foods. Packaging helps with the marketing of commercially preserved food products.

Think about the way you shop. Do you look at the size or colour or shape of a package? Do pictures or writing on the outside affect which product you purchase? What do you think would be the impact of being able to read the writing on packages in your own language? Packaging can also be an important source of information about the accountability of the processors, quality of the contents and how to use the product.

Packaging can be used as a powerful tool to communicate – lies, half truths and inaccurate information. In order to protect consumers, South Africa has passed laws that control what can and cannot be used on packaging as a marketing strategy. Because this information is on the outside of the packet, we can use it to tell us a lot about the quality and nature of the product inside.

In your work book you will find some exercises which will help you become familiar with words and what they mean in terms of food labels. By understanding these in relation to the type of ‘preservation’ of the foods, you are empowered to make decisions about the quality of the products you purchase.

Activity 2.2 Commercially available food and packaging



Complete this activity on your own or in groups in your workbook

Aim: To develop a practical understanding of food preparation and processing of commercially available food.

Time: 1 hour

What you must do:

1. Using the definitions given on page 9 of your learning guide, link the food item to the terminology in the second column.
2. The first section is completed for you as an example: Understanding terminology

Understanding terminology

Food item	Terminology			Explanation
	Primary Processing		Secondary Processing	
Fresh oranges in orange bags	√	or		Simple packaging
Freshly squeezed orange juice	√	or		Alternative way to serve fresh food
Orange flavoured gelatine (jelly powder)		or	√	Complex combination of foods, dried and powdered
Peanuts dried in shells	√	or		Drying to preserve
Peanut flour (traditional pounded/ground peanuts)	√	or		Grinding as an alternative way to serve food.
Peanut brittle (candy made from peanuts)		or	√	Complex combination of foods
Dried rice grains	√	or		Drying to preserve
Nestle infants rice porridge		or	√	New food – complex conversion of rice to baby food
Rice crispies (cereal)		or	√	Extruding and puffing of rice grain
Chicken braai cuts	√	or		Portioning for convenient marketing
Chicken flavoured Imana		or	√	Extruded soya beans with artificial chicken flavouring
Royco chicken soup powder		or	√	New Food - dried grain paste, flaked and flavoured with chemicals that resemble chicken flavour

Second Step: Go to a local supermarket or food store

- Ask the store manager if you can see the external packaging that fresh food arrives in before being displayed on the shelves. Notice things like apples individually wrapped in paper and packed in boxes. (Note: the paper stops the apples from losing moisture which would make them wrinkle).(You may not be able to do this exercise depending on the cooperation of the store manager)
- What kinds of food are individually wrapped, what does the wrapping look like – what do you think it is for – to prevent bruising or to keep out contaminants?
- What kinds of food come in what types of containers – paper, cardboard, bottles, crates, multiple layers?
- How many are sealed plastic? What is underneath the plastic?
- What purpose do these wrappings serve?
- Look at labels of packaged foods and notice the ingredients.

Compare three different tins of foods: List the ingredients in the spaces provided: use the same sequence of ingredients as shown on the packaging.

Tinned tomatoes

....

....

Bully Beef or other tinned meat:

....

....

Pilchards in tomato sauce

....

....

Compare three different bottles of foods:

Mayonnaise

....

....

Beet root salad

....

....

Bottled sauce: (such as HP Sauce, Mrs Ball's Fruit chutney, Steers or Nando's sauce)

....

....

Compare three different foods that come in boxes or paper/cardboard packages:

Imana soy mince

....

....

Icing sugar

....

....

Mabele (sorghum) meal

....

....

Reflection: What trends can you see in these examples? Which have the most ingredients? What ingredient is the most common? Which of these tins do you think has had the most processing and or preserving? Why do you think this is so? Write your conclusions in the space below.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

Prepare any questions that you may have to take to your contact session about processing of foods. Record them here so that you will not forget them

....

....

....

....

....

....

....

....

2.3.8 Seed systems and seed supplies for food security and nutrition

Earlier we mentioned cold smoking as a method of food preservation. Another use for smoking has to do with farming practices. You may have seen homes where mealie cobs (maize) for next year's planting are hung from the rafters of a cooking hut. The smoke helps to keep live insects away which would eat the reproductive portion of the seed. In addition, the smoke in someway (scientists are not sure how) improves the ability of the seed to grow making it mature faster than other untreated seeds (Modi 2002).

Seeds that have adapted to a local environment are handed down from farmer to son/daughter. These seeds are called ‘landrace’ seeds and carry the genetic material (DNA) of the plants that are best adapted to local weather and soil conditions and are most likely to produce food considering diseases and drought cycles within a specific area. When genetically modified (GM) seeds and hybrids are introduced, these landrace seeds are contaminated by new DNA which influences the integrity and adaptability of the land race DNA.

They also have the ability to impact the weeds and indigenous food sources (wild herbs, fruits and tubers) in the environment changing their nutritional and growth potential. In many cases, these are negative influences which impact the availability of food especially during times of environmental stress (FAO 2002).   So when we look at preservation and protection of food resources we must also be aware that seeds and the genetic information and diversity that they carry are very important parts of the system ensuring food security at household levels.

Figure 2.26 A seed collection

See Unit 4 Take action for portfolio activity.