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Improving Nutrition through Diversified Foods Production and Utilization

Course Reference Manual

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Empowering New Generations to Improve Nutrition and Economic Opportunities (ENGINE)
A Project of the US Global Health Initiative and Feed the Future Initiative

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Course Background

Malnutrition remains the world's most serious health problem and the single biggest contributor to child deaths. While developed countries are facing the problem of over nutrition, people of developing countries are suffering from consequences of both undernutrition and over nutrition. Near to one billion people suffer from hunger being unable to meet the minimum food energy requirement, and two billion suffer from hidden hunger caused by micronutrient deficiencies. Undernutrition disproportionately affects the poor, especially young children, pregnant and lactating women, the sick and the elderly. In developing countries majority of undernourished people are rural poor households engaging in agriculture. In order to improve the productivity and livelihood of a community, the nutritional status and health of this community needs to be sustainably improved.

The global nutrition community underscored that narrowing the nutrition gap requires nutrition sensitive food and agriculture systems that explicitly incorporate nutrition objectives. Agriculture and food-based interventions promote diversification of household food production and consumption, recognize the contribution of underutilized nutrient-rich local foods to healthy diets, and include the fortification and biofortification of staple foods. Because women's own nutritional status has substantial impact on child nutrition and health, agricultural development aimed specifically at improving the diets of women of reproductive age is crucial to ending the intergenerational cycle of hunger and malnutrition. Agricultural growth therefore should be pro-poor and nutrition sensitive.

Ethiopia is among the countries with severe forms of malnutrition. The highest rates of child and maternal mortality in Ethiopia are attributed mainly to the high magnitude of malnutrition. Ethiopia is currently achieving substantial progress in reducing child and maternal malnutrition and associated mortality. The government of Ethiopia has recently launched multisectoral National Nutrition Program (NNP). Nutrition sensitive agricultural production and nutrition education are at the center of the nutrition sensitive agriculture program in the new National Nutrition Program, and this nutrition reference course in prepared in line with the program objectives.

Description of the Course

This course is designed to provide agriculture TVET students the knowledge skill and attitude to enable them apply basic principles of human nutrition, promote and assist diversified agricultural foods production and consumption, and work in collaboration to address maternal and child malnutrition. The course is based on the nutrition core competencies identified for mid-level agriculture graduates and the principles of nutrition sensitive agricultural interventions and multisectoral collaboration for nutrition.

Course Objective

The main objective of the course is to enable students promote and assist diversified foods production and consumption by applying the basic principles of human nutrition, and work in collaboration with stakeholders to plan, implement, and monitor community level nutrition interventions. To achieve this objective at the completion of the course students will be able to:

1. Apply basic principles of human nutrition
2. Assist in variety food production and promote use of diversified foods
3. Promote safe handling of agricultural food products during storage and transportation
4. Apply nutrition promotion, behavior change communication and use of technology
5. Apply multisectoral collaboration and linkage principles
6. Plan, implement, monitor/evaluate agriculture related nutrition interventions
7. Apply professionalism and ethics while promoting good nutrition

CHAPTER ONE: BASIC PRINCIPLES OF HUMAN NUTRITION

Chapter Objective: The objective of this chapter is to enable students apply the basic principles of human nutrition in assisting production of diversified agricultural foods and in promoting utilization and importance of variety foods among the community.

Enabling Objectives: At the completion of this chapter students will be able to:

- Define important food and nutrition related terms
- Describe the different nutrients groups, their major body functions, and dietary sources
- Describe the different food groups of plant and animal sources
- Categorize the different plant and animal source foods in to major food groups based on their nutrient composition
- Explain the importance of adequate and balanced diets in the family
- Describe the forms, causes and impacts of malnutrition
- Describe the evidence based maternal and child nutrition interventions

Definition of Terms and Concepts

Food: Any product obtained from plant or animal source that can be taken into the body and contain usable nutrients to yield energy, for the maintenance of life and the growth and repair of tissues.

Diet: Diet refers to the way people feed themselves and the foodstuffs they use. It is concerned with the eating patterns of individuals or a group, and the sequence of meals in a day. People may eat twice, three or four times in a day. This is strongly influenced by people's traditions and religion, their economic position, their place in society and the possibilities offered by their natural surroundings. Even in one community different population group may its own eating pattern, i.e. diet.

Nutrient: Chemical substances that are essential to life which must be supplied by food to the body to yield energy and substances for the maintenance of life and the growth and repair of tissues.

Balanced Diet: A balanced diet is a diet that contains all the nutrients in the proportion that is optimal for long-term health and survival. Literally it is a diet having the desired proportion of carbohydrates, proteins and micronutrients.

Bioavailability: Bioavailability is a measure of the relative amount of the ingested nutrient that is absorbed from the intestinal content and reaches the systemic circulation

It is described as the rate and extent to which the nutrient is absorbed and becomes available to the body's metabolic processes.

Nutrition: The science of food and the nutrients there in, and their body function and interaction with health

Food taboos: Food taboo is defined as any food avoidance that is maintained solely because failure to do so would generate disapproval, exclusion or punishment within one's own cultural group or because it would compromise one's own ethical standards.

Window of opportunity: The period between conception and age two when irreversible damage caused by malnutrition can and should be prevented.

Body growth: Refers to the increase of the body size. Example child gets bigger in size.

(Body) Development: Refers to qualitative changes of the body such as changes in the activity of different body systems. It is different from growth, continues throughout the individual's life span

Hidden hunger: Micronutrient malnutrition or vitamin and mineral deficiencies, which can compromise growth, immune function, cognitive development, and reproductive and work capacity

Food fortification: The addition of one or more micronutrients (vitamins and minerals) to a food during processing at the factory/industry

Biofortification: The development of micronutrient-dense staple crop varieties using traditional breeding practices or biotechnology. It is fortification while the crop is growing and alive

Food security: the condition when all people, at all times, have physical and economic access to sufficient, safe and nutritional food to meet their dietary needs and food preferences for an active and healthy life. Food availability, access, utilization, and stability/vulnerability are pillars of food security.

Nutrition Security: The condition when all people have ongoing access to the basic elements of good nutrition, i.e., a balanced diet, safe environment, clean water, and adequate health care (preventive and curative), and the knowledge needed to care for and ensure a healthy and active life for all household members.

Smallholder farmer: Marginal and sub-marginal farm households that own and/or cultivate typically less than two hectares of land.

Cretinism: The stunting of body growth and poor mental development in the offspring that result from inadequate maternal intake of iodine during pregnancy.

Nutrient Groups and their Body Function

Different food staffs contain different nutrient which the body uses for life supporting functions. Based on their main body functions these different nutrients are classified in to 5 groups. Water is also considered as the sixth nutrient group but not discussed here.

Macronutrients (Carbohydrates, fats and proteins)

1. Carbohydrates

Carbohydrates are compounds containing carbon, hydrogen and oxygen elements. Carbohydrates are the main source of energy for our body. During metabolism a gram of carbohydrate generates 4 kilocalories of energy. Carbohydrates contribute most of the calories in human diets Carbohydrates should comprise 45-65% of the daily calorie for optimal nutrition. Carbohydrates include sugars, starch, and fibers. The carbohydrates in the human diet exist mainly in the form of starches and various sugars. Based on their complexity and sources carbohydrates are divided into three groups.

Monosaccharides

Monosaccharides are the simplest carbohydrates. They contain only one carbohydrate unit. They are called simple sugars. Examples are glucose, fructose, and galactose. Monosaccharides are the usable forms for our body. Monosaccharides are the end products of digestion of carbohydrates. Glucose is present in foods such as fruit, sweet potatoes, onions and other plant source foods. Glucose is the form of sugar in our blood, and it is the immediate source of energy. In the body cells glucose is burned to produce energy and heat for our body. Glucose is also used to make other forms of carbohydrates such as disaccharides and starch. Fructose is present in honey and some fruit juices. Galactose is produced when the milk sugar lactose is broken down by the digestive enzymes.

Disaccharides

Disaccharides (double sugars) are carbohydrates containing two simple carbohydrate units. Examples are sucrose (table sugar), lactose (milk sugar), maltose (malt sugar). During digestion disaccharides are converted in to monosaccharides. Sucrose (two glucose molecules), is used to sweeten foods and drinks such as tea. It is most commonly produced from sugar cane and from beets. Lactose (Glucose + Galactose) is present in milk. Maltose (Glucose + Fructose) is found in germinating seeds and fermented foods.

Polysaccharides

Polysaccharides are carbohydrates containing more than three simple carbohydrate units. Examples are starch, glycogen (animal starch), and cellulose. Carbohydrates containing 3-10 simple carbohydrate units are usually grouped as Oligosaccharides. Starch is found in cereal grains and root crops such as potatoes and cassava. Glycogen is made from glucose in the human body and is sometimes known as animal starch. Starch from foods is broken down in the intestine to form monosaccharide molecules, which pass into the bloodstream. Those surplus monosaccharides in the blood stream will fuse together to form glycogen. Glycogen is usually present in muscle and in the liver, but not in large amounts. Any excess monosaccharides are converted by the body into fat and deposited as adipose tissues. Cellulose, hemicellulose, lignin, pectin and gums are indigestible carbohydrates by human body. The human alimentary tract lack enzymes to break down these carbohydrate forms in to usable forms.

Dietary Fiber

In humans, any of the indigestible carbohydrates when consumed in food pass in the elementary tract as components of faeces. These carbohydrates are often termed "dietary fibres". Dietary fibre is an important component in diets. High-fibre diet is important for normal and healthy intestinal and bowel functioning, and reduces constipation. Because it facilitates the rapid passage of materials through the intestine, fibre may be a factor in the control of problems related to appendix, haemorrhoids and heart related disease and cancers. It is therefore advisable to promote the consumption of locally available nutrient-rich and high fibre content foods.

2. Lipids/Fats

Fats, like carbohydrates, are compounds contain carbon, hydrogen and oxygen, but in different composition and conformation. Lipids include all fats and oils that occur in human diets. Usually "oil" refers to liquid, and 'fat' to solids lipids at normal temperature. Fats/oils are concentrated source and storage form of energy for our body, and a gram of fat/oil generate 9 kilocalories up on combustion. Fat should comprise 20-35% of the daily calories for optimal nutrition. Digestion of dietary fat/oils products smaller molecules called fatty acids and glycerol. Fat/oils make the diet more palatable. Lipids also serve energy storage and structural functions. Stored fats serve as fuel reserves for the body by storing the excess calories. Excess calories from carbohydrates, protein and lipids are stored in the form of fat in the body. Structural fats are part of the essential structure of the cells, occurring in cell membranes, mitochondria and intracellular organelles. Fats also function in assisting the absorption of fat-soluble vitamins. Fat deposited beneath the skin serve as insulation against cold, and it forms a supporting tissue for many organs such as the heart and intestines. Cholesterol is a lipid present in all cell membranes. It plays a role in fat transport and is the precursor from which bile salts and adrenal and sex hormones are made. Diet containing optimal amount of cholesterol is therefore important.

The fat/oils in our diets can be saturated or unsaturated. All fats and oils eaten by humans are mixtures of saturated and unsaturated fatty acids. Saturated fatty acids are those fats that do not contain any double bonded carbon in the molecular structure while unsaturated fatty acids have on or more double bond in the structure. Fats from land animals (i.e. meat fat, butter and ghee) contain more saturated fatty acids than do those of vegetable origin. Fats from plant products and fish have relatively more unsaturated fatty acids. Due to the many body functions discussed above, fat/oils are essential to health. Optimal intake and availability of fat in the body is therefore important. But excess of some saturated fats in the body will be associated with health problems such as increasing risk of heart related diseases.

3. Proteins

Like carbohydrates and fats, proteins contain carbon, hydrogen and oxygen, but they all also contain nitrogen, and many of them sulfur and few phosphorus and iron. Proteins are necessary for growth and repair of the body, and for production of enzymes and hormones. Proteins are the main structural constituents of body cells and tissues, and next to water they make up the greater portion of the substance of the muscles and organs. Unlike carbohydrates and fats, there is no true storage of protein in the body. Any protein in excess of the amount needed for growth, cell and fluid replacement and various other metabolic functions is used to provide energy. A gram of protein upon combustion yields 4 kilocalories of energy. Proteins should comprise 10-35% of the daily calorie for optimal nutrition. The proteins in different body tissues are not all exactly the same. The proteins in liver, blood and in different hormones are all different.

If carbohydrate and fat in the diet do not provide adequate energy, then the body converts proteins to carbohydrate to produce energy in expense of body growth, cells repair, and enzyme and hormone production. This is especially important for children, who need extra protein for growth.

Amino acids

All proteins are large molecules which are made of smaller units called amino acids. The various proteins are made of different amino acids linked together in different chains. Because there are many different amino acids, there are many different proteins. During digestion proteins break down to form amino acids. Animals (humans) cells unlike plants are unable to synthesize amino acids directly from simple inorganic chemical substances. Humans derive all the amino acids necessary for building their protein from consumption of plants or animal source foods. 20 of the amino acids are common in plants and animals, and eight of them are termed 'essential' amino acids". They are essential because the body cannot synthesize them from other amino acids, and therefore should be taken from food.

Different foods items have different kind of proteins that contain different amino acids. The protein value of any food is assessed based on total quantity of protein it contains; the kind number, and proportion of essential amino acids it contains. The quality of the protein a food contains depends largely on its amino acid composition and its digestibility. If a protein is deficient in one or more essential amino acids, its quality is lower. If one essential amino acid is missed in the diet, it limits the use of the other amino acids for building protein in the body.

Proteins of a certain food that have a better mixture of the different amino acids have a higher biological value. Some proteins in a food contain a mixture of different amino acids which include all the essential ones, but other may not. Proteins from meat and other animal products are complete proteins, and supply all of the amino acids the body can't make on its own. The proteins albumin in egg and casein in milk, for example, contain all the essential amino acids in good proportions and are nutritionally superior proteins. Proteins from plant foods are incomplete proteins. The proteins in maize and wheat for example lack or have very little quantity of some of the essential amino acids. These plant based proteins must combine provide all of the amino acids your body needs.

Consuming variety foods/meal therefore helps the body get all the essential amino acids. The deficiency of one food item/group can be overcome by mixing it with other food groups. For example consuming maize or wheat together with pulses will yield complete set of amino acids for the body. A mixture of foods of cereals and vegetable origin can serve as a substitute for animal protein especially if consumed at the same meal. Children need more protein than adults because they are growing faster. Infants need more protein than young children. A pregnant woman needs an additional supply of protein to build up the fetus inside her. Similarly, a lactating woman needs extra protein foods, because the milk she secretes contains protein.

Micronutrients (Minerals and Vitamins)

Micronutrients include vitamins and minerals. Micronutrients are vital for healthy and normal functioning of our body. Micronutrients are used by the body to produce enzymes, hormones, and other substances essential for proper growth and development. The daily micronutrient requirement of the body is very small. Vitamins are essential for the development of the immune system of our body. Majority of minerals involve in the body metabolic processes.

1. Minerals

Minerals are inorganic elements. Many different minerals serve important functions in our body. Mineral are grouped in to macro and trace minerals. Calcium, phosphorus, potassium, and sodium are the principal micro minerals while iron, iodine and zinc are some of the trace minerals the human body. Minerals have a number of functions in our body. Sodium, potassium and chlorine are present in form of salt in the body and serve to maintain osmotic balance. Iron is the important component of haemoglobin in the red blood cells. Calcium and phosphorus form the bones tissues and give rigidity to the whole body. Some minerals such as chlorine are used to keep acidic, alkaline, or neutral body fluid conditions. Iodine is main component of thyroxin hormone. And zinc is component of different enzymes. Some of the minerals such as phosphorus are widely available and the deficiencies are not common. The minerals that are of most importance in human nutrition are thus calcium, iron, iodine, and zinc.

Iron

Iron is an important mineral element in human life. Iron is critical for brain development and function, regulation of body temperature, muscle activity and metabolism. Most of the iron in the body is present in the red blood cells, mainly as a component of haemoglobin. Substantial amount of iron also found in muscle cells as a component of myoglobin, and as storage iron (ferritin) mainly in the liver, spleen and bone marrow. Small quantities of iron are also found in the plasma proteins and in respiratory enzymes. The average iron content in a healthy adult body is only about 3 to 4 g, yet this relatively small quantity is vital. The main vital function of iron is transportation of oxygen through our body. The iron in haemoglobin of red blood cells carries oxygen from the lungs to different body tissues. Myoglobin in skeletal and heart muscle accepts the oxygen from the haemoglobin.

Our body is efficient, economical and conservative in the use of iron. Iron released when the red blood cells are old and broken down is taken up and used again and again for the manufacture of new red blood cells. The daily iron requirement of healthy adults is very small. Women of reproductive age, pregnant and lactating women have high iron requirements. Children have relatively high needs because of their rapid growth, which involves also increase in blood volume.

Dietary sources of Iron

Iron is present in a variety of foods of both plant and animal origin. Rich food sources of iron include meat, liver, fish, eggs, legumes, and green leafy vegetables. Cereal grains such as Teff, maize, rice and wheat contain moderate amounts of iron, but because these are often staple foods and eaten in large quantities, they provide most of the iron for many people in developing

countries. Iron cooking pots may be a source of iron. Milk is a poor source of iron. Human milk contains about 2 milligrams of iron per liter and cows' milk about 1 milligram per liter.

Iron Bioavailability and Absorption

Naturally our body is not efficient in iron absorption. Healthy persons normally absorb only 5 to 10% of the iron in their foods during digestion. Several factors also affect iron absorption. For example, compounds such as tannins, phosphates and phytates in food reduce iron absorption, whereas ascorbic acid (Vitamin C) increases it. Iron absorption generally increases during growth and pregnancy, after bleeding and in other conditions when the body demand for iron is enhanced. The absorption and bioavailability of iron is also different for different foods. The iron from animal source foods (called Haem iron) is more absorbable and bioavailable that iron from plant source foods (called non-haem iron).

Consumption of a mix of animal and plant foods of variety meals in general will facilitate iron absorption. Thus the addition of a quite small amount of meet/fish cereal-based foods such as rice and maize will result in much greater absorption of iron. If a meal also includes fruits or vegetables, the vitamin C in them will also enhance iron absorption. However, if tea is consumed with cereal source meal, the tannin present in the tea will reduce the absorption of iron.

Iron deficiency is a very common cause of child and maternal health problems in all parts of the world. Iron deficiency will result in a disease condition called anaemia. Infection with Hookworms, schistosomiasis, and malaria result in death of red blood cells and blood loss which may cause iron deficiency anaemia.

Iodine

Iodine is one of the important minerals found in our body. The body of an average adult contains about 20 to 50 mg of iodine, much of it in the thyroid gland. Iodine is absorbed from the gut as iodide, and excess is excreted in the urine. Iodine is essential for the formation of thyroid hormones in the thyroid gland. The adult thyroid gland traps iodine per day to make the desired amount of thyroid hormone. Thyroid hormones are important for regulating metabolism. In children they support normal growth and development, including mental development, and determine the school performance of children. Iodine also contributes a lot for the normal growth and development of fetus during pregnancy.

Iodine is widely present in rocks and soils. The quantity in different plants varies according to the soil in which they grow. Iodine tends to get washed out of the soil, and a considerable quantity has flowed into the sea. Sea fish, seaweed and most vegetables grown near the sea are useful sources of iodine. Drinking-water provides some iodine but very seldom enough to satisfy human requirements. Lack of iodine in the diet results in several health problems such as goiter, mental retardation, and cretinism. To prevent iodine deficiency in the community Iodine can be added to table salt, by the chemical process known as fortification. This is economically cost effective method of iodine deficiency prevention in a community/ country at large. Currently Ethiopia also

fortified the salt with iodine at the national level. Proper use of iodized salt should be promoted to prevent iodine deficiency in the community.

Zinc

Zinc is an essential mineral element in human nutrition, and its importance to human health has received much recent attention. Zinc is the constituent of many important enzymes essential for metabolism. It is involved in the metabolism of carbohydrates, synthesis of energy, protein, and transport of carbon dioxide. It is also important in wound healing, brain function and bone growth. Zinc is present in red meats and poultry, dairy products, seafoods, eggs and whole grains and vegetables. The richest sources of zinc are protein-rich foods such as meat, seafoods and eggs. As with iron, absorption of zinc from the diet is inhibited by food constituents such as phytates, oxalate and tannins.

2. Vitamins

Vitamins are organic substances playing vital role for healthy functioning of the body. They are essential for proper metabolism and body immunity building. Vitamins present in minute amounts in foodstuffs. Vitamin A, B, C, D, E and K are commonly known vitamins. Vitamin A, D, E, and K are fat soluble vitamins while vitamin B groups and vitamin C are water soluble. Vitamin A is the most public health important vitamin.

Vitamin A

Naturally vitamin A exist in two forms, Retinol and Beta carotenes. Retinol, a very pale yellow-green substance is the direct usable form of vitamin A, and found only in animal products. Carotenes, which act as precursors of vitamin A, are yellow substances that occur widely in plant source foods. In the body beta-carotenes are converted in to retinol (usable form of vitamin A). Vitamin A plays a role in vision, immune function, promotion of growth and skin health. Vitamin A deficiency therefore leads to night blindness, reduced ability to see in dim lights. Vitamin A is also necessary for the protection of surface tissue. Adequate vitamin A status contributes in the reduction of infant and child mortality. Vitamin A supplementation reduces deaths from measles.

Dietary sources

The main sources of retinol are butter, eggs, milk, liver of beef, pork, chicken, fishes. Carotene is contained in many plant foods. Various dark green and yellow vegetables and pigmented fruits, such as mangoes, papayas and tomatoes, and pumpkins contain useful quantities of carotene. Carrots and red palm oil are rich sources of carotene. Yellow maize is the only cereal that contains carotene. Most people in developing countries rely mainly on carotene for their supply of vitamin A. When the diet is entirely of plant origin, larger amounts of carotene are required because the conversion from carotene to Vitamin A is not very efficient.

Vitamin A is soluble only in fat. It is absorbed in the wall of the intestine. It is poorly utilized when the diet has a low fat content. Intestinal diseases such as dysentery and intestinal parasites limit the absorption of vitamin A. Bile salts are also essential for the absorption of vitamin A. Lactating

mothers need 50% more than normal adults, and children and infants need less vitamin A than adults. Excess vitamin A is stored in the liver, and the body can utilize it upon demand.

The five nutrient groups can be assigned to three functional categories based on their body function:

1. Nutrients that primarily provide us with calories to meet energy needs (Carbohydrates and Lipids)
2. Nutrients that are important for growth, development and maintenance (Proteins)
3. Nutrients that act to keep body remain healthy and functions normally (vitamins and minerals)

Food Groups

Foods are usually classified in to six different groups based on the dominant nutrient they contain. The six food groups are described as follows:

1. Vegetables food group

This group includes green leaf and yellow vegetables such as cabbage, kale, spinach, cauliflower, lettuce, carrot, celery, cucumber, eggplant, green pepper, broccoli, pumpkin, onion, tomato, and others such as mushroom. They provide mostly vitamins, minerals, and water. Vegetables also contain fiber, which is necessary for proper digestion.

2. Fruits food group

This group includes citrus fruits (oranges, lemons, and mandarins), bananas, apples, avocados, cherries, grapes, pineapple, papaya, mango, peaches, guavas, watermelon, sweet melon, and many others. Fruits provide mostly carbohydrates, vitamins, and water.

3. Legumes and nuts food group

This group includes groundnuts, soybeans, beans, peas, chick peas, broad beans, kidney beans, and lentils. They provide mainly protein and carbohydrates. Soybeans and nuts also contain a lot of fat in addition to protein and carbohydrates.

Nutrient content of pulses:

4. Animal source food group

Animal foods include meat, poultry, eggs, milk/milk products, and fish. They provide protein, fats, vitamins, and minerals.

-Milk and milk products

5. Fats oils and sweets food group

This group includes oil seeds (soybeans, sesame seeds, linseeds, and groundnuts); avocado pear; cooking oil; margarine; milk and milk products such as butter and yogurt; meat; fish; and poultry. They mainly provide fat.

6. Staples food group

Staple foods include cereal grains such as sorghum, millet, maize, barley, oats, wheat, teff, rice, starchy roots (cassava, sweet potato, false banana, potato), and starchy fruits (banana). They

mostly provide carbohydrates. They also provide many other nutrients such as proteins and minerals depending on how they are processed.

Healthy Diet

A Healthy Diet is characterized by its nutrient adequacy and balance. There are many types of healthy diets. There are no bad or good foods but good and bad foods for our health. Optimal nutrient adequacy, balance, and variety are characteristics of a healthy diet. Healthy diets contain different foods that provide the optimal functioning of the body. Variety of food is required to obtain all of the essential nutrients we need in our body. What is important is that the contributions of a variety of individual foods add up to an adequate and balanced diet. An Adequate is a diet that contains variety of foods to provide sufficient levels of calories and essential nutrients. Balanced diet is a diet that gives the body the right proportion of carbohydrates, proteins, and micronutrients for body energy production, body cell building, and healthy functioning. Diets that provide more calories than needed to maintain healthy body weight are out of balance.

Nutrient-Dense and Energy-Dense Foods

Nutrient-dense foods are those foods that provide multiple nutrients in appropriate amounts relative to calories. Nutrient-dense food contains sufficient amounts of vitamins, minerals and fibers. Nutrient-dense foods comprises foods are without solid fats in the food or added to it; added sugars, added refined starches, and added sodium. Nutrient-dense foods usually retain naturally occurring components such as dietary fibers. All vegetables, fruits, whole grains, see foods, eggs, peas and beans, unsalted nuts and seeds, fat-free and low-fat dairy, and lean meats and poultry are nutrient-dense foods when prepared without solid fats and sugars. Foods that provide calories and low amount of nutrients are referred to as Empty-Calorie or Energy-Dense foods. Nutrient-dense foods are easier to make them adequate and balanced diets than empty-calorie foods. Majority of the naturally occurring fibrous foods tend to be high in nutrient density and lower in energy-density while majority of the processed and fast foods are empty-calorie foods. Empty-calorie foods are usually deficient of vitamins and minerals. High water content in the food item also lowers energy density.

The choice of nutrient-dense or energy-dense foods depends on different factors such as age and daily energy expenditure. At normal circumstances consumption of high nutrient-dense foods is recommended for optimal nutritional and health status. Children can be provided energy-dense foods together with optimal provision of nutrient-dense foods. Adults with high energy-demanding physical works such as ploughing may consume energy-dense foods but complemented with nutrient-dense foods. Empty- calorie food that dominated the urban supermarkets are the major risk factors for overweigh and obesity and associated chronic diseases such as diabetes, cancer, and cardiovascular problems. The Agriculture and other development workers should promote production and consumption of adequate and balanced diets to achieve optimal community nutrition and health status. Below are some of the general dietary recommendations for optimal nutritional and health status of communities.

Foods and nutrients to increase:

- Increase production and consumption of fruits and vegetables- promote intake of a variety of vegetables especially dark-green and red & orange colored vegetables including peas and beans.
- Increase whole grain intake by replacing refined grains by whole grains- promotes the consumption of whole grains to promote consumption of nutrient-dense foods.
- Increase intake of fat-free and low-fat milk and milk products such as milk, yogurt, cheese
- Increase consumption of a variety of protein foods which includes seafoods, lean meat and poultry, eggs, peas and beans, soy products, and unsalted nuts and seeds. Consuming increased amount and variety of seafoods instead of meat and poultry is also encouraged.
- Use oils to replace solid fats where possible

Foods and nutrients to reduce:

- Reduce daily intake of sodium to less than 2300 milligrams under normal circumstances
- Further reduce daily intake of sodium to 1500 milligrams under conditions of age 51+, people with high blood pressure, diabetics, or chronic kidney disease.
- Reduce consumption of food rich in saturated fats and cholesterols such as solid cooking oils and meet-fat
- Reduce consumption of refined grains especially those that contain solid fats, added sugars and sodium
- Reduce the daily consumption of alcohol. Pregnant women are encouraged not to consume alcohol.

Malnutrition: Forms, Causes and Consequences

Introduction

Malnutrition refers to abnormal nutrition condition, both undernutrition and over nutrition. Currently it is a public health problem of both developed and developing countries. While majority of developed countries suffer from problems related overnutrition, developing countries suffers from the double burden of undernutrition and overnutrition. Even in sub Saharan countries people are suffering from the triple burden of hunger, undernutrition, and overnutrition. Globally 868 million people (12.5%) remain undernourished interterms of energy and protein consumption, and around 2 billion people are suffering from micronutrient deficiencies. To the contrary near to 1.5 billion people worldwide are overweight and obese, and at risk of contracting chronic non communicable disease.

Malnutrition is currently considered the leading cause of child mortality, and worldwide more than one third of child mortality is attributed to malnutrition. The global community is urging for prevention of undernutrition in children by focusing on the 1000 days nutrition interventions- the period from pregnancy to the first two years of life. This period is called the' window of opportunity' because proper nutrition at this period has the greatest effect on child health, growth and development. If undernutrition occurs during this period, the damage on child physical and cognitive development will be irreversible.

Forms of Malnutrition

From the perspective of developing countries, malnutrition results from inadequate intake of nutrients and/or from disease factors. Protein energy malnutrition (PEM), iron deficiency anaemia (IDA), vitamin A deficiency (VAD), and iodine deficiency disorders (IDD) are the most common forms of malnutrition.

A. Protein-Energy Malnutrition (PEM) arises due inadequate intake of calories from macronutrients: Carbohydrates, fats and proteins.
B. Micro-Malnutrition (Hidden Hunger) refers to mineral and vitamin deficiency such as iron, iodine, and vitamin A. Both these conditions can have serious negative consequences for physical and mental health.

Protein-Energy Malnutrition

Protein-Energy Malnutrition (Macronutrient Deficiency) is currently the most important nutritional problem in developing countries. Failure to grow adequately is the first and most important manifestation of PEM. It often results from consuming too little food, especially energy, and is frequently aggravated by infections. PEM can be due to long-term or short term food shortages and infections. The term PEM is used to describe both the moderate and the sever forms of undernutrition. Moderate (mild) PEM is manifested mainly as poor physical growth in children. Stunting, underweight, and wasting are manifestations of child growth failure due to mild/moderate PEM. Kwashiorkor (petting oedema) and nutritional marasmus (severe wasting) are manifestations of sever PEM, and often lead to death of many children.

Stunting: It is a malnutrition condition reflected by inadequate linear growth of a child. It is referred to as chronic malnutrition. Stunted children are too short for their age. Stunting develops over a long period of time as a result of inadequate dietary intake, and repeated infections. Stunting is a condition most of the time manifested in children of under 2 years ages. 26% of children under five years of age in the world are stunted in 2012 while in Ethiopia 44% of children under five years are stunted in 2011.Stunted children will have relatively poor physical and mental development. Stunting is an irreversible condition; a stunted child will become a stunted and mentally less developed adult. The irreversible physical and cognitive damage from stunting leads to lower adult productivity and enormous long-term economic loss to societies. Stunted children will perform low at schools, sport activities, and will be less innovative and productive at adult stages.

The 1,000-day period from pregnancy through age 2 is therefore the critical window of opportunity to shape a child's lifelong health and development. Proven interventions to reduce occurrence of stunting during the 1000days of life, and to sustainably reduce it in the population include:

- Appropriate breast feeding practices: Early initiation and colostrum feeding, exclusive breast feeding, and breast feeding continued up to 2 years of age

- Appropriate child complementary feeding practice (meal made of diversified food items and proper consistency)
- Greater access to and utilization of nutritious foods for pregnant and lactating women, and children during the first 5 years of life
- Increased household health care, water and sanitation access in the community
- Improved child caring practices such as mothers time for child care
- Promoting and improving household diet diversity through agricultural interventions such as sustainable diversified food production and utilization

Wasting: wasting is reflection of current nutritional status and is measured using the ratio of a child's weight to height/length. It is the most life threatening of the three types of malnutrition. Wasted children are too light for their height/length. Wasting is caused by inadequate intake of total calories resulting in rapid weight loss or failure to gain weight. Wasting and acute malnutrition are often used interchangeably. Wasting can be reversed with improved diet and the treatment of underlying illnesses. Wasted children should be identified and treated with nutritious foods at the community level or at health facilities. If not treated on time these children enter to marasmus or kwashiorkor stages and may die.

Underweight: underweight children have low weight for their age. Children may become underweight because of wasting or stunting or both. Underweight is measured in children using weight for age. While prevention of stunting and underweight through diet diversity may be the main contribution of agricultural development programs in addressing chronic malnutrition, children who are wasted/acutely malnourished need to be referred for treatment.

Body Mass Index (BMI): is often used to measure the nutritional status of adults, especially of adolescent girls and pregnant women. It is calculated by dividing the body weight in kilogram to the square of body height in meters (BMI = kg/m2). A BMI range of 18.5 to 24.9 is an indicator of normal nutritional status. A BMI less than 18.5 is an indication of underweight while greater that 25.9 is an indication of overweight status. Persons with BMI of out of the normal range should seek immediate dietary measures, or else in overweight cases will develop different disorders and complication such as diabetes and hypertensions.

Prevalence rates of underweight, stunting, and wasting, percent of children under 5 years of age

Status of children	CSA Surveys			Ethiopia DHS		
	1983	1992	1998	2000	2005	2011
Stunting (Low height-for-age)	60.7	64.0	52.0	58	51	44
Wasting (Low weight-for-height)	8.0	9.3	9.0	12	12	10
Underweight (Low weight-for-age)	37.3	46.9	42	41	33	29

Source: CSA 1999; CSA & ORC Macro 2001.., *Ethiopian DHS 2011*

Micronutrient Deficiency

Micronutrient deficiency refers to deficiencies in one or more essential vitamin or mineral, often caused by disease and/or inadequate intake of micronutrient-rich foods such as fruit, vegetables, animal products, and fortified foods. Micronutrient deficiencies increase the severity and risk of dying from infectious disease such as diarrhea, measles, malaria, and pneumonia. The deficiency of micronutrients is not usually visible, and termed as hidden hunger. Iodine, vitamin A, iron, and zinc are most important in terms of prevalence and severity. These deficiencies are most important public health problems in Ethiopia.

Worldwide about 2 billion people are suffering from the deficiency of one or a combination of iodine, vitamin A, iron, and zinc. This is one of the most serious impediments to socio-economic development, contributing to the vicious cycle of malnutrition, underdevelopment and poverty. Micronutrient malnutrition has long-ranging effects on health, learning ability and productivity, leading to high social and public costs, reduced work capacity in populations due to high rates of illness and disability and tragic loss of human potential. Therefore, overcoming micronutrient deficiencies is a precondition for ensuring rapid and appropriate development.

Iron Deficiency

Dietary iron deficiency contributes to the development of anaemia. Anaemia in general is a disorder condition related to red blood cells and shortage of oxygen for cellular respiration. The large majority of anaemia is estimated to be caused by dietary deficiencies. Iron deficiency is the major cause of dietary anaemia, and leads to a type of anaemia called iron deficiency anaemia (IDA). This results from lack of sufficient consumption of high-iron containing foods, such as animal products and legumes. Other forms of anaemia may be caused due to other dietary deficiencies such as vitamin A deficiency, deficiencies of vitamin B12 and folate, and health conditions that interact negatively with iron status, such as malaria, HIV, other infectious diseases, sickle cell disease, and other inherited anaemia. IDA is the world's most widespread nutritional disorder, children and women being the most vulnerable groups. In Ethiopia 44% of children, and 17% of women of reproductive age suffer from IDA.

The consequences of anaemia for children include increased morbidity and mortality, stunting, retarded cognitive development, reduced IQ, lower academic performance. Anaemic pregnant woman are at greater risk of giving birth to underweight babies, preterm and still births, and increased risk of maternal mortality associated with bleeding during and after birth. In adults, anaemia is associated with weakness and fatigue, lower productivity in agriculture and any other business. The economic loss in developing countries due to IDA is estimated to be 4% of their Growth Domestic Product (GDP).

There are proven cost effective interventions to prevent and control iron deficiency anaemia at scale. The sustainable strategy of preventing iron deficiency anaemia is in a community through nutrition sensitive agriculture is promoting the consumption of variety foods of plant and animal origin, and locally available iron-fortified foods. The following are also interventions undertaken by the health sector to reduce prevalence of anaemia.

- Providing iron and folic acid supplements to pregnant and lactating mothers
- Providing supplemental iron to children to prevent and treat IDA
- Providing deworming treatment services for children twice a year and for pregnant women (only after 3 months of pregnancy) in hookworm endemic areas.
- Providing malaria prevention and treatment services for the households

Iodine deficiency

Iodine deficiency in our body leads to enlargement of the thyroid gland developing a disease condition called goiter. Goiter can also appear in the form of smaller, less visible enlargements of the thyroid gland, and these forms are very dangerous than the more enlarged goiter. Apart from goiter iodine deficiency causes more severe consequences related to child physical growth and intellectual development. These conditions together are termed iodine deficiency disorders (IDD). Iodine deficiency during pregnancy may lead to cretinism, mental retardation and other problems, which may be permanent in the child. Cretinism occurs at the fetal stage if the pregnant mother is iodine deficient. The thyroid gland of the fetus will not develop properly and the growth of the fetus will be abnormal. Iodine deficient pregnant mothers will also be at greater risk of spontaneous abortions and stillbirth. Iodine deficiency at early age of the child causes mental retardation, and poor physiological and neurological development.

Iodine deficiency disorder is a problem of alarming magnitude in Ethiopia. Iodine deficiency can be easily prevented with less cost both at the household and community level interventions. For several decades worldwide the main measure used to control IDD has been the iodization of salt, and when properly conducted and monitored it has proved extremely effective. In Ethiopia also fortification of salt is recognized as an efficient and often the only way of overcoming iodine deficiency in Ethiopia. Universal Salt Iodization is recently enacted in Ethiopia and iodized salt is available at scale, but more effort is needed to secure the access of high-quality fortified salt to everybody and sustained nutrition education on its consequences and proper utilization of iodized salt. Promoting consumption of seafoods is also another possible intervention for the prevention of iodine deficiency.

Zinc deficiency

Zinc deficiency is recently recognized as a public health problem. Available evidences show that it is most likely to be a serious problem with diets poor in animal foods. Zinc deficiency will

contribute for child growth retardations, impaired immune function, increased child morbidity and mortality from diarrhea and pneumonia. Zinc deficiency also causes reduced appetite and may expose to protein-energy malnutrition.

Vitamin A deficiency

Vitamin A Deficiency (VAD) is a disorder condition resulting when vitamin A intake falls below recommended levels. Dietary deficiency of vitamin A most importantly affects the eyes, and the body immunity. Children with vitamin A deficiency are at greater risk of infection and death from diseases such as measles, diarrhea, and acute respiratory infections. VAD is the cause of about one million young children deaths each year. 31 % of children in the world suffer from VAD in 2012. VAD is also the leading cause of eye problems and childhood blindness. It causes eye dryness and corneal destruction. Severe stages of vitamin A deficiency cause eye damage, leading to night blindness and ultimately to complete blindness mainly in young children. Vitamin A deficiency also affects adolescents who are left out of the vitamin A supplementation program.

Dietary deficiency is the most common cause of VAD. Dietary diversification, with particular emphasis on vegetable and animal source foods is sustainable solution for VAD especially for the rural community. Periodic vitamin A supplementation for children and women, and consumption of vitamin A biofortified foods such as orange-flashed sweet potato and maize, and vitamin A fortified oils, are also the solution for the problem. Cooking some of vegetables with fats /oils will improving the digestion and bioavailability of Vitamin A.

Causes of Malnutrition

Malnutrition is not caused by a single factor. The nutritional status of an individual, households, and the community at large is determined by many different and interconnected factors. UNICEF in 1990 identified malnutrition and death in children and women as the final outcome of a long sequence of interconnected factors. These factors are classified at three levels of causes as immediate, underlying, and basic causes of malnutrition.

The Immediate Causes of Malnutrition

Inadequate dietary intake and diseases are the most significant immediate causes of malnutrition of children and women. An individual will get malnourished either due to inadequate dietary intake or infection of diseases, or both at the same time. If the individual do not get adequate food the body will not get the necessary nutrients for energy production, growth and healthy functioning. At the same time the individual will be malnourished if he gets infected with diseases. Parasitic worms and protozoa infections are the common conditions that cause child malnutrition in the majority of developing countries.

Malnutrition and disease conditions are self-reinforcing. Malnutrition makes the body more susceptible to disease by weakling the body immunity, and disease predisposes our body for

malnutrition by reducing food intake, affecting digestion and nutrient absorption, and disturbing the body metabolism.

The Underlying Causes of Malnutrition

The causes for inadequate dietary intake and disease can be numerous. The underlying causes for malnutrition are context-specific and classified in to three interrelated groups as follows.

- Insufficient food availability and access
- Inadequate care for children and mothers
- Insufficient health services and inadequate provision of a healthy environment (e.g. clean water and sanitation).

To ensure nutrition security at the household and community level these three groups of underlying factors should be addressed. To remain nutrition secured a household needs to have a sustainable access to adequate foods (food secured); children in the household needs to get optimal level of feeding and maternal care from parents (optimal child Care); the household members need to have sustainable access to improved health care, water and sanitation services. Ensuring nutrition security therefore is not a one or few sectors responsibility but, the responsibility of many different sectors working in collaboration both at national and local levels.

The Basic Causes of Malnutrition

The major *basic* causes of malnutrition include economic, technological, political, cultural, and institutional structures and processes, the means of control of physical resources, and the level of human development. These basic causes are very complex and diffused to different sectors. Improved education and economic status, political commitment, and evidence based and locally specific development policies will contribute for improved nutritional outcomes in a society.

The three categories of causes of malnutrition function synergistically with each other. It is also important to recognize that there are horizontal cause and effect relationships at all levels, although these linkages are somewhat more obvious for the underlying causes, the food-care-health triad. The following framework of causes of malnutrition depicts these vertical and horizontal relationships of causes at different levels.

Consequences of Malnutrition

Malnutrition has a series of public health consequences that diminish the individual quality of life and the prospects for socioeconomic progress. The impacts of malnutrition can be reflected at the individual, household, and community level. Malnutrition harms both physical and cognitive development. Poor health status, intergeneration cognitive deficits, and reduced economic productivity and growth are some of the impacts of malnutrition. Children and mothers usually suffer the most because many nutrients are critical for normal growth and development. Malnutrition in pregnant mothers causes intra-uterine growth retardation of the fetus leading to low weight at birth and lower chance of survival. Long time malnourishment deprives our body from the nutrients for proper health and development and makes us vulnerable to infection and

disease. Without timely and proper treatment, severe forms of malnutrition in children lead to death. Consequences of malnutrition are described below:

1. Susceptibility to mortality (death)

Stunting and other forms of undernutrition are clearly a major contributing factor to child mortality, disease and disability. A severely stunted child faces a four times higher risk of dying, and a severely wasted child is at a nine times higher risk. Specific nutritional deficiencies such as vitamin A, iron or zinc deficiency also increase risk of death. Child undernutrition predisposes and aggravates infection and death from infectious diseases such as diarrhea, measles, and pneumonia. Depending on the socioeconomic development status of countries undernutrition accounts for 33-60% child deaths. Over nutrition also increases the risk of infection and death from non-communicable disease such as diabetes, cancer and cardiovascular disorders.

2. Susceptibility to acute morbidity (disease)

Compared with people with adequate nutrition, those with poor nutritional status (determined by anthropometry) are more likely to contract diarrheal, malarial and respiratory infections and more likely to suffer from these illnesses for longer duration. They are also more likely to develop devastating consequences from these common infections

3. Poor cognitive development

Stunting is associated with poor school achievement and poor school performance. Specific nutrient deficiencies such as iodine and iron impaired cognitive development. Malnourished children score poorly on tests of cognitive function and have poorer psychomotor development and poor fine motor skills. Ethiopian PROFILES Team & AED/Linkages 2005 concluded that stunted children have, on average, an IQ that is 5 points lower than normal children. Therefore, improving nutritional status of members of the community is central is a development issue.

4. Decreased economic productivity

Undernutrition early in life clearly has major consequences for future educational, income and productivity outcomes. Malnourished individuals will remain unhealthier and physically unfit than individual with optimal nutritional status. Malnourished people will have less motivation and encouragement, and will be ineffective in agricultural and related business activities. Malnourished people will not experience prompt and complete recovery from infectious diseases, and often may stay longer off-works in critical production seasons. Reduced school attendance and educational outcomes result in diminished income-earning capacity in adulthood. All these condition will result in less productivity and innovation which leads to poor socio-economic development of countries. Malnutrition therefore is a bottleneck for economic and human development.

5. Susceptibility to chronic diseases in later life

Children experiencing malnutrition in their early life will have increased risk of overweigh and obesity. Different researches are proving that stunted children will suffer from disproportionate

and rapid weight gain later in life. Poor foetal growth, small size at birth and continued poor growth in early life followed by rapid weight gain later in childhood raises the risk of coronary heart disease, stroke, hypertension, and diabetes (type II). Attaining optimal growth before 24 months of age is desirable; becoming stunted but then gaining weight disproportionately after 24 months is likely to increase the risk of becoming overweight and developing other health problems.

Prevention and Control of Malnutrition

Nutrition interventions are generally classified in to nutrition sensitive and nutrition specific interventions. Nutrition sensitive interventions are usually designed to address the underlying and basic causes of malnutrition and have multisectoral and preventative in approaches. Nutrition specific interventions are more of sector specific and have both preventative and curative approaches. Both macro nutrient and micronutrient malnutrition can be prevented mainly by using food-based approaches such as dietary diversification, and consumption of fortified foods implemented by the agriculture sector. While severe malnutrition can be treated and controlled using nonfood-based approach such as vaccination, deworming, supplementation, and therapeutic feeding usually implemented by the health sector. Nutrition education and behaviour change communication activities implemented in line with other nutrition interventions are also effective in achieving optimal feeding practices. Maternal and child nutrition are given particular emphasis in this section.

Maternal nutrition

Good nutritional and health status of mothers before and during pregnancy benefits both the mother and her child. Maternal malnutrition, such as deficiency of iodine and iron leads to poor foetal growth, still birth, and low birth weight which leads to infant and child malnutrition. For better fetal and child development outcomes the mother requires adequate nutrient intake, proper supplements and prevention of disease. Pregnant mothers should also be protected from stress factors such as cigarette smoke, narcotic substances, environmental pollutants and psychological depression.

Direct nutrition specific interventions to improve maternal nutrition, usually delivered by the health care facilities include micronutrient supplementation such as iron, disease prevention and control such as malaria and deworming, maternal dietary and child feeding advice and counselling. Adequate intake of micronutrients such as iron and iodine during pregnancy are important, especially for development of the nervous system of the fetus. To properly support fetal development and breast milk production, pregnant and lactating mothers require at least one extra meal per day. For undernourished pregnant mothers balanced protein-energy supplementation will be necessary to reduce the prevalence of low birth weight.

Parallel to the direct maternal nutrition intervention indirect nutrition sensitive interventions should be carried out through community-based programmes to sustainably improve the nutritional status of mothers of the community. Programs such as production and consumption of diversified

foods, women empowerment, and nutrition behaviour change communication are some of the nutrition sensitive interventions to improve maternal nutrition. Preventing adolescence pregnancy, delaying age of marriage, preventing unwanted or unplanned pregnancy and overcoming sociocultural barriers to healthy practices and health-care seeking are also intervention that will contribute to improved maternal nutrition.

Infant and Young Child Feeding

The fact that the irreversible process of stunting happens early in life, has led to a shift in programming focus. Previously the emphasis was on children under 5 years, while now the increasing emphasis is on the 1,000-day period –from pregnancy up to 2 years. This period of life is now called 'Window of Opportunity'. Severe undernutrition before age 2 has significant impact on physical growth and intellectual functioning later in adolescence. Brain and nervous system development begins early in pregnancy and is largely complete by the time the child reaches the age of 2 years. The developing brain is highly vulnerable, and nutrient deficiencies during critical periods have irreversible and long-term effects. Improvements in nutrition after age 2 do not usually lead to recovery of lost potential. Optimal IYCF practices include initiating breastfeeding within one hour of birth, exclusive breastfeeding for the first six months of life and continued breastfeeding up to the age of 2 and beyond, together with safe, age-appropriate feeding of solid, semi-solid and soft food starting at 6 months of age are the main areas of child nutrition interventions. The two practices together – ensuring optimal breastfeeding in the first year and complementary feeding practices – could prevent almost one fifth of deaths of children under 5 years of age.

Breastfeeding

Early initiation of breast feeding, colostrum feeding, exclusive breast feeding (EBF), and continuing up to 2 years are the concerns of breast feeding interventions. The development workers are expected to promote and ensure that every mother in the community practices these child lifesaving interventions.

Early initiation of breast feeding (with in 1 hour of birth), and colostrum (the yellow first milk) feeding saves lives by reducing the risk of neonatal mortality. Colostrum, the rich milk produced by the mother during the first few days after delivery, provides essential nutrients as well as antibodies to boost the baby's immune system. Early initiation of breastfeeding promotes stronger uterine contractions, reducing the likelihood of uterine bleeding. It also reduces the risk of hypothermia, improves bonding between mother and child and promotes early milk production.

Worldwide less that 50% of newborns are put to the breast within the first hour of birth. In many parts of Ethiopian especially in rural area there exists a culture of delaying breast feeding until the placenta removed out. But the scientific evidence is to the contrary that early initiation of breast feeding facilitates the removal of the placenta. Colostrum feeding in many parts of Ethiopia is considered unclean and unhealthy milk for the child and usually removed before the child starts to feed on the breast.

Exclusive breastfeeding in the first six months of life have high contribution for the survival and healthy growth of the infant. Breast milk is a naturally perfect and complete food that satisfies all the nutritional requirement (including for water) of the infant for the first 6 months of age. Infants who are exclusively breastfed are less likely to die from infection such as diarrhea and pneumonia. Starting complementary food before 6 months of age will increase infections through food contaminations. Complementary foods before 6 months also cause alimentary canal complications because the system is not yet well developed.

Complementary feeding

As the child grows the nutritional requirement of the body gets increased. After six months of age breast milk alone will not satisfy all the nutrient requirement of the child. Providing appropriate, adequate and safe complementary foods for children from the age of 6 months onwards leads to good nutritional status and improved growth outcomes. Breastfeeding should be continued until children reach 2 years of age. Proper complementary feeding is important intervention to reduce stunting in a population. Children should receive appropriate and safe complementary foods at the right age, the right frequency, and adequate quality.

In Ethiopia the commonly used commentary food, gruel ('Atimit') is poor in its nutrient adequacy. It is inadequate both in quality and quantity. It is usually made of a single or many cereal grains only. Much of its content is also water. The complementary food should be prepared based on the recommended national or local complementary food guidelines. The complementary food should be a balanced diet. Cereal and pulse grains, meet and vegetables should be mixed in proper proportion and cooked appropriately and served safely. The agriculture extension workers in collaboration with health workers should educate the community about the importance of appropriate complementary feeding and demonstrate the preparation. The extension workers should also promote and assist the production of energy and nutrient-dense complementary foods, and the distribution of available fortified complementary foods.

Summary

Different animal sources food contains different nutrients that our body uses for proper body and life functions. The human body life system is supported, maintained, and sustained with action food nutrients. Animal and plant source foods are grouped in to different food groups. Optimal use of the different nutrients is essential for proper growth, for both physical and mental development, and healthy and productive life. Utilization of variety foods helps to achieve the daily nutrient requirement of members of a family. Abnormal nutritional status disrupts the normal functions of the body and affects the health and wellbeing of individuals. Malnutrition is caused by food, health care services, and environment related and complex factors. Poor physical and mental development, poor health status, poor educational performance, and poor lifetime productivity are the consequences of malnutrition. Malnutrition disproportionately affects mothers and children, and due attention should be paid to maternal and child nutrition.

CHAPTER TWO: PROMOTING DIVERSIFIED FOODS PRODUCTION AND VARIETY DIET CONSUMPTION

Chapter Objective: The objective of this chapter is to enable students promote and assist production and consumption of diversified agricultural foods in the community they will be serving.

Enabling Objectives: At the completion of this chapter students will be able to:

- Explain the importance of diversifying diet with a variety of agricultural food products
- Describe the dietary diversification strategies
- Explain diversified agricultural food production interventions as the main dietary diversification strategies
- Identify and promote the production and consumption of nutrient rich underutilized local varieties of animal and plant sources
- Demonstrate integrated farming methods: home gardening, small livestock raising, poultry keeping, use of traditional crops introducing mixed cropping systems
- Explain how to enrich/enhance the nutrient content of the family foods using different food groups

Importance of Dietary Diversification

Dietary Diversity refers to the number of food groups consumed over a given period of time. Food-based strategies that promote diet diversity are a viable, cost-effective and sustainable solution for controlling and preventing all forms of malnutrition. Household level dietary diversity can be used as an indicator of household food security, and individual level dietary diversity is an indicator of diet quality for an individual, typically measured for women or young children. Varity foods improve diet and nutrient intake. Nutrients from different food sources can interact to increase the absorption and bioavailability of other nutrients. Different foods from within each food group provide more of some nutrients than others, and can complement each other for essential micronutrients. Dietary diversification creates opportunity for children and pregnant mother better food item preferences which will increase daily food consumption. Varity diet is generally important because it ensures adequacy and balance of a diet to achieve better nutrition.

Rural households can diversify their household diet from the monoculture of traditional staples to more nutritious balanced diets through:

- Practicing mixed cropping and integrated farming systems
- Adopting new crops and varieties (such as soybean)
- Producing underexploited traditional foods, home gardens, and small livestock raising
- Producing fish and forestry products for household consumption
- Adopting improved preservation and storage of fruits and vegetables to reduce waste, post-harvest losses and effects of seasonality
- Involving in different community based income generation activities
- Participating in nutrition education and behaviour change communication programs and adopting the consumption of a healthy and nutritious diets

Dietary Diversification Strategies

Dietary diversification, in conjunction with nutrition education, focuses on improving the availability, access to and consumption of nutrient rich foods with high bioavailability of

micronutrients throughout the year. Dietary diversification strategies are designed to enhance the energy and nutrient density of cereal-based diets; increase the production and consumption of micronutrient-dense foods (especially animal-source foods); incorporate enhancers of micronutrient absorption; and reduce the phytates content of cereals and legumes through germination, fermentation and soaking. The different dietary diversification interventions are grouped in to three main strategies as producing variety and nutritious agricultural foods, reducing post-harvest loss and improve post-harvest processing, and designing nutrition behavior change communication.

I. Producing Variety and Nutritious Agricultural Foods

Production diversification and variety foods consumption is the sustainable solution to the problem of malnutrition particularly of rural households. Farmers need to know what to produce on-farm to optimize nutrition. They also need to have crop specific guidelines. To achieve nutrition impact improve dietary quality over quantity is usually recommended. The development agents should clearly identify locally appropriate energy and nutrient rich plant and animal source foods and should actively involve in the promoting and assisting the production and utilization of these foods. Nutrient rich and underutilized locally-adapted varieties need to be highly promoted.

Production diversification can offer support for multiple pathways to nutrition, including:

- Food access and dietary diversification
- Natural resource management
- Productivity enhancement
- Reduce seasonality and risk (e.g. from mono crop failure due to biotic or abiotic stresses, price shocks)
- Improved income streams and reduced cost of a nutritious diet
- Adaptation to climate changes
- Women's empowerment, based on production of home gardens and minor crops, which in many cases would constitute production diversification

Variety and Nutritious Agricultural Foods Production Interventions

1. Promoting Homestead Food Production/Home Gardening

Homestead food production is the one of the best intervention of dietary diversification. It includes home gardening, small livestock rearing and fishing as well as the processing and preservation of food, and nutrition behaviour change communication. Many rural households have the culture of working on a small plots around the home, managed by household members, where a variety of crops including vegetables, fruits, legumes, tubers are grown throughout the year and often small livestock and fish are also raised. It is primarily used directly for household consumption or indirectly earning income to purchase of item for household consumption. They typically use low-cost inputs and indigenous varieties, as well as local knowledge and practices.

Home gardening maximizes sustainable nutritional gain at the community level. Home gardening improves the nutrition of households through increased availability, access and consumption of variety foods, improved micronutrient and food fiber intakes. Home gardening also improves nutrition by creating market accessibility and affordability of fruits and vegetables from the increased production. Home gardening usually is under the control of women. It helps to increase food access and decision making without harming childcare. Home gardening helps to reduce seasonality through year round production using minimal resources. Home gardening also contributes to better nutrition indirectly by increasing household income. Different fruits, yellow and dark green leafy vegetables are usually produced at the vicinity of homes and used for house hold consumption and for sell.

To ensure that production of home gardening is translated into increased consumption, and improved nutritional status, it needs to be combined with nutrition education and linked with other health and development activities in the community. The specific crops to be produced, the appropriate production technology will be promoted and assisted by the community development agent.

In Ethiopia recently homestead production is challenged by scarcity of land and water resources, and lack of access to productive seed varieties. Destruction of home gardens by domestic animals and pests is also a challenge for homestead food production in the rural communities. Extension workers should promote homestead food production and assist them by creating access to improved seeds, water harvesting technologies, pest control mechanisms.

2. Promoting Production and Utilization of Animal-Source Foods

Animal-source foods production was identified as an important means of food security, improving household diet and nutrient intake. Animal source foods are important sources of proteins, fats, and minerals and vitamins. They are important components of child and maternal nutrition. They are important to increase energy density and micronutrient absorption and bioavailability. Animal source foods such as meat, milk, fish, and their products should make up the substantial proportion of child and maternal meals. The development agents can encourage animal source foods production and utilization through promoting production of small livestock and fish, distributing improved poultry species, training on livestock management and, improving veterinary services. The development agent will lead the selection of appropriate animal species, and assist the production practices at the household level.

3. **Increasing Production and Consumption of Locally Available Nutrient-Rich Underutilized Foods**

Traditional, indigenous wild foods are often cheap nutritious food resources. They usually have superior productivity response against local stresses. Many traditional and underutilized crops are often controlled by women and help to increase women's empowerment. Indigenous food crops

are important in the diet of poor households and their continued productivity is important for household food and nutrition security. Traditional nutrient rich foods are usually neglected because they have low market price. Farmers usually replace these with cash crops.

The nutritional value of these locally available foods should be promoted, and their production needs to be assisted. They are environmental friendly and easily produced; help to achieve good household diet diversity and improved nutritional status. Production of these foods is also an important strategy to reduce seasonality of food. In different societies and culture there are different locally available, nutrient rich, underutilized foods. Agricultural development agents should identify these foods, and introduce improves production and utilization technologies for these foods. Nutrition education and behaviour change communications programs including cooking demonstration of these foods will help to increase acceptance, production and utilization of these groups of foods.

4. **Promoting Production and Consumption of Legumes**

Legumes are rich sources of proteins, iron and zinc as well as dietary fiber. The levels of iron and zinc in legumes are similar to those in meats, poultry and fish. Legumes are important protein sources for rural communities. If legumes are used in combination with cereals and other legumes, they provide proteins equivalent to animal sources. For populations with a cereal-based diet, using legumes will be a cost effective way to complement the protein profile of staple foods such as rice and maize. Mechanisms to incorporate legumes in the local diet include, increasing awareness via extension services, nutrition education on complementary cereal-legume protein, and promoting intercropping methods of production. Because legumes fix nitrogen into the soil as they grow, replenishing critical nutrients lost during production of staple crops and improving soil health, they also have significant agronomic value. Legumes are ideal intercropping plants with cereals such as maize, rice, sorghum and millet, as well as some vegetables.

5. **Promoting Use of Biofortified Crops**

Biofortification is the process of enriching the live crops with the desired micronutrient either through agronomic practice or breeding. Staples produced and consumed by majority of rural communities are deficient of one or more of the essential micronutrients. Biofortified crops are important means of improving micronutrient deficiencies among the larger low income staple foods-dependent community.

Golden Rice, Orange Fleshed Sweet Potato is the best examples of staples biofortified for vitamin A. Sweet Corn is a corn biofortified for a protein. Currently there are also iron fortified staples such as wheat.

Biofortification can be done through agronomic practices such as addition in the form of fertilizers and through the irrigation water, or through breeding techniques. The breeding can be through conventional breeding methods such as cross breading or through genetic modification. Some

institutions framed biofortification as a complement to other approaches. Biofortification of staples is cost effective and sustainable strategy of micronutrients deficiencies prevention in a wider community

6. **Promoting production and mixed consumption of staple Crops**

Maximization of the production of staple crops is an important food and nutrition security intervention. They are necessary for energy intake and income generation. Majority of staples in rural communities are usually insufficient for addressing micronutrient deficiencies because of their limited ability to provide dietary diversity and also the anti-nutrient effects of phytates that reduce iron and zinc absorption. To ensure the nutritional security of the staples producing community appropriate production and consumption mix needs to be practiced. If corn for example is consumed with another staple such as wheat or with a pulse, its protein status will be improved. Staples such as rice can also be consumed mixed with different vegetables.

II. Reducing Post-Harvest Loss and Improve Post- harvest Processing /Preservation

Beyond growing more food, retaining more of the food that is already grown would make a significant contribution to food and nutrition security. It is evidenced that 20-30 % of harvest is lost due to bad storage and handling. Improved storage and preservation reduces seasonally of food availability and access.

Reductions in post-harvest loss and improved post-harvest processing improve household nutrition for three main reasons:

(1) Increasing and prolonging food availability, access and consumption, particularly micronutrient-rich foods (2) Preserving or increasing the nutrient content of the food, and (3) increasing income through higher profit margins of food sold during the off-season or with value-added processing, steadier income flows throughout the year, and employment in the processing cycle. Other reasons also include: improving food safety, and improving consumer access to diverse foods, through improved availability and reduced prices. Reductions in waste at all stages of the value chain needs to be emphasized.

Safe post-harvest handling, processing, and preservations techniques will be discussed in detail in the next chapter.

III. Designing Nutrition Behavior Change Communication

Nutrition education and behaviour change communication is considered an effective household food diversification strategy. It is found effective to promote diversified agricultural foods production and consumption. Appropriate production, harvesting, and postharvest handling methods should be communicated among the farmers. Community members in group and at the household level can be educated on the nutritional value of the local foods and the preparation and preservation methods. Maternal and child nutrition and the appropriate feeding practices should be communicated among the group of pregnant and lactating mothers. In order to translate agricultural productivity maximization and food security in to nutrition security, these programs should be integrated with nutrition education and behaviour change communication programs.

Nutrition promotion and behaviour change communication will be discussed in detail in chapter four.

Family Foods Nutrient Enrichment/Enhancement Mechanisms

In addition to the consumption of variety foods from variety productions, and use of fortified foods, there are also different methods by which a household can enhance or enrich the nutrient content present in foods consumed by the family.

These are: a) Combination, b) Fermentation and c) Germination, fortification, Food Supplements

How many of the diets are combined foods, fermented and germinated, fortified and supplemented?

(A) Combination/Mostly at preparation

Combination is the process of combining cheaper and commonly available foods from different food groups to improve the quality of nutrients. These method, of course demands diversified foods production, access and affordability.

- Combining foods from different food groups is the easiest way of eating all nutrients.

Combination of foods improves the quality of nutrients. Cereals lack certain amino acids and these are present in pulses. On the other hand pulses lack some other amino acids that are present in cereals. The quality of proteins becomes as good as that of milk. The combination of a variety of foods ensures better availability of nutrients.

Combination helps to

- Eat a diet that has good quality nutrients.
- Use cheaper and easily available foods that enhance the nutrient content of food considerably.
- Provide balanced diet to the family.

(B) Fermentation

Fermentation is a process in which some micro-organisms are added to the food. They change nutrients already present in the foods into simpler and better forms and also make other new nutrients. Fermentation makes the dough rise and become almost double in quantity. During fermentation the micro-organisms use up some of the nutrients present in the dough and change them into other better quality nutrients. They also make some new nutrients.

- Milk Curd, bread, 'Injera' etc. are all examples of fermented foods.

Advantages of Fermentation

Fermentation improves the digestibility of foods. The micro-organisms which cause fermentation break the proteins and carbohydrates into smaller parts, which are easier to digest.

- During fermentation of cereals and foods like peas, beans etc. the minerals, calcium, phosphorus, and iron are changed into better quality ones. These are then easily absorbed by the body.
- Fermented foods become spongy and soft and are liked by children and adults.

(C) Germination

Germination is a process in which small shoots come out of the pulse or cereal when these are kept with small amount of water. The grains and pulses to be sprouted need to be soaked in just enough water so that all of it is absorbed. If the extra water in which they are soaked is thrown away, a lot of nutrients are lost.

Grains like wheat, barley, sorghum, etc. can also be sprouted. These grains can then be dried in shade and roasted lightly. They can be ground and used in many dishes. Pulses are also sprouted first and

then steamed and consumed. The time and water which each grain or pulse needs for soaking and sprouting is different. Normally 8-16 hours are needed for soaking and 12-24 hours for sprouting. The cloth in which the soaked dhal is tied should be kept moist all the time. When sprouting is followed by fermentation the vitamin content becomes much more improved.

Germination helps you to:

1. Increase the digestibility of foods:

- Some carbohydrates and proteins are broken down into smaller and easily digestible forms.
- Grains and pulses become soft after sprouting, so they take less time for cooking and are easy for you to digest.

2. Increase the nutritive value of food with no additional cost.

Some vitamins and minerals become more when foods are germinated. Vitamin B becomes almost double in quantity while vitamin C increases almost 10 times.

Summary of the chapter

Consumption of variety foods an effective strategy to ensure the family members meet the daily body requirement for different nutrients. Variety foods ensure nutrient density and balance. Diversified foods production, improved postharvest handling of food, and use of nutrition promotion and behaviour change communication are strategies for diversified food consumption at the household and community level. Many rural communities practice mono-cropping and consume a single or few cereal crops which leads to high level of child and maternal malnutrition. Homestead production, promotion of nutrient rich local food, and use of fortified/biofortified foods are effective household variety food production and consumption interventions. By homestead production a household can produce horticultural crops combined with rearing of small animals for household consumption and for income generation. The widely used cereal staple foods can be fortified with micronutrients, and consumed by the community members. Combination, fermentation, and germination of certain food also help to enrich and enhance the family foods.

CHAPTER THREE: PROMOTING SAFE HANDLING OF AGRICULTURAL FOOD PRODUCTS DURING STORAGE, PROCESSING AND PRESERVATION, AND TRANSPORTATION

Chapter Objective: The objective of this chapter is to enable learners assist in, and promote safe handling of agricultural food products during storage, transportation and preservation

Specific Objectives: At the completion of this chapter students will be able to:

- Identify causes and effects of postharvest loss
- Describe food quality and safety aspects, and the local food supply chain
- Describe the basic postharvest principles
- Explain improved postharvest handling mechanism of cereal grains
- Explain Safe postharvest handling, processing and preservation of horticultural crops

- Explain Processing and preservation of animal source foods (Mill and milk products and meat)

Introduction

Substantial amount of the food globally produced for human consumption is lost due to improper postharvest handling practices. All agricultural foods produced at a certain season of the year will not be consumed all at once. They need to be store for consumption in the year round. At the same time most of the agricultural foods have only limited shelf-life. Therefore the household should have a certain mechanism to keep the food suitable for later use. Both quantitative and qualitative food loss occur as nutrients spoil and deteriorate during storage, processing and distribution. Nutrient losses can occur during on-farm storage, preservation and preparation, and during later storage, processing and transport from farms to points of sale. Minimizing postharvest losses of already produced food is far more sustainable than increasing production to compensate for these losses. Improved postharvest practices can contribute to food and nutrition security in multiple ways. They can reduce postharvest loss, thereby increasing the amount of food available for consumption by households. Thus, efforts to increase production need to be balanced with corresponding efforts to achieve gains in reducing postharvest loss. This chapter will discuss important safe postharvest food handling, processing/ preservation techniques of cereal grains, horticultural crops, and animal source foods (milk and meat)

Causes and effects of postharvest losses

Mechanical Injury: Fresh fruits and vegetables are highly susceptible to mechanical injury owing to their tender texture and high moisture content. Poor handling, unsuitable packaging and improper packing during transportation are the cause of bruising, cutting, breaking, impact wounding, and other forms of injury in fresh fruits and vegetables. Mechanical injury is the most important postharvest loss factor.

Parasitic Diseases: Agricultural products can be infected before or after harvest by parasites widespread in the air, soil and water. Some diseases are able to penetrate the unbroken skin of products; others require an injury in order to cause infection. Invasion by fungi, bacteria, insects and other organisms, is a major cause of postharvest losses in fruits and vegetables. Microorganisms readily attack these products and spread rapidly. Abundance of nutrients and moisture supports the growth of these organisms. Parasitic infection is another external postharvest loss factor, usually initiated and aggravated by mechanical injury.

Physiological Deterioration: Fruit and vegetable tissues are still alive after harvest, and continue their physiological activity. Physiological disorders occur as a result of mineral deficiency, low or high temperature injury, or undesirable environmental conditions, such as high humidity. Physiological deterioration can also occur spontaneously owing to enzymatic activity, leading to over ripeness. All these condition increase the rate of physiological deterioration. This may cause

unpalatable flavours, failure to ripen or other changes in the living processes of the produce, making it unfit for use. Physical deterioration is an internal postharvest loss factor.

Food Quality, Safety, Supply chain, and Basic Postharvest Handling Principles

Food Quality Factors: Proper handling of postharvest products aims to ensure both the quality and safety aspects of the product. Food quality refers to the degree of excellence or superiority of food. It is a combination of attributes and characteristics that give each food value, in terms of its intended use. Texture, flavor, and nutrient profile are important quality attributes of crop products. To producers, high yields, good appearance, ease of harvest, and the ability to withstand long-distance shipping to markets are important quality attributes. Appearance, firmness, and shelf-life are important attributes from the point of view of wholesale and retail marketers. Consumers, on the other hand, judge the quality of products on the basis of appearance (including 'freshness') at the time of initial purchase. Subsequent purchases depend upon the consumer's satisfaction in terms of flavor (eating) quality of the edible part of produce.

Food Safety Factors: A number of factors threaten the safety of agricultural products particularly of fruits and vegetables. Some of these safety factors include: naturally occurring toxicants, natural contaminants such as fungal and bacterial toxins and heavy metals, environmental pollutants, pesticide residues, and microbial contaminations. Microbial contamination and pesticide residues are often regarded as the most important postharvest safety concerns. The best approach to achieving and maintaining the safety of fresh fruits and vegetables is to focus on limiting potential contamination during their growth, harvesting, handling, treatment, packaging and storage. Careful handling and washing of all products to be consumed raw and the strict observance of proper sanitary measures are strongly recommended to reduce microbial contamination at the food service, retail, and consumer levels.

The local food supply chains

Agricultural products reach consumers through food supply chains. Food supply chain is the channel through which agricultural foods from production reach to consumers. It involves harvesting techniques, temporary storage at the field, and transportation to home/storage site, processing and preservation techniques, and transportation to markets. The local food supply chain determines the availability, affordability, diversity of foods and affects the nutritional quality of foods. Postharvest loss can be mitigated by appropriate handling and management of the product along the chain to minimize the effect of biological and environmental factors on product deterioration and avoid product contamination. Safe handlings of products throughout a chain can improve the nutrient content of the local foods. The local food supply chain therefore shapes consumer choices, dietary patterns and determines nutritional outcomes of the community. Different opportunities exist at each component of the supply chain to deliver more diverse and nutritious foods. Household food preservation techniques will affect the nutrient value and bioavailability of nutrients. Application of better harvesting and processing technologies and

management practices can preserve nutrients, reduce food losses and waste, and enhance availability of diverse and nutritious foods.

Basic Post Harvest Handling Principles

The ten useful postharvest principles are listed here under:

1) Harvest at correct maturity
2) Reduce physical handling
3) Protect product from sun
4) Keep packing line simple and clean; ensure good worker hygiene
5) Select, classify, and pack carefully
6) Align cartons, strap pallet
7) Cool as soon as possible
8) Know market and product requirements
9) Coordinate efficient & rapid handling
10) Train and compensate workers adequately

General strategies for loss prevention are: use of genotypes that have longer postharvest life, use of integrated crop management systems and good agricultural practices that result in good keeping quality of the commodity, and use of proper postharvest handling practices in order to maintain the quality and safety of fresh products.

Postharvest Handling, Processing and Preservation of Cereal Grains

Introduction

Within the grains post-harvest food supply chain continuum, a set of functions are performed. Examples of functions include: harvesting, assembling, drying, threshing/shelling, milling, storage, packaging, transportation, and marketing. From a functional point of view, the primary role of an effective postharvest system is ensuring that the harvested product reaches the consumer, while fulfilling market/consumer expectations in terms of volume, quality, and product safety. Once harvested, products are subject to deterioration. The rate of deterioration is influenced by many different biological and environmental factors and postharvest practices. Increased exposure of a product along the chain to extreme temperatures, excessive rain, contamination by chemicals and microorganisms, mechanical damage, etc. will increase postharvest loss. Therefore, a critical step in minimizing postharvest loss is the understanding of these factors, as well as postharvest handling practices and, use of technologies associated with postharvest loss. Postharvest loss can be quantitative (e.g., physical weight losses) and qualitative (e.g., loss in edibility, nutritional quality, caloric value, consumer acceptability, etc.).

Production Condition and Postharvest Loss

While the causes of the postharvest loss are manifold and can occur at any stage between harvest and consumption, postharvest loss can also greatly influenced by production conditions at the pre-harvest stages. For example, end-of-season drought and mechanical damage to pods during pre-

harvest are important factors contributing to fungal contamination and subsequent mold growth during postharvest stages. Proper condition and cultural practice is therefore important to reduce postharvest loss.

Harvesting Conditions and Postharvest Loss

Good harvesting practice at the right time is critical to avoid losses down the chain. Postharvest loss occurs when the harvest is too early, as the crop will still be moist and grains not filled, or too late, as attacks by insects, birds, and rodents will have begun. The harvesting conditions such as the weather condition and time of harvest influence the subsequent postharvest loss. When harvesting is done close to the start of a rainy season, a delay can result in the harvest being undertaken in damp, cloudy weather, and the crop will be insufficiently dried. African producers harvest grain crops once the grain reaches physiological maturity (moisture content is 20–30 percent). At this stage the grain is very susceptible to pest attacks. Also, unseasonal rains at this stage can dampen the crop, resulting in mold growth and the associated risk of contamination. Harvesting by hand is the traditional method used by small producers in Africa. The relatively very few large-scale farmers may use machines to harvest their crop.

Post-Harvest Practices to Reduce Grain Loss

Draying threshing, storage and transportation are important postharvest practices that influence the nutritional and market value of grains. These post-harvest practices are briefly explained below.

Drying

Drying the harvested crop is usually practiced to bring the moisture content of the grain to optimal level that will be appropriate for storage. Majority of harvested grains have moisture content from 15-30%. For better storage outcome this should be reduced down to 13-15% usually by drying. Most farmers rely on natural drying of crops from a combination of sunshine and movement of atmospheric air through the product. Grains should be dried in such a manner that damage to the grain is minimized and moisture levels are lower than those required to support mold and insect growth during storage. This is necessary to prevent further growth of a number of fungal species that may be present on fresh grains. To achieve this, the harvested crop may be left standing in the field, cut and left drying on the ground. In some places, the crop may be moved immediately from the field to a swept area of ground at the homestead or to racks or cribs that are specifically designed to promote drying. Commercial farms may rely on large-scale drying cribs such as for maize and rice. However, successful drying alone is not a remedy against all postharvest loss, as insects, rodents, and birds may attack well-dried grain in the field before harvest or may invade drying cribs or stores after harvest.

Threshing/Shelling

Substantial postharvest loss occurs during threshing and shelling. The threshing and shelling practice in Ethiopia is very traditional that negatively affects the quality and quantity of the grain. Teff, maize,

and wheat for example are threshed on ordinary ground that facilitates contamination with different dusts and biological organisms which compromises both the nutritional and market values of the grain. Threshing using sticks or animal trembling causes physical damage to grains which reduces storage capacity and market price.

Appropriate time of threshing will minimize the graining loss. For some grains, particularly millet and sorghum, threshing may be delayed for several months after harvest and the unthreshed crop stored in open cribs. In the case of maize, the grain may be stored on the cob with or without sheathing leaves for some months, or the cobs may be shelled and grain stored. All grains will eventually be threshed or shelled. For smallholders this is almost exclusively a manual process, except for the few cases in which some groups have access to machinery suitable for small-scale operation, such as the maize shellers that some tractor owners may hire out.

Winnowing/Cleaning

Winnowing and cleaning of grain is usually done prior to storage or marketing if the grain is to be sold directly. For the majority of smallholder grain, this process is undertaken manually. It is relatively ineffective from a commercial perspective, since grain purchased from smallholders frequently requires screening to remove stones, sand, and extraneous organic matter. Some small-scale equipment is available to farmers' groups to winnow or clean maize and rice.

Storage

The degree of postharvest loss in storage varies depending on the crop type and variety, climate conditions, storage structure, grain protection options, and length of storage time. Postharvest losses at storage are associated with both poor storage conditions (grain and environmental conditions) and lack of storage capacity. The store is required to maintain the quality of the grain. Once grain is stored the quality depends on the control and management of the storage system. Molds and insects need adequate food, moisture and temperature to survive and reproduce. It is important that stores be constructed in such a way as to provide (i) dry, well-vented conditions allowing further drying in case of limited opportunities for complete drying prior to storage; (ii) protection from rain and drainage of ground water; and (iii) protection from entry of rodents and birds and minimum temperature fluctuations**.**

Storage Conditions: Both the grain and environmental conditions influence the degree of grain loss at the time of storage. Store sanitation, temperature and moisture, and biological organisms are important storage conditions that affect the quality of stored food grains. The grain store is a biological system. The store manager should be well aware of the interaction among the stored grain, temperature, moisture, and insects, molds and bacteria. These different factors also reinforce each other to influence the nutritional quality and market value of the sored grains.

Most damage that occurs during storage is caused by molds and insects. Grain spoilage occurs as microorganisms and insects feed on the nutrients in the grain. As they grow and develop these organisms produce heat which increases the temperature of the surrounding grains. This heating may create spot on the stored grains. At the favorable temperature and moisture conditions different mold species will start to produce toxins that can cause serious illness and even deaths when consumed by humans and other livestock. Poor storage hygiene and sanitation will facilitate the deterioration of the stored grain. Good store hygiene and sanitation practices are essential for better pest management.

The following are some of the recommended good store sanitation practices

1. To avoid pests contamination totally remove old grains from equipment that are used for harvesting transporting or handling of grains
2. To reduce the likelihood of rodent infestation, remove any spilled grain and any forms of vegetation around the store
3. Inspect the conditions of the store such as walls and roofs for cracks, looses, rust etc., to prevent damage by water and rodents
4. Clean storage facilities thoroughly before filling to eliminate existing insects and mold infestation.
5. Following cleaning and repairing sanitize the walls, roofs and floors with an approved residual spray

Transportation

The means of transport used to take the harvested crop for temporary or permanent storage or to the market will have significant impact on the nutritional quality and market values of the crop. Substantial amount of grain is lost when transported for storage and market. Locally appropriate means of transportations should be designed to reduce post-harvest loss of grains. The poor condition of roads and the fact that the majority of villages do not have access to all-weather roads may cause extended delays or even prevent transport to market. Poor road conditions contribute to physical postharvest loss, as they increase the shocks to which grain kernels are subjected during transport

Safe Handling, Preservation and Processing of Horticultural Crops

Introduction

Fruits and vegetables play a significant role in human nutrition, especially as sources of vitamins, minerals, and dietary fibre. Increased consumption of a variety of fruits and vegetables brings health benefits, which include reduced risk of some forms of cancer, heart disease, stroke, and other chronic diseases. Fruits and vegetables are living plant parts containing 65-95% water, and they continue their living processes after harvest. Their postharvest life depends on the rate at which they use up their stored food reserves and their rate of water loss. When food and water

reserves are exhausted, the product dies and decays. Both quantitative and qualitative losses occur in horticultural commodities between harvest and consumption. Post-harvest losses vary greatly across commodity types, with production areas and the season of production. Losses of fresh fruits and vegetables are enormous both in developed and developing countries. Overall, about one third of horticultural crops produced are never consumed by humans. Expedited and careful handling, immediate cooling after harvest, maintenance of optimum temperatures during transit and storage, and effective decay-control procedures are important factors in the successful post-harvest handling of fruits and vegetables. Attention must be paid to all of these factors, regardless of the method of harvesting used. These factors will be critical in the case of mechanically harvested commodities.

Proper Harvesting and Handling of Horticultural Crops

Maturity at harvest in relation to food quality

Maturity at harvest is the most important determinant of storage-life and final product quality. Immature fruits for example are highly susceptible to shriveling and mechanical damage, and are of inferior flavor quality. Overripe fruit are likely to become soft with insipid flavor soon after harvest. Fruit picked either prematurely or too late, are more susceptible to postharvest physiological disorders than fruit picked at the proper stage of maturity.

Majority of fruits attain optimal eating quality when allowed to ripen on the plant. Some fruits are, however, picked at a mature but unripe stage of development so as to allow them to withstand postharvest handling conditions when shipped over long-distances. The proper time of harvest for each horticultural crop should be identified and practiced accordingly based on the purpose of the crop, the distance of market and the weather conditions.

Fruit maturity and ripening process:

Based on the ripening process fruit can be divided into two groups:

1. Fruits that are incapable of continuing their ripening process once removed from the plant, and
2. Fruits that can be harvested at the mature stage and allowed to ripen off the plant

The first group of fruits includes cane berries, cherry, citrus fruits, grape, pineapple, and strawberry. The second group includes apple, apricot, avocado, banana, cherimoya, guava, kiwifruit, mango, nectarine, papaya, passion fruit, pear, and peach. Fruit of the first group produce very small quantities of ethylene and do not respond to ethylene treatment except in terms of de-greening (removal of chlorophyll). If good flavor quality is to be ensured these fruits should be picked when fully-ripe. Fruit of the second group, on the other hand, produce comparably larger quantities of ethylene which is associated with their ripening, and undergo more rapid and uniform ripening upon exposure to ethylene.

Many vegetables, in particular leafy vegetables, and immature fruit-vegetables (such as cucumbers, sweet corn, green beans, peas, and okras), attain optimum eating-quality prior to reaching full maturity.

Method of harvesting in relation to physical damage and uniformity of maturity

The method of harvesting (hand vs mechanical) can significantly impact upon the composition and post-harvest quality of fruits and vegetables. Mechanical injuries (such as bruising, surface abrasions and cuts) can accelerate loss of water and vitamin C resulting in increased susceptibility to decay-causing pathogens. Most fresh fruits and vegetables are harvested by hand. Root crops (such as carrot, onion, potato, and sweet potato) and some crops destined for processing (such as processing tomatoes, European plums, and tree nut crops) are mechanically harvested.

Management of harvesting operations, whether manual or mechanical, can have a major impact on the quality of harvested fruits and vegetables. Proper management procedures include selection of optimum time to harvest in relation to product maturity and climatic conditions, training and supervision of workers, and proper implementation of effective quality control. It should be noted that any practice that reduces the number of product handling steps will help minimize losses. Field packing (selection, sorting, trimming, and packaging) of product at the time of harvest can greatly reduce the number of handling steps in preparation for marketing. Mobile field packing stations with adequate shading are used for those fruits (such as grapes and strawberries) and vegetables (such as broccoli, cauliflower, and green beans) that do not require washing as part of their preparation for marketing.

Preservation and Processing of Horticultural Crops

Preparation for preservation and processing

Fruits and vegetables should be prepared for preservation as soon as possible after harvesting, in any case within 4 to 48 hours. The likelihood of spoilage increases rapidly as time passes. The preparation activities carried out for each preservation technique will affect the shelf-life and nutritional quality of the preserved fruit and vegetable. Most commonly used preparation methods used before the various processing and preservation methods are described below.

Cleaning and washing: Before preservation most fruits and vegetables have to be thoroughly cleaned to remove any dirt or insecticide residues. The outer layers of some fruits and vegetables such as onions also have to be removed. Cleaning and washing process usually involves washing the products under a faucet with running drinking water or in a bucket with clean and safe water that is regularly refreshed. When cleaning leafy vegetables, it is best to first remove the stems. Some types of fruit, such as cherries, strawberries and mushrooms are *not washed*, because this would actually increase the spread of micro-organisms. It is also not advisable to wash cucumbers, because this shortens their shelf-life.

Sorting: To achieve a uniformly sized product, fruits and vegetables are sorted immediately after cleaning according to their size, shape, weight or colour. Sorting by size is especially important if the products are to be dried or heated, because their size will determine how much time will be needed for these processes.

Peeling and Cutting: Many types of fruits and vegetables have to be peeled in order to be preserved. In order to soften and remove the peel easily it is advisable to first submerge citrus fruits, tomatoes and peaches, whose peels are all securely connected to the fruit, in hot water for about two minutes. Cutting is important in order to have approximately uniform pieces for the heating, drying and packing stages. Fruits and vegetables are usually cut into cubes, thin slices, rings or shreds. The cutting utensils have to be sharp and clean to prevent micro-organisms from entering the food. From the moment they are cut, the quality of the products decreases due to the release of enzymes and nutrients for micro-organisms. A decrease in quality is also caused by the damage done to the plant tissues. For this reason, the interval between peeling/ cutting and preserving has to be as short as possible.

Blanching: Blanching or 'pre-cooking' is done by immersing fruits or vegetables in water at a temperature of 90-95°C. It can also be done by exposing produces to steam. The purpose of blanching is make fruits and vegetables to be preserved soft and deactivate the enzymes. Leafy vegetables also shrink in this process and some of the microorganisms die. Blanching is done before a product is dried in order to prevent unwanted colour and odour changes and an excessive loss of vitamins. Fruit that does not change colour generally does not need to be blanched. Onions and leek are not at all suited for blanching. You should consult the postharvest related courses and further understand the procedures of blanching.

Fruit and vegetables Preservation methods

1. Preserving by heating

One of the most common and effective ways to preserve fruits and vegetables is to prepare them and place them in air-tight containers, which are then heated. The high temperatures ensure that microorganisms are killed and the enzymes are inactivated. Any remaining spores will not have the right conditions to grow into bacteria and microbial contamination from outside is prevented. However, it is important to remember that some microorganisms are unfortunately less sensitive to heat. Clostridium and Staphylococcus, for example can still multiply and spoil the food through the poisonous substances they produce.

The heating method for fruit is different from that of vegetables. Since most fruits have a low pH level, they can be heated in boiling water(100°C), whereas most vegetables have to be heated at temperatures above 100°C, because they have a higher pH and are thus more susceptible to bacterial contamination. This preservation method produces the best results, but only if fresh Products are used and the instructions for heating are followed exactly. As with other methods, heating has advantages and disadvantages as outlined below:

Advantages

- Most micro-organisms are destroyed so there is less chance of spoilage.
- After being sterilized and stored, the food can be kept longer and more safely.

Disadvantages

- Heating requires the following investments: Heat-resistant storage containers (which can be difficult to obtain) such as cans or glass jars, cooking utensils, such as a steamer, and fuel
- These investment costs will have to be represented in the final cost of the product.
- This method is labour intensive.
- It requires access to abundant clean water.
- Preserved fruits and vegetables have a lower nutritional value and generally less taste than fresh products.

However, fewer nutrients are lost using the heating method than any other preservation method. Pasteurization and sterilization are two methods of heating food products to prevent them from rotting and to prepare them for storage in glass jars or tins. Proper packing and preparation activities carried out before heating will have substantial influence on the quality of the produce preserved by heating.

2. Preserving by drying

Drying is one of the oldest preservation methods. The moisture level of the produces is reduced to 10-15% so that the microorganisms present cannot thrive and the enzymes become inactive. Further dehydration is usually not desired, because the products then often become brittle. To ensure that the products do not spoil after being dried, they have to be stored in a moisture-free environment. Drying of potato, tomato and mango is commonly practiced.

Drying is generally not difficult. Since the products lose water, they also become much lighter and thus easier to transport. Two disadvantages, however, are that the products also lose vitamins, and they change in appearance. The most common drying method is exposure to air. Air can absorb water; and the warmer the air is, the more it will absorb. For optimal results, the air should be hot, dry and in motion. In a closed environment, the air has to be refreshed regularly because it will otherwise become saturated with the moisture it absorbs from the products. Good ventilation is therefore essential. For drying, the relative humidity of the air should be less than 65%. If the relative humidity is higher than 65% the fruits and vegetables will eventually dry out, but not in the right way. When the sun is shining, the relative humidity is usually lower than 65%, but when it is cloudy and definitely when it is raining the humidity is usually higher. Sunshine is therefore extremely important! For this reason, it is not possible to dry products in this way in every season of the year.

Before drying, the vegetables and fruits have to be thoroughly washed and cut into pieces if necessary. Sometimes extra preparation is needed to retain the colour of the product and to minimize nutrient loss. The final quality of the dried product is determined by a large number of factors such as quality of the product to be dried, the preparation of the product, the drying method used the packing and storage conditions. Up on drying the moisture content of fruits will be reduced to 12-14%, while those of the vegetables to 4-8% for vegetables contain relatively less

sugar. Proper packing following the completion of drying and proper storage will minimize bacterial contamination and improve the self-life the dried produce.

3. Preserving with salt and vinegar

Adding salt is one of the oldest ways to preserve food, except fruits. Since salt absorbs much of the water in products, it makes the condition difficult for microorganisms to survive. Two salting methods are practiced, use of a lot of salt, and use of only a small amount of salt. The disadvantage of using a lot of salt is that it has a very negative impact on the taste of the food. To overcome this problem, the food can be rinsed or soaked in water before it is eaten, but this also decreases the nutritional value of the food. It is therefore advisable to use a lot of salt only when there is a surplus of fresh vegetables and no other preservation method is possible. Heavy salting (part salt and 5 part vegetable) is a simple preservation method, and much less labour intensive than preserving with a small amount of salt.

The use of a small amount of salt is in itself not enough to prevent the growth of bacteria, but it result in the development of a certain kind of acid-producing bacteria that limits the growth of other bacteria. The salt can be added as dried granules or as brine (a salt-water solution in various concentrations). Sometimes a little bit of vinegar also has to be added. In light salting enough salt (1 part salt and 20 part vegetable) is added to the vegetables to create appropriate conditions for the growth of micro-organisms that form acids, which will in turn preserve the vegetables. The acid gives the product a special taste that is often appreciated. When vinegar is also added to this light brine less salt is needed. The brine method is easier than the dry salt method, as brine gives an even distribution of salt and vegetables.
Peas, beans, sweet corn and greens preserved with salt always have to be cooked for at least 10 minutes before use. Do not eat (even for tasting) preserved vegetables that have not yet been cooked. It is important that the vegetables are always kept submerged below the level of the liquid.

Another way to preserve vegetables is by adding vinegar. Pickling in vinegar or acetic acid can also preserve food. This method of preservation can be done with vegetables (cabbage, beets, onions, cucumber) and fruits (lemons, olives). To obtain a product that can be stored, the vegetable first has to be salted and heated before being put into vinegar. The appropriate type and concentration of vinegar needs to be determined before preserving vegetable with vinegar.

Processing fruits and vegetable to products

In addition to preserving fruits and vegetable, processing them in to products will improve its shelf-life, nutritional value, and transportation to different market. Fruit can be processed to produce juice, jams, jellies and candied fruit. This can be done with all kinds of fruits. A mixture of two or more kinds of fruit often gives a better, more rounded taste in the final product. The proportions

have no effect on the shelf-life of the product. The methods deployed in the processing and preserving these products can be using sugar or heat or a combination of the two.
Both the pre-processing (preparation), and post processing (packing, bottling, and storage) activities affect the final quality of the processed product. It is best to start with fresh, undamaged fruit that is not overripe. Moldy fruit increases the chance of spoilage and of causing food poisoning. All materials with which the fruit comes into contact, such as knives, pots, kettles, cans, pans and bottles, should be made of stainless steel, glass, undamaged enamel or good-quality plastic. Avoid using aluminum or galvanized tools and kettles, as the acid in the fruit will attack these. The acid can dissolve the aluminum and the zinc layer of the galvanized materials, resulting in a metallic taste and possible zinc poisoning.

Safe Handling, Preservation, and Processing Animal Source Foods (Milk and Meat)

Safe handling preservation and processing of Milk

Milk and dairy products in human diet

Milk contains components that are essential to human body such as proteins, carbohydrates, fat, water, all the B-vitamins, vitamins A and D, calcium and phosphorus. It also provides energy.
An important protein in milk is casein (in many cases 80% of the milk protein). This is the base for cheese making. In addition to casein, milk contains whey proteins (20% of the milk protein). The whey proteins are in most cases not incorporated in the cheese; they remain in the whey. Whey proteins (globulins and albumins) have a very high nutritive value. Milk protein is of a high quality. It is a complete protein, which means that the human body can use a large part of the protein efficiently. Proteins in various other foodstuffs are incomplete proteins, and have a complementary effect. In combination with cereals, potatoes, meat, eggs or nuts in one meal, the body can use an even greater percentage of the milk protein.

Milk sugar (lactose) is a carbohydrate, a necessary component to keep the body going. Milk fat is present in the form of small fat globules, which have a lower weight than the other components of the milk. When cow milk is allowed to stand, these globules collect on top of the milk and form a layer of cream. Milk fat is easy to digest. Milk is also an important source of minerals and vitamins. It contains large quantities of calcium, which can easily be absorbed by the body after digestion and is important for the formation of bones (the skeleton). Vitamin B2 (Riboflavin), is an important vitamin found in milk. Little vitamin C and E also found in milk.
Milk is able to compensate for a lack of certain nutrients in a monotonous diet because of the great diversity of nutrients it contains and the high value of milk protein. It can therefore greatly improve the quality of the diet. Products derived from milk contain these nutrients to a greater or lesser extent. Milk is especially desirable for vulnerable groups, for instance babies, toddlers, children and pregnant and nursing mothers.

Safe Handling of milk and milk products

Milk should be handled with care. There are several factors that can make milk contaminated, and become unsuitable for further consumption. These factors include:

- The presence of too many microorganisms in the milk
- Contamination by diseased animals (tuberculosis, brucellosis) and/or people
- Bacterial and/or chemical conversion of certain substances in the milk
- Contamination of the milk with antibiotics (used for treatment of diseased animals), disinfectants, pesticides and so on

The factors mentioned above always cause some forms of deterioration of milk. In some cases it is only the flavor that is affected, but usually the structure and smell of milk also change. In the case of contamination with antibiotics and disinfectants, the milk's appearance does not change, but fermentation, which is necessary for processing the milk, is inhibited. Thorough cleaning of dairy utensils and equipment is essential. Anyone handling milk must also pay great attention to hygiene. Lack of hygiene can contaminate milk with other types of bacteria, which turn it sour and reduce its storage life. The prevention of contamination is especially difficult when milk is collected from various places and processed centrally. Addition of even a small quantity of infected milk contaminates the total quantity of the milk.

Development agents should be well aware of the way microorganisms that cause the deterioration of milk, and the precautions which can be taken to minimise the impact of these microorganisms.

Milk preservation and processing techniques

Milk can be stored longer if it has been processed. Extended storage is possible if you are able to control the growth of micro-organisms. The processing technique used will determine the storage life of the milk and dairy products. The following rules should be followed during the production, storage and processing of milk.

- Always wash your hands and avoid putting them in the milk if not necessary.
- See to it that all equipment used during processing is properly cleaned and disinfected if needed.
- Take care that no dirt particles or insects enter into the milk
- Try to prevent the use of copper utensils. (Copper can give off flavours in butter and milk.)
- Do not expose milk to sunlight; store it in a dark place.
- The use of a thermometer is recommended.
- Make sure that milk used for consumption has always been boiled or pasteurized.
- Never store raw (i.e. unheated) milk if it is not immediately cooled below 4°C.

Pasteurization, Cooling, Souring (acidification), and Creaming are the commonly used milk processing and preservation techniques, and will be dealt in the following section.

Pasteurization: It is a milk preservation mechanism by applying heat to destroy microorganisms. Milk contains certain micro-organisms that can spoil it. These bacteria grow best at temperatures between 10°C and 40°C. It is therefore important to cool milk as quickly as possible. This is usually difficult in the tropics where cold water and refrigerators are not easily accessible. Heating will be

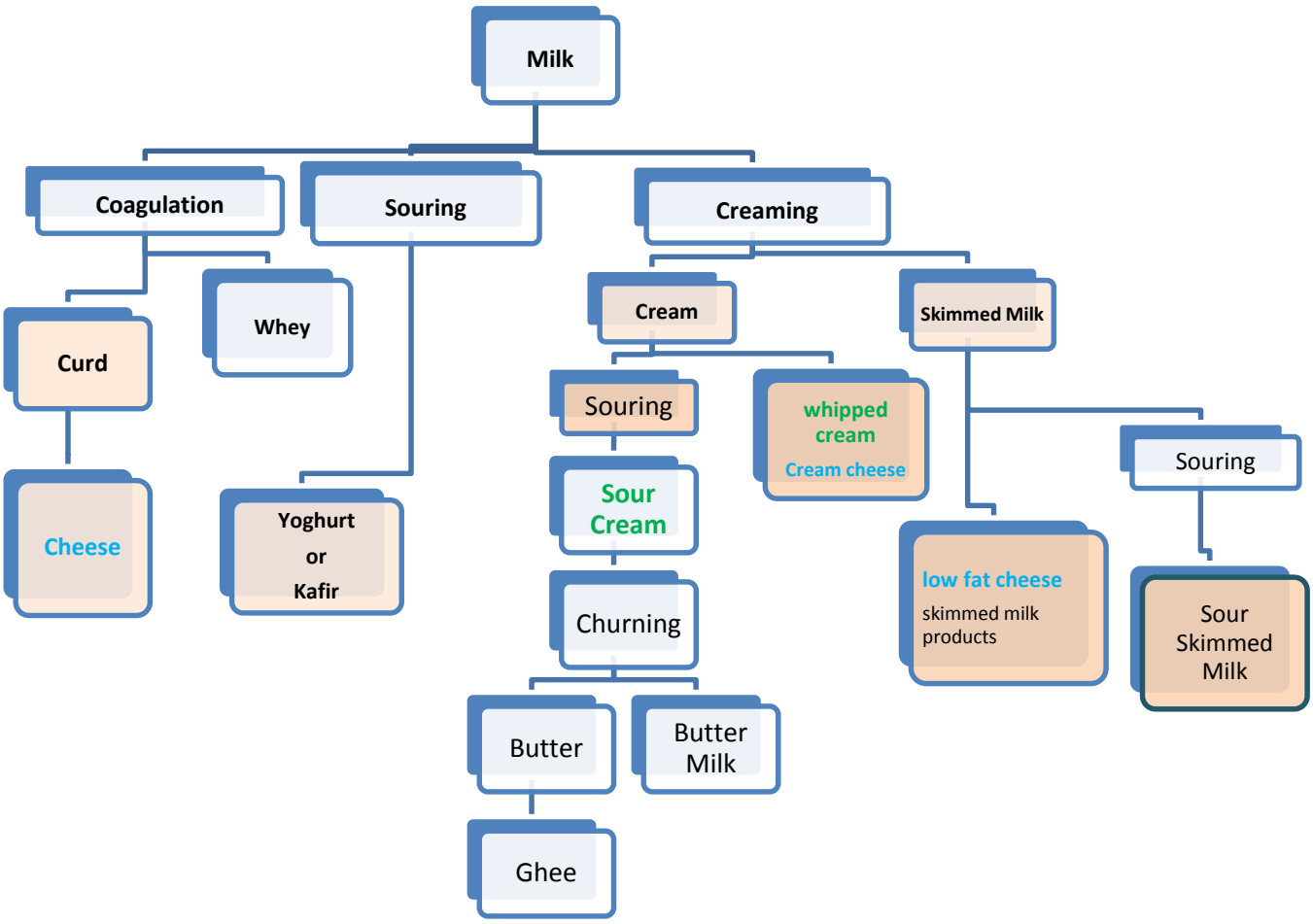
an alternative. Most bacteria will be destroyed during heating. The most effective temperature depends on the heating time. Heating for a longer period at a lower temperature can be as effective as heating for a shorter period but at a higher temperature. Pasteurization improves the safety and storage life of a product, while the taste hardly changes and the loss of vitamins is minimal. Pasteurized milk can be kept for about one week at 4-6°C if no re-infection takes place.

Cooling: Storing milk at a low temperature will greatly reduce the growth of bacteria. Bacteria develop much slower in cold milk. The best storage temperature is 4°C. Properly pasteurized or boiled milk can be kept for about one week if stored at 4°C.Without cooling, raw milk will spoil within a day. Put the hot pasteurized or boiled milk in a clean container. Let it cool down as quickly as possible, preferably in a large pan with cold water (refresh the water if it warms up). Stir both the water and the milk during cooling with a clean spoon, using different spoons.

Fermentation/acidification: Another way of increasing the shelf-life of milk is to ferment the milk into soured milk products. During fermentation part of the milk sugar is converted into lactic acid by bacteria, for example by the yoghurt bacteria Streptococcus Thermofilus and Lactobacillus Bulgaricus or the bacteria that grows at room temperature Streptococcus Lactis. Fresh raw milk can be left to sour spontaneously, but then you cannot control which bacteria are growing. It is better to sour the milk with the help of specific lactic acid bacteria as a starter culture after the milk has been pasteurized. Quality and taste are influenced by the products that the different lactic acid bacteria produce.

Creaming: Cream is made from the fat that rises to the surface of cow milk. A layer of fat forms on the surface of the milk after it has been left to stand for at least half a day. After a day this layer contains about 20% fat. The simplest way of collecting it is by skimming it off the top of the milk. 10 liters of milk usually produces about 1-2 liters of cream. The skimmed milk which remains after the removal of the cream is still very nutritious, because it contains nearly all the protein of the milk. You can either drink it or use it for the production of sour milk or cheese. Sour (fermented) cream and sour (fermented) milk are produced by incubation of inoculated fresh cream or fresh milk. A culture of lactic acid bacteria is used for inoculation of the fresh milk or the fresh cream. Butter (80% fat) and buttermilk are made by churning cream or milk. One hundred liters of milk with a 4% fat content produces 20-30 liters of cream, which yields about 4 kg of butter. Butter and cream can be used to make ghee. Ghee keeps better than cream and butter as it contains practically no moisture; it is almost pure milk fat.

The following figure gives an overview of the different dairy products that can be made from milk.



There are many reasons to process milk into dairy products, such as the following:

- Many dairy products can be kept longer than fresh milk; therefore the milk does not have to be consumed immediately.
- The demand for fresh milk may be limited, and there may be more interest in dairy products.
- If the daily amount of fresh milk for sale is limited, it may be more economical to process the milk into less perishable products, store them, and sell them later in greater quantities.
- There may be no market for fresh milk close by, and only preserved products can be sold at markets at a greater distance.
- Greater financial gain may be obtained.
- Many population groups in Asia and Africa cannot or can hardly consume milk because of so-called lactose intolerance.

Lactose intolerance implies that the body is almost or entirely unable to digest the milk sugar, lactose, which is found in milk. Only small amounts of milk (up to 200 ml) consumed several

times a day can be digested. Dairy products in which a proportion of the milk sugar is converted during production, such as cheese, curd, yoghurt and sour milk or buttermilk, do not cause many problems in this respect.

Before processing surplus milk, one must consider whether it is profitable to do so. The processing is not always easy and there may be losses. For example, a waste product of cheese making is whey, which contains many valuable nutrients. If the whey is not used, a valuable part of the milk is lost. Furthermore, while milk is being processed quality deterioration may occur and it can go off. Only when milk is drunk immediately can you be sure that nothing is lost.

Safe handling, processing and preservation of meat

Introduction

The speed with which meat spoils depends on hygiene conditions, storage temperature, the acidity of the meat, and the structure of the muscular tissue. The firm muscular tissue of beef, for example, spoils less quickly than liver. Hygienic slaughtering and clean handling of the carcass have a positive effect on storage life. After slaughtering, it is better to store the parts of the carcass in cooling cells. However, as cooling facilities are often absent, the meat must be consumed or processed as quickly as possible.

Meat processing and preservation

Salting

For salting, it is important that the meat has been prepared in such a way that the salt added can quickly draw into the flesh and the moisture can leave the meat. To achieve this, try to keep the flesh of the products thin and the surface area of the product as large as possible. Depending on different condition dry salting, wet salting, pickling and brine salting methods can be deployed in preserving meat with salting.

During the salting of meat in the tropics, attention must be paid to the following:

1. Use the cleanest salt available.
2. Use enough salt. Note that salting products is not the same as using a lot of salt. Large amounts of salt give meat a very salty taste. At the same time many of the nutrients are lost if too much salt is used.
3. The water which is to be used must not be contaminated; it must be clean and clear (drinking water quality).
4. The most effective way of preserving meat is to combine salting with smoking or drying.

Drying

Meat spoilage is slowed when water is drawn from the meat. This can be achieved by salting as described above, but also by naturally drying the meat. The best results are achieved by combining salting with drying. Salting the meat is not essential but has great advantages and is therefore strongly recommended before drying. Salting ensures, among other things, that during drying the

microorganisms at the surface are inhibited and pests are kept away, thus the spoilage of meat is slowed. After drying, salt gives a more stable product with a longer storage life. The use of salt before drying and the manner of salting depend on the availability of salt and local customs. Make sure that a batch of meat to be dried is made up of pieces of roughly the same size. This ensures that the whole batch dries evenly and that after drying part of the product is not too dry or actually not dry enough. Very fatty meat is difficult to convert into a good salted and/or dried product. The problem is that the fat forms a barrier to salt penetration and/or loss of moisture.

Drying must take place carefully and uniformly. The best results are achieved in dry weather with a lot of wind. During drying ensure that there is an even drying. Therefore do not put the meat to be dried directly in the sun at the start of the drying process. The product to be dried must be protected as much as possible against insects and other pests. Insects are carriers of various bacteria which can cause the product to spoil. The meat must also be protected against dusty wind, rain and dew. Well-dried meat has a uniform appearance after being broken. The colour is the same throughout the product and is often dark red. The smell and taste of dried meat is different to that of fresh meat. Light oxidation of the meat fats gives a typical dried meat taste. Meat which has any signs of spoilage should not be stored any longer nor eaten.

After drying, the meat can be packed and stored. Keep the dried and packed meat in a cool, dry, well-ventilated and dark place. In such conditions, well dried meat can be kept for months. Before using salted or unsalted dried meat, it must first be soaked in boiling water or be boiled gently. How long the meat is soaked or heated depends on the desired taste and consistency.

Smoking

Raw meat can also be preserved by smoking. The preserving effect of the smoke is a result of drying (withdrawal of moisture) of the meat during the smoking. The smoke particles, absorbed by the flesh, also have a preserving effect which, however, is less than the drying effect. The smoke particles, after being absorbed by the meat, inhibit bacterial growth on its surface. The smoke particles also have a positive effect on the taste and colour of the meat.
The heat of the fire, as source of the smoke, dries the meat during the smoking process and if the temperature gets high enough, the flesh is cooked. This means that bacterial spoilage and spoilage due to enzyme activity is prevented.

Canning

Canning is generally a food preservation process which involves placing foods in cans or jars and heating them to a temperature that destroys microorganisms that could be a health hazard or cause the food to spoil. Canning also inactivates enzymes that could cause the food to spoil. Packing the product in can/jars and heating are the main features of canning. As the cans or jars are sealed hermetically, re-contamination from outside is prevented. In general, canned products can be stored for a long time without refrigeration.

Advantages of canning:

- The product can be stored longer and more safely.
- A good-quality product is ensured with fish and meat; it is better than that of foods preserved by other methods like drying in the sun. The best quality is achieved by using fresh, healthy products and by exactly following the heating specifications for that product.

Disadvantages of canning:

- The high price of the preserved foods due to the following:

-Glass or tinned steel packaging materials must be used, and may be expensive and difficult to obtain. Glass can be reused.

-The processing equipment is, when compared with sun drying or smoking, very expensive. The costs for canning in glass jars are less.

-The process requires a lot of fuel.

- The process requires more clean water than other methods do.
- The extended heating at high temperatures causes both a decrease in taste and vitamin losses. The nutritional value of the food, compared to the fresh product, is therefore somewhat lower. Nutrients dissolving in the brine are lost if these juices are not consumed.

In general, almost all meat products are suitable for canning. Only products which are eaten raw such as raw dry-cured ham or dry sausage are not suitable.

Store the canned foods in a cool place. Label them so that you know the contents. The storage temperature should preferably stay below 20 °C; the cooler the better, as chemical quality degradation still continues after canning. With conventional canning techniques as described in this chapter not all bacterial spores may be killed. Fortunately, these heat resistant survivors do not grow at temperatures below 35 °C. If you want to store the product for a long time (up to 2 years) in tropical conditions with higher temperatures (of 35 °C or more), than a much more intensive heat treatment at 121 °C (250 °F) is necessary so that all micro-organism spores are inactivated. Pasteurized meat products (heat treatment at 80 °C can be kept in cooling cells (2-4 °C) for up to 6 months.

Cooling and freezing

Cool/freezing is meat preservation method by extremely lowering the temperature. There are two possibilities for storing fresh meat at low temperatures:

- Cooling at -1°. +4 °C / 30-39 °F, which inhibits the growth of micro- organisms
- Freezing at -18°. -30 °C / -0.5. -22 °F, which completely stops bacteria from growing.

Because of the low temperatures, all (bio) chemical, physical and micro- biological processes are slowed down so decaying does not occur.

To increase the storage life of the product, it is important to lower the temperature very quickly so as to preserve its quality. If the freezing goes too slowly, large ice crystals are formed which affect the structure of the product. To cool meat, one needs a large cooling cell. This requires ice-making machines. Very expensive and advanced freezing equipment is needed for the freezing of fresh

meat. Furthermore, these preservation methods require a lot of energy and a large investment in the necessary materials. Therefore cooling and freezing can only be done at an industrial level.

Summary

Improved postharvest handling of food products during storage processing/preservation and transportation has significant contribution for household food and nutrition security. Both internal and external factors affect the postharvest loss. Mechanical injury, microorganism contamination, and physiological disorders are important factors for post-harvest food loss duty spoilage and deterioration of food. Food spoilage and deterioration affects the nutrient content of the food, thereby it affects the nutritional and market value of the food. Safe postharvest handing, processing and preservation practices conserve or enhance the nutrient quality, and ensures the safety of food. There are different postharvest handling, processing, and/or preservation techniques and technologies for cereal grains, horticultural crops, and animal source foods.

CHAPTER FOUR: NUTRITION PROMOTION THROUGH BEHAVIOR CHANGE COMMUNICATION AND USE OF TECHNOLOGY

Chapter Objective: The objective of this chapter is to enable learners identify, and use the basic concepts, strategies and tools of nutrition behavior change communication as related to diversified foods production, postharvest handling, and utilization.

Specific Objectives: At the completion of this chapter learners will be able to:

- Explain the basic concepts of nutrition education, and behaviour change communication
- Discuss nutrition behaviour change communication strategies and tools
- Design appropriate behaviour change communication strategies and tools for a target audience
- Develop and communicate appropriate messages for a target audience

Introduction

Increased yield in agriculture and incomes should be translated in to better diet and improved household nutritional status. Households should be informed of the nutritional qualities of the foods they produced and consumed. Nutrition behaviour change communication is found to be highly effective strategy to improve family diet and nutrition. It enhances the impact of nutrition and food security interventions and is often critical to their success. Long term nutrition education develops people's capacity to make good dietary choices and builds self-reliance. Different organizations use different names for programs designed to inform and help people to achieve improved dietary practices, and optimal nutritional status such as nutrition behaviour change communication, and apply different strategies and tools at different scopes. Different nutrition promotion and behaviour change communication strategies and tools, and designing of appropriate messages for specific audiences will be discussed in this chapter.

Components of Nutrition Behaviour Change Communication

Nutrition education and behaviour change communication interventions usually include Information Education and Communication (IEC), and Behaviour Change Communication (BCC) components.

Communication

Communication is an act by which a person shares knowledge, feelings, ideas and information, in ways such that recipients of the communication gain a common understanding of the meaning, intent and use of the message. It requires a sender and receiver, a message to be transmitted, a channel through which information flows and a medium or media where the message appears.

Information Education and Communication (IEC) is a process of working with individuals, communities and societies to develop communication strategies to promote positive behaviors which are appropriate to their settings.

Nutrition IEC therefore focuses on development and transmission of different nutrition information through different strategies for different segment of a society to promote improved dietary practices and lifestyles to achieve improved nutrition.

Behavior Change Communication (BCC) is a process of working with individuals, communities and societies to develop communication strategies to promote positive behaviors which are appropriate to their settings; and provide a supportive environment which will enable people to initiate and sustain positive behaviors. Behaviour change communication is beyond mere communication. It is evidence-based, through formative assessment; interactive; consists of strategic messages; and involves audience segmentation

Nutrition behaviour change communication focuses on provision/creation of supportive environment for the specified behaviour/practice to be achieved in addition to developing and transmitting nutrition information. Provision of improved varieties of small animals and improved fruit and vegetable seeds after educating farmer about benefit of diversified homestead foods production is the best example of nutrition behaviour change communication.

Nutrition behaviour change communication refers to learning better dietary practices or helping people to improve their diets. It is the process helping people to improve their own health and others' by eating better, through discussion, demonstration and practice.

Message Segmentation refers to targeting key messages to the relevant audience at the right time, to ensure people get the information most relevant to them when they need it. This helps prevent "information overload" by ensuring people are not given unnecessary information. For instance, during pregnancy, it is better to focus on giving the expecting mother maternal nutrition and breastfeeding messages, rather than talking to the mother and family about complementary feeding, which can be discussed at a later stage.

It should be well understood that nutrition behaviour change communication is different from 'learning about nutrition science'. You learn the science of nutrition such as nutrients and foods groups to understand the principles and facts about nutrition, but as a development agent you also need to know about how to educate and communicate people to help them practically apply the sciences of nutrition to improve their nutrition and health status. In the community you will work as nutrition educator/communicator, not as nutrition instructor. You are not expected to teach the rural households about nutrition science but to help them practically apply the nutrition sciences by providing them the basic informations and creating favorable conditions. Nutrition behaviour change communication therefore helps you to understand the different strategies and tools to be used in developing and transmitting nutrition informations to bring change in behaviour in the communities.

Nutrition behaviour change communication strategies and tools

The goal of nutrition education and behaviour change communication is to improve the nutritional status of households particularly of women and children through improved dietary diversity, dietary habit and feeding practice. Nutrition behaviour change communication motivates farmers to maximize productivity, diversify production and retain more food for household consumption. It is also effective in increasing and sustaining consumer demand for variety foods.

Nutrition behaviour change communication interventions are designed to facilitate the adoption of eating and other nutrition related behaviours conducive to health. It builds on local knowledge of foods that are available, either in the market or locally produced, in order to define better ways, including better storage, processing and preparation techniques to improve family diets. Nutrition behaviour change communication involves educating the community about a wide range of activities including breast and complementary feeding, promotion of homestead foods production and use of irrigation and water harvesting systems. It can persuade women to increase production and consumption of diversified foods, rather than for sale. It also helps communities gain a sense of empowerment through a better understanding of what makes their children healthy. Nutrition behaviour change communication will be more effective if it emphasizes on the promotion of

consumption of locally produced nutrient dense food and on developing messages based on local perceptions, barriers and incentives for behavior change.

The nutrition behaviour change communication strategy should promote the range of practices recommended for specific ages in a culturally appropriate and timely way, targeting not just those who practice the behaviors but also those who influence the behaviors in a household and community. Clear, age-appropriate and action-oriented messages delivered through multiple contact points and channels are usually most effective. Effective entry points for nutrition behaviour change communication in low-income rural communities include agricultural extension, school feeding and school garden programmes, and community-based health care that provide prenatal advice, vaccinations and growth monitoring of infants.

A nutrition behaviour change communication intervention to be successful needs to consider the following important points:

- Which groups of the community are most vulnerable to the undesirable behaviour/ malnutrition?
- Which vulnerability factors are most important for the occurrence of the behaviour /malnutrition?
- Which vulnerability factors the community wants to address?
- What could be motivators for behavior change?
- What could be barriers to behavior change?
- What type of messages will be meaningful to the target group?
- Which communication media would best reach the target group?
- What approaches can be address factors that influence their behavior?

The community nutrition educator should select appropriate nutrition topics to be communicated to the target communities, and develop different messages on that topic to be communicated through the selected strategy and channel. Selection of topics depends on the existing local nutrition context and topics needs to be prioritized and sequenced. Important topics of nutrition behaviour change communication could address the following:

BCC Topics	BCC Strategies	BCC tools
▪ Food handling and food safety measures ▪ Healthy food choices and balanced diets ▪ Nutritional requirements of different family members ▪ Cultivation and consumption of locally-available nutrient-dense foods ▪ Food preparation and storage, including cooking demonstrations ▪ Reduction of post-harvest losses and long-term storage to maintain nutrient content	• Drama and songs • Community groups • Mass media (radio, television) • Individual counseling • Group discussions or talks (Community Gatherings) • Oral and printed word • Counseling cards • Home visits	➢ Billboards ➢ Banners ➢ Posters ➢ Leaflets ➢ Brochures ➢ Audio-visuals ➢ Counseling cards

▪ Strategies to increase and diversify family food supplies ▪ Environmentally sustainable food consumption patterns ▪ Health risks of highly processed foods and obesity/chronic disease, and ▪ Care practices, breastfeeding and addressing food taboos	• Care groups or small groups • Community-based growth promotion (CBGP) • Visual aids • Group activities for family and community	➢ TV and radio broadcasts ➢ Magazine ➢ Bulletin ➢ Newspaper etc.

Many different organizations develop principles for developing specific messages to make the nutrition behaviour change communication efforts successful education and behaviour change efforts.

- Base messages and strategies on an understanding of local perceptions about diet and nutrition, reasons for current behaviours and barriers to and opportunities for behaviour change
- Have a concise set of clear, actionable messages
- Build on existing messages and guidelines in-country, such as essential nutrition actions (ENAs)
- Relate messages closely to the agricultural intervention, such as nutrition information about crops produced and ways of preparing and preserving them
- Release information through multiple channels at once

Nutrition behaviour change communication should be designed based on proven theories and models of behavior change. Behaviour change communication process began with formative research and behavior analysis, followed by communication planning, implementation, and monitoring and evaluation. Audiences are carefully segmented, messages and materials are pre-tested, and both mass media and interpersonal channels are used to achieve defined behavioral objectives. A successful behaviour change communication program requires careful development and thorough pre-testing of communication materials. Educators must be able to improvise or adapt strategies using locally available resources in the community's context. The table below shows some of the behaviour change communication strategies and tools that can be used in nutrition programs.

Nutrition behaviour change communication can be conducted at different places such as at group-based activity sites (women's groups, marketing associations, microfinance clubs); at schools; at home during home visits; and community gardens or other gatherings specifically organized for training sessions.; at market places; and religious centers.
Community based nutrition behaviour change communication activities can be carried out by different groups of educators, and the collaboration of agricultural, health extension, and mass media workers, and volunteers groups maximizes effectiveness.

Summary

Nutrition behavior change communication is an effective intervention for dealing with much nutrition related problems at individual and community level. Nutrition behaviour change communication has been adapted as an effective intervention to improve dietary practices and life styles to improve nutrition and health status of communities. Enhanced knowledge of the behavior change communication process has facilitated the design of communications programs to reduce the risk of malnutrition and ill health by providing people with information and educating them how they can improve their behavior. Nutrition behaviour change communication intervention can be implemented as a standalone nutrition program or integrated to other programs. Nutrition behaviour change communication implemented in integration with programs in the health and agriculture sectors in terms of education, information, promotion and/or behaviour change is found to be more successful.

CHAPTER FIVE: MULTISECTORAL COLLABORATION FOR NUTRITION

Chapter Objective: The objective of this chapter is to enable learns discuss sectoral linkages and apply multisectoral collaboration for nutrition

Specific Objectives: At the completion of this chapter learners will be able to

- Describe the nutrition agriculture and health linkage
- Describe the effect of poor nutrition on health and vise-versa
- Explain the importance of nutrition to agriculture and vise-versa
- Explain the rational and importance of multisectoral collaboration for nutrition
- Apply multisectoral collaboration while working as community development agent for better nutritional outcomes of the community

Introduction

Nutritional problems and its determinants are very complex and multifaceted. Achieving nutrition security involves different interventions related to different sectors such as nutrition, agriculture, health, education, social protection, water & sanitation, and food industries. Interventions and approaches undertaken by a single sector such as health or agriculture will not be effective to achieve sound and sustainable nutritional improvements in the community. Combating

malnutrition and improving the nutritional status of a community therefore needs multisectoral action. This chapter will discuss the nutrition health, and agriculture linkages, the interplay of nutrition and health outcomes, and the importance of multisectoral collaboration for nutrition.

Nutrition Agriculture and Health linkage

Agriculture and health are the two broad sectors that contribute the majority of determinants of nutritional status. Nutrition is the bridge between agriculture and health. Good health outcomes such as reduced child and maternal mortality depend on good nutrition. Good nutrition in turn depends on agriculture for different foods for a balanced diet that meets our needs for energy, protein, vitamins and minerals. The linkage between agriculture and nutrition has reciprocal benefit. Citizens will not get balanced diet unless nutritious food availability, access, and affordability is ensured through diversified agricultural production. Agricultural growth and productivity will not be achieved with a working force having poor nutritional and health status. Farmers suffering from malaria, TB, HIV/AIDS and anaemia for example will not be strong enough to be productive in the farm. Children suffering from hunger and with ill health will not perform better in school. Poor access to safe drinking water, hygiene and sanitation will also influence the nutritional and health status, and agricultural productivity of communities.

Poor nutrition and Health outcomes

The pathway between poor nutrition and health status operates largely through a compromised immune system due to micronutrient deficiencies as well as growth failure.

- Vitamin A deficiency increases the incidence and risk of dying from measles, respiratory tract infections, and diarrhea.
- Other micronutrient deficiencies (zinc, iodine, and iron), also depress the immune system.
- Poor maternal nutrition during pregnancy can cause intrauterine growth restriction leading to low birth weight, and increased risk of infections, poor growth, and greater risk of onset of chronic diseases in adulthood
- Undernutrition can accelerate the severity of infectious disease, and the progression of HIV/AIDS.

Poor Health and Nutrition Outcomes

The reverse linkage from poor health to poor nutrition operates primarily through changes in metabolism, malabsorption, and appetite loss, as well as behavioral changes affecting feeding practices. At a systems level, access to and quality of health care and health insurance that covers basic services, for example, directly influences a child's health status and risk of death, which in turn affects nutrition through different pathways. Examples of interactions where poor health affects nutrition outcomes include the following

- Malaria frequently causes iron deficiency and anaemia
- Measles and diarrheal infections increase the body's vitamin A requirements and can precipitate severe forms of deficiency (e.g., blindness)
- Parasitic infections (e.g., hookworm) cause iron deficiency and anaemia; both bacterial and parasitic infections can reduce absorption of vitamin A from the gut

- Infections often suppress appetite and decrease the amount of food that is consumed, leading to lack of catch-up growth, weight loss, and micronutrient deficiencies
- Maternal infections and poor health (e.g., HIV/AIDS, depression) limit the ability of women to care properly for their children.

Importance of Agriculture Sector for Nutrition

Agriculture has a unique and critical role in improving nutrition outcomes. Agriculture's unique role in food production and consumption makes it indispensable sector for food and nutrition security. Improved agricultural productivity and food security are vital for nutrition security.

The following are some of the reasons explaining why agriculture is important sector for nutrition security.

A. Agriculture products food and affects consumption

Agriculture sector directly affects food production and consumption of nutritious foods needed for healthy and active lives. Physical and economic access to adequate and affordable nutritious food is primarily a function of the agriculture sector through increased production and improved post-harvest storage and processing.

B. Majority of undernourished people in the world is involved in Agriculture

Agriculture has the most direct influence on the majority of households in the world where undernourished individuals reside. Among the world poor peoples, 75% are rural, and most of those are smallholder farmers. Nutrition is one of the development activities of this population having an enormous potential to impact on factors that constrain human capital and well-being. For example, agriculture extension workers have direct and ongoing contact with smallholder farmers, and therefore have a unique opportunity to strengthen messages regarding consumption of nutritious foods.

C. **Agricultural growth is more pro-poor**

Agriculture-led growth and development is more pro-poor than non-agricultural-led growth; thereby increasing agriculture's potential to improve nutrition. Agricultural growth is at least twice as effective in reducing poverty as GDP growth originating outside agriculture and is therefore pro-poor. Agriculture-led growth has led to faster (though still insufficient) declines in undernutrition than non-agricultural growth.

D. **A large percentage of rural women are employed in the formal/informal agriculture**

Women contribute over 50% of the agriculture labor force in many developing countries. Agricultural interventions will have a large direct impact on nutrition outcomes for the entire household through increased discretionary income and reduced workloads for women.

E. **Some agriculture projects could cause unintended nutritional harm.**

Nutritional status of household members is strongly influenced by clean water, disease occurrence, food quality, and child care practices. Several unintended but related consequences, such as reducing women's available time for child care, have been documented as arising from some agricultural interventions.

Importance of Nutrition for Agriculture sector

Undernutrition is intimately linked with both poverty and smallholder farmer well-being and is a major constraint to rural development among farmers. When farmers are undernourished, they are less productive. Furthermore, undernourished children are less likely to attend school. These children in smallholder families are less likely to transition out of small-scale farming, and thereby fail to get out of the poverty trap. Improving nutrition can benefit agriculture sector performance at least in the following four ways:

A. **Improved nutrition means improved smallholder farmers well-being.**

Reducing malnutrition among the world's most vulnerable people is the main objective of poverty reduction programs of different international donor and civil society organizations. Most of these agriculture program and projects have the goal of improving the well-being of farmers and poor people living in rural areas, and this will be possible only when the nutritional status of the community members is improved.

B. Nutrition investments improve human capital and have a positive impact on agricultural productivity.

Smallholder farmers are often among the populations most likely to be malnourished. Women smallholder farmers, who form a majority of the agricultural labor force in many cases, are disproportionately likely to be malnourished. Undernutrition accounts for the majority of maternal and child deaths and this is naturally reflected in communities with poor agricultural productivity. Evidence shows that when farmers are malnourished, they are less productive. Iron deficiency anaemia results in lower work capacity. In an agricultural context, anaemia has been shown to reduce productivity by 17 %. Overall, malnutrition diminishes lifetime earnings by 10% or more, and reduces GDP by 2-3% in the worst affected countries. Investments in human capital, including nutrition, consistently have been shown to increase productivity.

C. Nutrition knowledge may be an added incentive for transition to a diversified production model.

Transition of households to diversified production is an often-cited goal for the agricultural sector to raise household income, minimize risk exposure, and promote ecosystem resilience. Nutrition education and information can be leveraged to improve both supply and demand for high-value vegetables, fruits, legumes, fish, and livestock products. Nutrition knowledge among farmers could be an additional incentive for farmers to diversify their production model to include nutritious, high-value crops, beyond the widely recognized incentives to reduce risk exposure to

weather, biotic stress, or price shocks. Additionally, nutrition knowledge among consumers can increase demand for high-value nutritious products substantially, and increase income for farmers who grow them.

D. **Nutrition sensitivity promotes agricultural productivity through better women participation and empowerment**.

Adopting a nutrition lens is likely to improve women's participation and empowerment, with important effects on income and productivity, in addition to nutrition and gender equity. Approximately half the world's farmers are women. In some countries, the ratio is much higher. In Southeast Asia, women supply up to 90% of the labor required for rice cultivation. Women account for 70% of farm labor and perform 80% of food processing in Africa.

Retaining female participation may improve if agriculture projects adopt nutrition sensitive approaches. Apart from their livelihoods, women farmers' main time demands come from infant and child care and feeding. Agricultural projects that do not account for women's major role in child care are likely to see female participation in projects flag. Structuring programs so women with small children can meet care needs for their children can increase female participation and improve project outcomes. If women had the same access to productive resources as men, they could increase yields on their farms by 20-30%, raising total agricultural output in developing countries by 2.5-4%, and reducing the global number of hungry people by 12-17%.

The Rationale, and advantages of Multisectoral Collaboration for Nutrition

As discussed in the first chapter malnutrition is caused by many different factors at different levels. To improve the nutritional status of a community all these factors at different levels should be addressed. Interventions implemented to address the immediate causes of malnutrition are called direct nutrition interventions or nutrition-specific interventions. While interventions implemented to address the underlying and the basic causes of malnutrition are called indirect nutrition interventions or nutrition-sensitive interventions. Nutrition-specific interventions include exclusive breast feeding, complementary feeding and micronutrient supplementations. Most of the nutrition-specific interventions are implemented by the health sector. Nutrition-sensitive interventions include different nutrition related activities implemented in different sectors such as agriculture, social protection, water and sanitation, industries etc.

Evidence shows that direct actions to address the immediate causes of undernutrition can be further enhanced by action on some of the more distal or underlying determinants. For example, in addition to supporting improved infant and young child feeding practices, addressing gender issues through health, agriculture or education programs can have a powerful impact in preventing undernutrition by reducing women's workloads and allowing them more time for child care. Similarly, in addition to providing micronutrient supplements to address micronutrient deficiencies, improving food security, and enhancing hygiene and environmental issues have been

shown to improve nutrition outcomes among children. Some of the nutrition-sensitive interventions in different sectors are listed below.

Nutrition Sensitive Interventions	Responsible Sector
Diversified and nutritious foods production for household consumption	Agriculture
Improved post-harvest handling and processing	Agriculture and Food Industries
Food fortification/Biofortification	Agricultural research, Food Industries, Health
Food for work and conditional cash transfer	Social Protection
Improved access to safe drinking water	Water Resources
Improved child and maternal care	Health, Women's Affairs
Improved access for health care and sanitation services	Health
Nutrition education and behaviour change communication	Education , Health, Others
Girls education and women empowerment	Education, Others

Nutrition interventions in general and nutrition-sensitive interventions in particular require different sectors to work together. Multisectoral collaboration for nutrition is therefore an approach designed to effectively address the determinants of malnutrition.

Multisectoral collaboration is the process for organisations to work together to efficiently and effectively achieve a common goal. While working in collaboration the collaborating sectors will exchange information, alter activities, share resources and enhance each other's capacity, for

mutual benefit and a common purpose, by sharing risks, responsibilities and rewards. The concept of multi-sectoral collaboration for nutrition is globally approved strategy. Different sectors will collaborate to define the desired nutrition objectives, intervention, and approaches, and then each sector will be responsible for the implementation of its own sector specific interventions. Based on the nutrition targets and indicators of each sector the progress and achievement of interventions will be monitored and evaluated multisectorally. The principle of multisectoral collaboration for nutrition is therefore "think multisectorally, act sectorally". Nutrition is not prioritized in different development sectors because policymakers see it as an outcome, not an input into human and economic development.

Interventions aimed at improving diets and community nutritional status should combine public health, nutrition education and dietary strategies. Agriculturalists need to work with nutritionists to identify deficits in local diets and micronutrient intakes. Food-based interventions such as dietary diversification will be more effective when accompanied by community health programmes.

Multisectoral actions can strengthen nutritional outcomes in three main ways: (1) by accelerating action on determinants of undernutrition; (2) by integrating nutrition considerations into programs in other sectors which may be substantially larger in scale; and (3) by increasing "policy coherence" through government-wide attention to policies or strategies and trade-offs, which may have positive or unintended negative consequences on nutrition.

Summary

Prevention of malnutrition and ensuring nutrition security will not be achieved by the action of a single, or few sector. The complex causes of malnutrition will be addressed with the consorted efforts, and interventions of agriculture, nutrition, health, social protection, health, and other sectors. Poor nutritional status negatively affects the health status of the community members which in turn negatively affect the productivity and wellbeing of that community. Agriculture is the source of food nutrients required by human body. Failure in agricultural productivity will end up with poor nutritional status of a community. Malnourished community members will be less hard working and less productive both in agriculture productivity, and other development endeavors. Agriculture, health, education, and social protection sectors should work in close collaboration, and should be nutrition sensitive. Multisectoral collaboration for nutrition is an approach designed to improve the nutrition status of the community members through an integrated and nutrition sensitive interventions.

CHAPTER SIX: NUTRITION PROGRAM PLANNING IMPLEMENTATION, MONITORING, AND EVALUATION

Chapter Objective: The objective of the chapter is to enable students assist in planning, implementation, monitoring and evaluating nutrition interventions integrated in agricultural activities using appropriate methods and tools with emphasis on nutrition sensitive production and improving utilization

Specific Objectives: At the completion of this chapter students will be able to:

- Describe basic steps for planning for nutrition interventions
- Identify nutritional problems and plan for mitigation in line with agricultural programs
- Describe the nutrition implementation approaches as integrated in agriculture programs
- Mobilize stakeholders to implement planned nutrition interventions in line with agricultural programs
- Describe monitoring and evaluation methods and basic tools used for monitoring and evaluation of nutrition interventions
- Identify and use nutrition-sensitive production indicators with routine agricultural activity monitoring and evaluation tools
- Collect, analyze and interpret data related to nutrition-sensitive production and promotion

Introduction

Nutrition sensitive agricultural interventions are designed and implemented to improve the nutritional and health status of the community through production and utilization of variety foods. Thus, the effectiveness of nutrition interventions is crucial to the well-being of the affected population. Monitoring interventions and periodic evaluation are vital activities to ensure an intervention is meeting its intended objectives and is having the desired effect. Good monitoring & evaluation also helps to identify best practices and lessons learned to strengthen future interventions. Nutrition program management at the community level involves nutrition interventions planning, implementation and monitoring and evaluation. This chapter will discuss steps of planning nutrition sensitive interventions, selecting implementations approaches, and monitoring and evaluation of nutrition interventions.

Nutrition interventions planning

Planning appropriate community based nutrition interventions requires the participation of development workers from agriculture, health, water and sanitation, and other sectors. Before starting to plan nutrition programs, the planners should clearly understand the contemporary evidence based nutrition interventions. The agriculture development workers should actively participate in the community based nutrition interventions planning, and implement and monitor these programs.

Step 1- Analyzing the situation: Identifying the main nutritional problems, and Reviewing existing nutrition interventions

The planning of nutrition or any other type of development intervention starts with an analysis of the situation. The purpose of situational analysis is to identify the needs, interests, priorities and resources in the community of interest. The analysis begins with general nutrition related situations in the community and identification of stakeholders. Using appropriate data sources, the planning team involving relevant stakeholders should analyze the nutritional status of the different segments of the target community with particular emphasis on children and women. The planning team should identify the nature of the prevailing nutrition problems (energy and protein deficiency, micronutrient deficiency or overweight and obesity in the community. The population groups which most from these problems should also be identified, e.g., smallholder farm families, landless laborers, women-headed families, Orphan and vulnerable children etc.

Child nutritional status can be assessed using stunting, wasting and underweight rates, and number of severely acute malnourished children in the targeted community. Data from Growth Monitoring and Promotion (GMP) can be used to assess child malnutrition status. Anthropometric data may also be used. The nutritional status of women can be assessed using data on the percentage of undernourished and anaemic reproductive age groups. The vitamin A, iron and iodine deficiency status of the community should also be assessed. At the conclusion of this step the most important nutritional problems are identified

Step 2- Cause Analysis

In order to address the identified nutritional problems, the causes of these problems should be identified. Identifying the household food security status, child and maternal feeding practices, community and health-facility based nutrition service provision will help to identify the immediate and underlying causes of the nutritional status of the target community.

Step 3- Setting Objectives and Targets

Based on the identified causes of the prevailing nutritional status of the target community, the planning group will propose solutions which will be translated in to objectives. The nutritional problems identified as negative situations in step one will be changed in to positive situation and this positive situation will be set as objectives to be achieved through interventions to be implemented.

Step 4- Reviewing existing nutrition interventions

The nutrition interventions and approaches implemented in the community, and the responsible sectors and organizations should be identified. The planning team should review and identify the nutrition specific and nutrition sensitive interventions (services) both at health facility and community levels including the targeted groups. The planning team should also be well aware of the national nutrition strategy and program directions. This will help the decision whether to strengthen or modify the existing interventions or to plan for new ones. This will help the planning team to map the existing capacity of local nutrition services at the community and facility level to inform subsequent decision making on appropriate nutrition approaches.

Step5. Selecting interventions and setting implantation strategies (Approaches)

Based on the objectives to be achieved, and the national/regional nutrition policy directions the planning team will select appropriate direct nutrition specific and indirect nutrition sensitive interventions and design implementation approaches. This step will result in list of all potential preventative and curative approaches that could be considered based on an analysis of the needs and resources in the target area.

Nutrition Interventions Implementation Approaches

Identifying the appropriate nutrition implementation support groups will help for program effectiveness. After the priority nutrition actions and services are identified, the planning team should select the appropriate community based nutrition support group that will promote and facilitate the implementation of the interventions. Tasks and responsibilities has be defined and assigned to each support group. To insure the effectiveness and sustainability of the interventions, the planning team should ensure the active participation of community level social and political leaders and women's groups. The involvement and participation of other groups such as mothers group, farmers' cooperatives, schools, and water and sanitation committees will play significant role for the successful implementation of the community based nutrition intervention. An effective

strategy should be designed to foster responsibility, commitment, and accountability and communication among the key partners such as health facilities, community institutions, and external organizations.

Monitoring and Evaluation of nutrition sensitive interventions

Monitoring is the systematic and continuous assessment of the progress of a piece of work over time…It is a basic and universal management tool for identifying the strengths and weaknesses in a programme. Its purpose is to help all the people involved make appropriate and timely decisions that will improve the quality of the work. It is conducted to check whether the implantation progress is on the right truck or not. The information obtained from monitoring is usually used to take corrective measures such as activity revisions and verifies targeting criteria. The implementation of the program/project will be modified based on the existing contextual situations. Monitoring is conducted to direct the implantation towards achieving the desired objectives.

Evaluation is defined as the systematic and objective assessment of an ongoing or completed intervention, programme or policy, its design, implementation and results. The aim is to determine relevance and fulfilment of objectives, as well as efficiency, effectiveness, impact and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons learned for future decision making. Evaluation attempts to link a particular output or outcome directly to an intervention after a period of time has passed.

An evaluation is usually carried out at some significant stage in the project's development, at the middle of the project life and at the end of programs. Measuring the nutritional outputs and outcomes of agricultural interventions

In order to be effective monitoring and evaluation activities should be participatory. All stake holders including the direct program targets should involve in the monitoring and evaluation processes. Stakeholder should be well aware of the indicators and targets against which monitoring and evaluation data will be collected. Indicators are variable that can be measured to assess the nutritional status of individuals/ households directly or indirectly.

Measuring nutritional outputs and outcomes of the agricultural programs will help to ensure the nutrition sensitivity of the agriculture programs. Explicit nutrition objectives and interventions should be accompanied by indicators to measure progress at the output, outcome, or impact levels. Monitoring and evaluation of the nutritional impact of agricultural programs is usually considered difficult, and even some times impossible. But it is quite possible if appropriate nutrition related indicators are incorporated during the planning phase. Nutritional status at the community level is measured with anthropometric or biochemical indicators. The impact of nutrition interventions at the community level can most directly be measured by using anthropometric or biochemical indicators. Collecting anthropometric or biochemical indicators, however, would require additional training and resources, such as medical equipment. It also requires large sample size

and long term implementation period to observe a difference in these indicators. Therefore, attempts to measure effects on anthropometry may not be appropriate in all circumstances.

Using Food Consumption Indicators

The success of nutrition interventions in the agriculture programs can easily be measured by incorporating food consumption indicators. Food consumption indicators have been developed to measure dietary quality without having to conduct a full food intake survey, which would be costly and cumbersome to administer. Simple household food consumption indicators can be constructed based on nature of the nutrition interventions. For nutrition intervention implemented in line with agricultural interventions for example indicator such as percent of produced food consumed, number of days in the previous week where any amount of that food was consumed, percent change in grams/day of the food consumed can be assessed to measure the quantity and quality of different foods in the household.

Food consumption indicators could be employed by agricultural projects to capture nutritional outcomes. Collecting data on food consumption does not require special resources like the anthropometric or biochemical measures except some additional training of the monitoring and evaluation staff. Therefore, for agricultural projects, using such consumption indicators is a practical option to provide relevant information about the nutrition-related impacts of nutrition sensitive agricultural programs. For example, dietary diversity scores are simple to collect at the household level (to indicate food access), or at the individual level (to indicate dietary quality). Other indicators, such as the Household Hunger Scale (HHS) are useful indicators of household food security. Another food security indicator, Months of Adequate Household Food Provisioning (MAHFP), can also be useful to indicate year-round continuity of food security.

By monitoring tools we usually collect information on output and outcome indicators and by evaluation tools we collect information on outcome and impact level indicators. Indicators at the output level include days of nutrition education provided to beneficiaries, number of households trained on homestead production, amount of fruits and vegetables produced per households, etc. However, at the outcome level, measurement of changes in food consumption is an important step to determine if projects have positive effects on diet and food security, given that a major pathway of nutrition impact for agricultural projects is through food consumption effects, either by household production or through market purchase

There are several food consumption indicators developed for different purposes. The Dietary Diversity Score (DDS) and the Food Consumption Score (FCS) measure dietary quality, the MAHFP measures continuity of food access and the adapted HHS measures the subjective experience of food insecurity.

1. The **Dietary Diversity Score** consists of a simple count of the different food groups that a household or an individual has consumed over the preceding 24 hours. The household dietary diversity score is meant to reflect household access to a variety of foods, while individual scores are meant to reflect nutritional quality of the diet. The dietary diversity

scores have been validated for several age and sex groups, e.g., infants between 6-23 months, and women between 15-49 years old, as a measure for micronutrient adequacy of the diet.

2. The **Food Consumption Score** is a composite score based on dietary diversity, food frequency, and relative nutritional importance of different food groups consumed by the household, which can be used as a proxy measure of food security. Information about frequency of consumption (in days) by a household over a recall period of the past seven days is collected from a country-specific list of food groups. The food consumption score has been validated against per capita calorie consumption, and several alternative indicators of household food security such as percentage expenditures on food, asset, and wealth indices.
3. **Months of Adequate Household Food Provisioning** measures household food accessibility throughout the past year, and reflects the seasonality aspect of food security. It captures changes in the household's ability to address vulnerability in such a way as to ensure that food is available above a minimum level the year round. It has been incorporated as a standard impact indicator in all many African food security programs.

4. The **Household Hunger Scale** is a measure of the degree of food insecurity (i.e., access) in the household over a recall period of four weeks: the higher the score, the more food insecure the household. This indicator has demonstrated the potential for both internal and external validity, and has been shown to have a strong relationship with household income and wealth scores.

Summary

Nutritional problems of a certain society are addressed by designing appropriate nutrition specific and nutrition sensitive intervention, and implementing them using the appropriate stakeholders, and approaches. Based on the nature of the problem analyzed, the stakeholders at the community and higher level will plan and design different nutrition interventions. Clear understanding of the objectives and intervention approach, and active participation of all the stakeholders at the Community level is important for the successful implementation of the nutrition interventions, and achievement of the desired objectives. Monitoring of the implementation progress of the nutrition interventions provides information based on which corrective measures and adjustments will be made. Evaluation is conducted to assess the effectiveness and outcome, and impacts of the nutrition intervention implemented at a certain period of time. Program evaluation results usually provide lessons for future decision making.

CHAPTER SEVEN: APPLYING PROFESSIONALISM AND ETHICS IN PROMOTING NUTRITION

Chapter Objective: The objective of this chapter is to enable learner apply professionalism and ethics while promoting variety food production and utilization.

Specific Objectives: At the completion of this chapter learners will be able to

- Identify the contextual and cultural situation of the community
- Identify the existing tradition related to nutrition in the community
- Identify the existing food taboos repeated to maternal. Child and adolescent nutrition

Introduction

In addition to programmatic factors such as the design, implementation, and/or management of the program or project, which are easily influenced by program managers, the effectiveness and success of community-based nutrition interventions is also affected by different contextual, cultural and factors. The contextual factors that affect community based nutrition interventions include, for example, high literacy rates, women's empowerment, community organizational capacity and structures, appropriate legislation.

Influence of Contextual and cultural factors on community based nutrition interventions

Culture is the complex set of beliefs of human societies; their roles, behavior, values, customs, and traditions. Cultural factors greatly contribute for the effectiveness and success of community based nutrition interventions particularly of nutrition education and behaviour change communication activities. In addition to the way people dress and interact each other, cultural factors also exert the broadest and deepest influence on food production, handling and preserving, marketing

strategies, consumer behavior, and feeding practices in a certain community. Culture influences food consumption through the norms and values established by the society in which they live.

Feeding and dietary practices of a community are closely linked to the culture of that community. Culture influences what and how people eat. It has a broad influence on their buying and utilization behavior of food products and services, and the extent of their satisfaction. Cultural beliefs and food taboos of the community will affect the way families practice child and maternal feeding and care. The nutritional status of children, adolescents and mothers in general and that of the community members in general is highly dependent of cultural beliefs and food taboos.

The cultural factors, and the way they interact, need to be identified in order to understand the dynamics behind success.The development workers and nutrition intervention implementing partners need to consider and clearly understand the contextual and cultural factors in the community. In promoting and assisting diversified foods production and consumption development extension workers should work in line with the contextual and cultural factors. Useful traditional feeding practices should be identified, acknowledge and promoted. Harmful feeding practices and food taboos that hinder optimal child and maternal nutrition should also be identified and addresses through behaviour change communication.

References: