

, Wollo University
College of Agriculture
Department of Animal science

Course Name: Nutrition Sensitive Agriculture, AnSc 4216

Program: B.Sc. Animal Science

ECTS/Cr.Hr: 5/(3 Crhs)= 2+1

Target Group: Animal Science 3rd Year

Academic Year 2020 Semester: II

Meeting Day _____ Meeting Time: _____ Meeting Location/Room: _____

Way of delivery: Semi-block

Course coordinator: Name: Tolosa Taye Phone No: +251917287256

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Student Workload

- | | |
|----------------------------|------------------|
| • Lecture: 32 | • Home study: 50 |
| • Tutorial: 10 | • Total: 140 |
| • Practice/field works: 48 | |

Pre-requisite course

Principles of Animal Nutrition, Applied Animal Nutrition and Feed Processing, General Micro Biology, Food Hygiene and Veterinary Public Health, and Livestock Products Processing Technology

Course Status: Basic/Core

Course Description

This course is designed to equip agriculture students with the basics of human nutrition and the various nutrition sensitive agricultural practices. The course will enable them to design and implement nutrition sensitive agricultural programs, promote and assist production and consumption of diversified foods, and contribute for improvement of the nutritional status of mothers, children and the public at large.

Course main objective

At the end of this course, students will be able to apply the basics of human nutrition and its relation with gender and demonstrate nutrition sensitive agricultural practices through multi-sectoral approach.

Course specific objectives

At the end of this course, the students will be able to:

- Apply the basic principles of human nutrition
- Explain the life cycle approach of human nutrition
- Assist production and household consumption of diversified and nutritious foods
- Apply safe production and post-harvest handling techniques including preservation and processing of animal origin foods
- Analyze community level food production and consumption trends
- Describe the role of the agriculture sector in nutrition interventions in terms of nutrition-sensitive production and consumption
- Describe good agricultural practice (GAP) and good hygienic practice (GHP)
- Describe concepts and principles of hazard analysis critical control point (HACCP)
- Identify the effect of post-harvest handling, processing and preservation on nutrient content of foods
- Discuss the role of gender in food production and consumption
- Explain the importance of empowering women farmers on nutrition sensitive production and consumption with appropriate technologies
- Promote and assist in accessing of labor, time and energy saving technologies to reduce women workload
- Identify SBCC strategies and tools, food taboos, aversions and cravings that contribute to malnutrition for successful nutrition promotion
- Explain use of nutrition promotion to improve nutritional status of individuals and groups through basic nutrition-sensitive production, utilization trends, diversification and food safety practices
- Plan nutrition interventions jointly with other nutrition stakeholders in feasible agricultural activities by respecting their boundaries
- Monitor and evaluate implementation of nutrition sensitive agriculture interventions and its impacts on the community

Topic/ Sub topic

1. Introduction to Human Nutrition

- 1.1. Introduction
- 1.2. Definition of basic terms
- 1.3. Nutrients and their functions
- 1.4. Food groups and their sources
- 1.5. Food and nutrition security
- 1.6. Malnutrition
 - 1.6.1. Definitions and basic concepts
 - 1.6.2. Courses of malnutrition
 - 1.6.3. Forms of malnutrition
 - 1.6.4. Status of malnutrition in Ethiopia
 - 1.6.5. Impacts of malnutrition
- 1.7. Nutrition intervention strategies to combat malnutrition

2. Diversified Agricultural Food Production and Consumption

- 2.1. Introduction
- 2.2. Definitions and concepts
- 2.3. Nutritional benefits of plant and animal origin foods
 - 2.3.1. Nutritional value of plant source food
 - 2.3.2. Nutritional value of animal source food
- 2.4. Importance of consumption of diversified foods
- 2.5. Dietary Diversification strategies
 - 2.5.1. Diversified food production strategy
 - 2.5.2. Reducing post-harvest loss and improve post-harvest process
 - 2.5.3. Nutrition education
 - 2.5.4. Income generation
- 2.6. Factors to be considered in the diversification of food production and consumption
- 2.7. Nutrient Enrichment/ Modification strategies
 - 2.7.1. Food fortification
 - 2.7.2. Bio fortification
- 2.8. Agriculture-Nutrition Impact Pathways
 - 2.8.1. Food production pathways
 - 2.8.2. Agriculture income pathways
 - 2.8.3. Women's empowerment pathways

3. Safe Production and Post-Harvest Handling of Animal Origin Foods

- 3.1. Introduction
- 3.2. Safety of Agricultural Products
 - 3.2.1. Definition of food safety and related terms
 - 3.2.2. Food quality versus food safety
 - 3.2.3. Food safety hazards
 - 3.2.4. Safety and Quality Management Systems
 - 3.2.5. Food safety and nutrition linkage
- 3.3. Postharvest Handling
 - 3.3.1. Basic principles of post-harvest handling
 - 3.3.2. Postharvest loss
 - 3.3.3. Causes of postharvest losses
 - 3.3.4. Post-harvest losses of animal source food
 - 3.3.5. Impacts of postharvest loss on food and nutrition security

3.3.6. Pre and post-harvest food safety problems and associated health risks

4. Gender and Nutrition

- 4.1. Introduction
- 4.2. Basic gender related terminologies
- 4.3. Gender role in food production and consumption
- 4.4. Gender equality and equity for nutrition
- 4.5. Empowering women in food production and consumption
 - 4.5.1. Women's access and control over assets
 - 4.5.2. Labor, time and energy saving technologies for women
 - 4.5.3. Involvement of male in feeding and caring practices

5. Social Behavioral Change Communication (SBCC) for Nutrition

- 5.1. Introduction
- 5.2. The Culture of Food Consumption in Ethiopia
 - 5.2.1. Food Preferences and Nutrition
 - 5.2.2. Food Taboos and Nutrition
 - 5.2.3. Food sharing among family members
- 5.3. Nutrition Education, Counseling and communication
- 5.4. Nutrition Behavioral Change Communication (NBCC)
- 5.5. Tools for nutritional behavioral change communication
- 5.6. Nutrition Extension through SBCC/NBCC

6. Multi-Sectoral Collaboration for Nutrition

- 6.1. Introduction
- 6.2. Multi-sectorial nature of nutrition
- 6.3. Ethiopian National Nutrition Programs
- 6.4. Roles and responsibilities of various sectors
- 6.5. Role of agriculture and livestock sector in NNP II
- 6.6. Strengthening Multi-sectoral coordination

7. Planning, Monitoring and Evaluation of Nutrition Sensitive Agriculture Interventions

- 7.1. Introduction
- 7.2. Basic principles of planning for NSA interventions
 - 7.2.1. Program principles
 - 7.2.2. Policy principles
- 7.3. Monitoring and evaluation indicators for NSA activities

Mode of delivery/Teaching and learning methods:

Interactive lecture
Group work
Brainstorming
Case study
Lab
Field trip
Role-play
Reading assignment
Demonstration
Project work

Assessment Methods

- Continuous Assessment ($\geq 50\%$)

Assessment types

- Test
- Quiz (Assignment) & Final Exam. ($\leq 50\%$)
- Project work
- Practical test /Demonstration, interview / others
- Final exam

Course Policies

Preparedness: All students should get with necessary materials

Participation: Class participation has its own value. Therefore, the student should participate actively in the class.

Class/Practical Attendance: The student who didn't attend the class more than 20% will not sit on final exam

Examination: Tests/quizzes/assignments/lab reports: all students must sit/take all tests/quizzes/ assignments/ lab exercise given.

Cheating: The students should be aware that both obtain or attempt to obtain information from another Student and giving improper assistance during quizzes or examinations constitutes academic dishonesty. i.e. cheating is strictly forbidden. No mobile phone, books, papers or other items will be allowed at students' desks during a test or final exam is given. No Student shall represent or attempt to represent him or herself as another or have or attempt to have himself or herself represented by another in the taking of an examination, preparation of a paper or other similar activity.

Plagiarism: It will lead the student grade invalid.

References

1. Synthesis Of Guiding Principles On Agriculture Programming For Nutrition, FAO 2013
2. Compendium of indicators for nutrition-sensitive agriculture, FAO 2016
3. Designing nutrition-sensitive agriculture investments, Checklist and guidance for program formulation, FAO 2015
4. Ending Malnutrition from commitment to action, FAO 2015
5. Improving Diets and Nutrition, Food-based Approaches, FAO 2014
6. Milk and Dairy Products in Human Nutrition, FAO 2103

Approval Section

Prepared by instructor

Name: Tolosa Taye

Signature: _____

Date: 09/03/2020

Approved by department head

Name: _____

Signature: _____

Date: _____

Chapter 1: Basics of Human Nutrition

1.1. Introduction

The science of nutrition is the study of the nutrients and other substances in foods and the body's handling of them. Its foundation depends on several other sciences, including agriculture, biology, biochemistry, and others. Human nutrition is a complex, multifaceted scientific domain indicating how substances in foods provide essential nourishment for the maintenance of life. To understand, study, research, and practice nutrition, a holistic integrated approach from molecular to societal level is needed. Optimal, balanced nutrition is a major determinant of health. It can be used to promote health and well-being, to prevent ill health and to treat disease. The hundreds of millions of food- and nutrition-insecure people globally, the coexistence of under-nutrition and over nutrition, and inappropriate nutritional behaviours are challenges that face the nutritionist of today. Nutrition practice has a firm and well-developed research and knowledge base. Therefore, this chapter can be used as a tool to bridge theory and practice of nutrition and to stimulate discussions to link agriculture with nutrition. It summarizes the holistic understanding of human nutrition.

1.2. Definitions of basic Terms

Nutrition: is the science of foods, the nutrients, and other substances they contain, and of their actions within the body (including ingestion, digestion, absorption, transport, metabolism, and excretion).

Foods: Any substance, consisting essentially protein, carbohydrate, and fat used in the body of an organism to sustain growth, repair, and vital process and to furnish energy; also together with supplementary substances (as minerals, vitamins and condiments).

Diet: is the foods and beverages a person eats and drinks.

Meal: is an eating occasion that takes place at a certain time and includes specific, prepared food, or the food eaten on that occasion.

Energy: the capacity to do work. The energy in food is chemical energy. The body can convert this chemical energy to mechanical, electrical, or heat energy.

Nutritional requirement: refers to the different nutrients required by the body for energy, growth and repair, as well as protection from disease. Nutritional requirements differ according to age, gender, physical activity, height, weight, and health status of the individual. **Nutritional status** of an individual person results from nutrient intake, nutrient requirements, and the body's ability to digest, use and absorb the nutrients that are ingested.

Nutrition Assessment: a comprehensive analysis of a person's nutrition status that uses health, socioeconomic, drug, and diet histories; anthropometric measurements; physical examinations; and laboratory tests.

Nutrition specific interventions: are interventions or programs that address the immediate determinants of fetal and child nutrition and development. Adequate food and nutrient intake, feeding, care giving and parenting practices, and low burden of infectious diseases are parts of nutrition specific interventions.

Nutrition sensitive interventions: programs that address the underlying determinants of fetal and child nutrition and development. Food security; adequate care giving resources at the maternal, household and community levels; and access to health services and a safe and hygienic environment are incorporated in nutrition sensitive goals and action.

Nutrition sensitive agriculture: Nutrition-sensitive agriculture is a food-based approach to agricultural development that puts nutritionally rich foods, dietary diversity, and food fortification at the heart of overcoming malnutrition and micronutrient deficiencies.

1.3. Nutrient and their functions

Nutrients: are chemical substances obtained from food and used in the body to provide energy, structural materials, and regulating agents to support growth, maintenance, and repair of the body's tissues. Nutrients may also reduce the risks of some diseases. There are two types of nutrients: Macronutrients and micronutrients. **Macronutrients:** are nutrients required in a large amount and they provide the bulk energy an organism's metabolic system needs to function. Macronutrients include carbohydrates, proteins and fats. **Micronutrients:** are nutrients required in a small amount and provide the necessary co-factors for metabolism to be carried out and include vitamins and minerals. Micronutrients are very important for normal growth and maintain health of human body. Based on function and source there are six different types of nutrients:

1. Carbohydrates – are what our body burns most often for fuel, much like firewood. They are used in the body to provide the first source of energy. Cereal, grains, legumes, fruits and vegetables are the main source of carbohydrates.

2. Proteins - are the building blocks of the body tissue, and can also serve as a fuel source. They build the walls of our body (hair, skin, muscles, etc), just like bricks build our home. Meat, egg, poultry, milk, fish and legumes are main source of protein.

3. Fats - are also burned for energy and they give more fuel and are easy for our bodies to store for later use. Fats have twice as many calories as proteins or carbohydrates. This is much like paraffin in our homes; it is stored in a small jug and a little fuel goes a long way. They also help the body absorb vitamins. Fish, butter, beef, egg, pork, milk, fruits such as avocado, nuts and soybeans are good source of fat.

4. Vitamins- are essential for normal growth and health. They are like watchdogs, which protect us from thieves while vitamins in our body protect us from diseases. They are required in small quantities in the diet because the body cannot synthesize them. Most vegetables and fruits are good source of vitamins. Based on solubility, there are two types of vitamins:

i. Fat-soluble vitamins:

They are digested and absorbed with the help of fats those are in the diet.

They can be stored in the body for long periods.

They are soluble in fat and this group includes vitamin A, D, E & K

Table 1.1: Vitamins sources and functions

<i>S.No</i>	<i>Vitamin</i>	<i>Source</i>	<i>Function</i>
1	Vitamin A	<ul style="list-style-type: none"> – Dark green and yellow fruits and vegetables. – Butter, eggs, milk, liver of beef, pork, chicken, and fishes – Orange flashed sweet potato (OFSP) and Yellow maize 	<ul style="list-style-type: none"> – Needed for strong bones, good vision and healthy skin. – Plays a role in immune function, promotion of growth and skin health. – Protection of surface tissue
2	Vitamin D	<ul style="list-style-type: none"> – Foods are also considered as good source of vitamin D – Sunlight 	<ul style="list-style-type: none"> – Helps calcium and phosphorus to form straight, strong bones and teeth.
3	Vitamin E	<ul style="list-style-type: none"> – Vegetable oils, cereals, meat, poultry, eggs, fruits, vegetables, and wheat germ oil. 	<ul style="list-style-type: none"> – antioxidant activities
4	Vitamin K	<ul style="list-style-type: none"> – Green leafy vegetable 	<ul style="list-style-type: none"> – Reduce the risk of bleeding.

ii. Water-soluble vitamins

✓ They are water-soluble and not stored in the body for long, therefore, good sources of vitamin B and C should be eaten every day. Vitamins in this group include vitamin **B & C**.

Vitamin B: helps to maintain healthy skin, a well-functioning nervous system and helps to convert carbohydrates into energy.

Vitamin C or ascorbic acid: is needed for building the connective tissue that holds body cells together. Vitamin C is essential for healthy teeth, gums and blood vessels. It also helps the body to absorb iron. Vitamin C deficiency will result in scurvy. Citrus fruits are good sources of vitamin C.

5. Minerals - are nutrients such as iron, calcium, iodine, zinc and magnesium that are important for normal body growth and health. Animal and plant food sources provide most of the essential minerals.

Table 1.2: Public health important minerals

S.No.	Mineral	Source	Function
1	Iron	Hem iron (Highly bio-available) – Animal products like red meat and liver – Non Hem iron (Less bio-available) – Plant products (Pulses, Cereals)	Part of hemoglobin, a protein which carries oxygen from our lungs throughout our bodies
2	Iodine	– Iodized salt – Sea foods, vegetables grown near the sea	Participate in regulation metabolic rate, reproduction, growth, blood cell production, nerve and muscle function
3	Zinc	Meat	Cofactor by more than 100 enzymes – stabilizes cell membranes, helping to strengthen their defense against free-radical attacks – Assists in immune function and in growth and development

6. Water - is needed for most body functions, including maintenance of health and integrity of every cell in the body.

1.4. Food groups and their sources

A low-income people consume only one or two types of mostly staple foods. However, consumption of diversified foods is important for health, proper growth and development. There are a number of food classifications containing five, six, seven and ten food groups according to different literature. The basis for the classification is mainly on the nutritional needs of population group. Here in this chapter we will see the six-food group classification, which is adopted from FAO food group classification (Fig 1.1).

i. Staples: This food groups are basic sources of energy. Foods in this category include cereal grains such as sorghum, millet, maize, barley, oats, wheat, teff, rice and starchy roots (inset, cassava, sweet potato and potato).

ii. Legumes and nuts: This group includes beans (like faba, haricot and kidney beans), lentils, peas, chickpeas, groundnuts and soya beans. Apart from soybean and groundnut, which is rich in oils and fats, they provide mainly protein and are important for growth, repair and bodybuilding.

iii. Animal source foods: All animal origin foods such as meat, poultry, eggs, milk and milk products and fish. They provide protein, fats, vitamins and minerals. They help the child to grow, have strong bones and be health.

iv. Vegetables: includes green leafy, yellow, and orange vegetables such as cabbage, kale, green pepper, pumpkin, onion, tomato, carrot, spinach, cauliflower, lettuce, celery, cucumber, eggplant, broccoli, and others such as mushroom. They provide mostly vitamins, minerals and water. They also contain fibers that are necessary for proper digestion and healthy bowel movement.

v. Fruits: citrus fruits (oranges, lemons and mandarins), bananas, papaya, mango, avocado, pineapple, apple, guava, watermelon, grapes, peach, sweet melon and many other indigenous fruits. Fruits provide mostly carbohydrates, vitamins, minerals and water.

vi. Fats: includes fats from plant and animal origin. Fats and oils from plants are oilseeds (soybean, linseed, and groundnut). Fats provide an additional energy, essential fatty acids and fat-soluble vitamins.

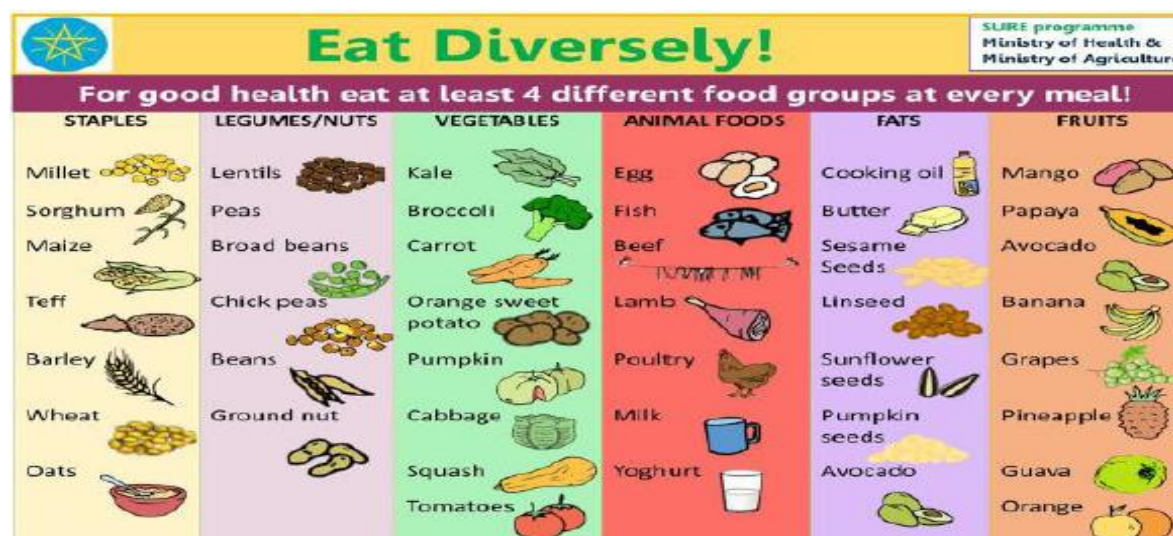


Figure 1.1: Six food classifications (adopted from FAO food classification)

There are foods unclassified in this food groups and not desired for diet diversification. These are mainly processed foods such as biscuits, various kinds of sweets and alcohol. Industrial food processing in most cases refines or modifies natural foods and makes them nutrient dense by removing natural components like fibers. They also have more undesired nutrients like salt, sugar and fats in excess to enhance their flavor and taste for market purpose.

1.5. Food and nutrition security

✓**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.

✓**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. The overlap between food and nutrition security is shown in Figure 1.2.

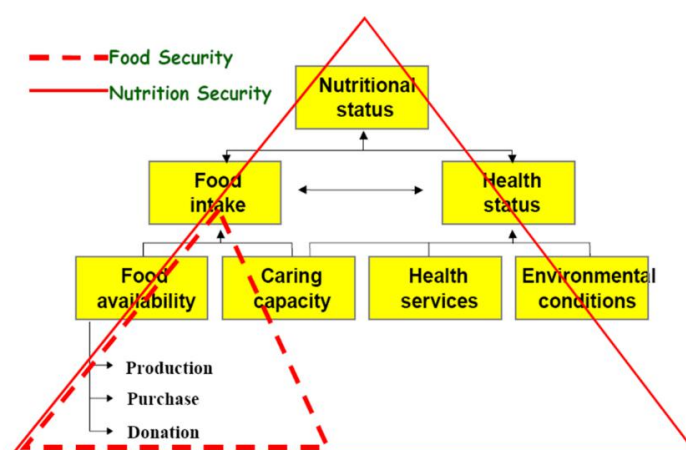


Figure 1.2. Conceptual frameworks for food and nutrition security

Food and Nutrition security: Food and nutrition security exists when all people at all times have physical, social and economic access to food, which is consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life.

1.6. Malnutrition

1.6.1. Definition and basic concepts of malnutrition

Malnutrition refers to abnormal nutrition condition, both under-nutrition and over nutrition. While majority of developed countries suffer from problems related over-nutrition, developing countries suffers from the double burden of under-nutrition and over-nutrition. Currently it is considered the leading cause of child mortality. The global community is urging for prevention of under-nutrition 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 during this period has the greatest effect on child health, growth and development. If under-nutrition occurs during this period, the damage on child physical and cognitive development will be irreversible.

1.6.2. 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 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.

Immediate Causes of Malnutrition

Inadequate dietary intake and diseases are the most significant immediate causes of malnutrition. An individual will get malnourished either due to inadequate dietary intake or infection of diseases, or both at the same time.

Underlying Causes of Malnutrition

These causes are context-specific and classified into 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).

Basic Causes of Malnutrition

This includes economic, technological, political, cultural, and institutional structures and processes, the means of control of physical resources, and the level of human development. The three categories of causes of malnutrition function synergistically with each other (Fig 1.3).

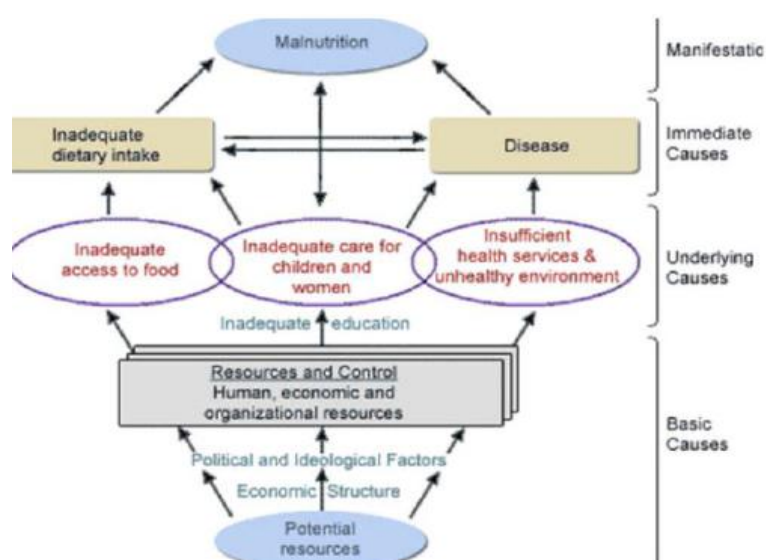


Figure 1.3 Causal framework of malnutrition

1.6.3. Forms of Malnutrition

In general, malnutrition can be classified into:

1. Under nutrition

Protein-energy malnutrition: arises due to inadequate intake of calories from macronutrients: Carbohydrates, fats and proteins.

Micro-Malnutrition (Hidden Hunger) refers to mineral and vitamin deficiency such as iron, iodine, and vitamin A.

2. Over-nutrition

Overweight and obesity

Health consequences (diabetes, cardiovascular diseases)

3. Co-existence of under and over-nutrition: “double burden of malnutrition”

Obesity and protein-energy malnutrition (PEM) in the same family

Obesity and micronutrient deficiencies in the same individual

4. Chronic and acute malnutrition

Malnutrition results from inadequate intake of nutrients and/or from disease factors. Protein energy malnutrition, iron deficiency anaemia, vitamin A and iodine deficiency disorders are the most common forms of malnutrition. Both protein energy malnutrition and micronutrient deficiency can have serious negative consequences for physical and mental health.

Protein-Energy Malnutrition (PEM)

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

Stunting 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 because of inadequate dietary intake, and repeated infections. Stunting is an irreversible condition; a stunted child will become 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.

Wasting: wasting is reflection of current nutritional status and is measured using the ratio of a child's weight to height/length. 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 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 will start to manifest clinical sign and symptoms of marasmus, kwashiorkor or marasmic kwashiorkor and they may die.

Underweight: underweight children have low weight for their age. Children may become underweight because of wasting, stunting, or both. Underweight is measured in children using weight for age.

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. The deficiency of micronutrients is not usually visible, and termed as “hidden hunger”. Deficiency of Iron, Iodine, vitamin A, and zinc are most important in terms of prevalence and severity.

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. 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. The consequences of anaemia for children include increased morbidity and mortality, stunting, retarded cognitive development, reduced IQ, lower academic performance. Anaemic pregnant women 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.

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. 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. 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.

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 infectious diseases like diarrhoea. 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. Consumption of vitamin A bio-fortified foods such as orange-flashed sweet potato and maize, and vitamin A fortified oils, are some of the solution for the problem.

1.6.4. Status of Malnutrition in Ethiopia

Under-nutrition is a major public health problem in Ethiopia. Thirty-eight percent of children under age 5 are stunted (short for their age); 10% are wasted (thin for their height); 24% are underweight (thin for their age), and 1% are overweight (heavy for their height). The feeding practices of only 7%

of children in Ethiopia age 6-23 months meet the minimum standards with respect to all three IYCF practices (breastfeeding status, number of food groups, and times they were fed during the day or night before the survey). Regarding the maternal nutrition, twenty-two percent of women age 15-49 are thin (with BMI less than 18.5), while 8% are overweight or obese

1.6.5. Impacts 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. 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. Impacts of malnutrition are described below:

1. Susceptibility to mortality (death)

Stunting and other forms of under-nutrition are clearly a major contributing factor to child mortality, disease and disability. Specific nutritional deficiencies such as vitamin A, iron or zinc deficiency also increase risk of death.

2. Susceptibility to acute morbidity (disease)

Compared with people with adequate nutrition, those with poor nutritional status are more likely to contract diarrheal and respiratory infections and more likely to suffer from these illnesses for longer duration.

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.

4. Decreased economic productivity

Under-nutrition 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. All these condition will result in less productivity and innovation, which leads to poor socio-economic development of countries (fig 1.4).

5. Susceptibility to chronic diseases in later life

Children experiencing malnutrition in their early life will have increased risk of overweight and obesity. Different researches are proving that stunted children will suffer from disproportionate and rapid weight gain later in life. Poor fetal 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).

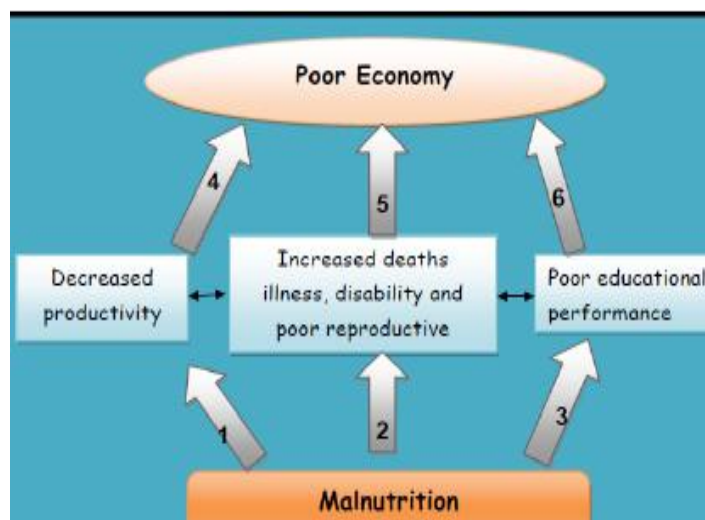


Figure 1.9: Over all influences of malnutrition

1.7. Nutrition Intervention Strategies to Combat Malnutrition

Nutrition intervention strategies are designed to change nutrient intake, nutrition-related knowledge or behaviour, environmental conditions, or access to supportive care and services. Nutrition intervention strategies and goals provide the basis for monitoring progress and measuring outcomes. There is no single bulletproof nutrition strategy that can meet the goal of achieving optimum nutrition for all. So, different strategic intervention approaches need to be applied based on context for improvement of nutritional out-come of the population.

Nutrition interventions are of two types. The first one is nutrition sensitive intervention. Nutrition sensitive interventions or programs address the underlying determinants of under nutrition, which are food security; adequate care giving resources at the maternal, household and community levels; and access to health services and a safe and hygienic environment with specific nutrition goals and actions.

Nutrition-sensitive programs can serve as delivery platforms for nutrition-specific interventions, potentially increasing their scale, coverage, and effectiveness. Nutrition Sensitive interventions/programs include:

- Agriculture and food security;
- Social safety nets;
- Early child development; maternal mental health;
- Women's empowerment; child protection; schooling;
- Water, sanitation, and hygiene; health and family planning services

Nutrition Specific interventions are interventions or programs that address the immediate determinants of fetal and child nutrition and development. Adequate food and nutrient intake, feeding, care giving and parenting practices, and low burden of infectious diseases are among the main nutrition sensitive interventions. The major areas of action are

- Adolescent, preconception, and maternal health and nutrition
- Maternal dietary or micronutrient supplementation
- Promotion of optimum breastfeeding
- Complementary feeding and responsive feeding practices and stimulation
- Dietary supplementation
- Diversification and micronutrient supplementation or fortification for children

Treatment of severe acute malnutrition
Disease prevention and management
Nutrition in emergencies

The above nutrition sensitive and specific activities are summarized in to core intervention areas and presented in detail as follows.

1. Life Cycle Approach to Nutrition

The life cycle of human beings originates from a fertilized egg, which develops into a fetus that is eventually born as a baby. A baby develops into a child, transitions through the wonderful phase of adolescence, becomes an adult, and then advances into old age and eventually death. A person's stage of life influences their health and nutritional requirements. Nutritional status is an intergenerational continuum. Maximum benefits in one age group come from investments in an earlier age group (there is a cumulative effect in the next generation). Health & nutrition programs implemented well before women become pregnant, & within a life-cycle perspective, have long-term impacts on succeeding generations. Investing in nutrition throughout the life cycle will have both short term and long-term benefits of economic and social significance, including large savings in health care costs, increased educability and intellectual capacity, and increased adult productivity vitamin B and C.

i. Pre-conception nutrition

Human reproduction is the result of a superb orchestration of complex and interrelated genetic, biological, environmental and behavioural processes. Given favourable states of health, these processes occur smoothly in females and males and set the stage for successful reproduction. However, less than optimal states of health, brought about by conditions such as acute under-nutrition or high levels of alcohol intake, can disrupt these finely tuned processes and diminish reproductive capacity. Sometimes conception occurs in the presence of poor nutritional status. Such events increase the likelihood that fetal growth and development, and the health of the mother during pregnancy, will be compromised.

Generally, every population group needs to make sure of getting diversified diet every day to ensure adequate nutrient intake for an active and healthy life. The following are important measure that a women planning to be pregnant needs to take care of.

1. Achieve health body weight: among the critically important factor for improved pregnancy outcome is maternal body weight.
2. Use iodine fortified salt
3. Consume diversified diet from at least five different food groups
4. Take folic acid supplementation every day if you are planning for pregnancy to lower your risk of folic acid deficiency.
5. Stop smoking and drinking alcohol.

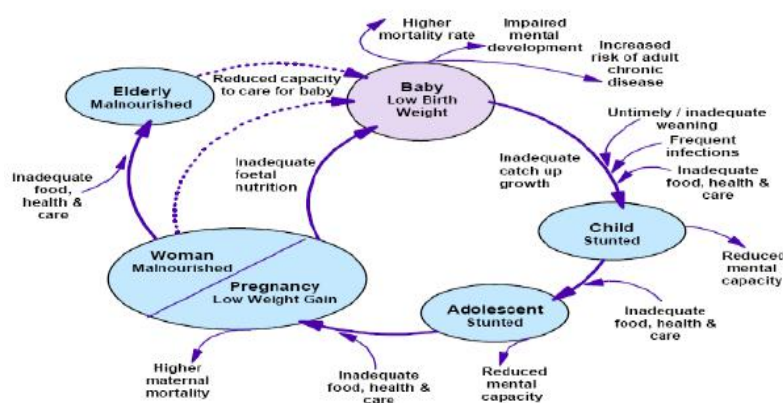


Figure 1.5: Diagram depicting nutrition throughout the lifecycle

ii. Windows of opportunity (1000 days)

The 1,000 days between pregnancy and a child's 2nd birthday are the most critical time for positive impact on a child's cognitive and physical development. The health and well-being of a pregnant and lactating woman is directly connected to the growth and health of her infant.

Optimal nutrition for the mother and for the child during this time can have a profound impact on the child's growth and development and reduce disease risk, as well as protect the mother's health. Under-nutrition during pregnancy, is among the major determinant of stunting and can lead to restricted growth which later results in neurological problems, poor school achievement, early school dropout, low-skilled employment, and reduced productivity during adulthood which cannot deliver good care of their own children, thus contributing to the intergenerational transmission of poverty and malnutrition.

Promote and support good maternal nutrition during pregnancy and lactation

Meeting women's nutrient requirements is key, as nutrient needs increase during pregnancy and lactation. Engagement of fathers, grandmothers, and other community influencers to assure that pregnant and lactating women receive adequate food and support are very much important. Therefore, it is important to make sure that the following key interventions are addressed to ensure optimal maternal nutrition during pregnancy and lactation.

- ✓ During pregnancy & lactation provide
 - Iron/Folic Acid supplementation
 - Treatment & prevention of malaria
 - Increase food intake
- One extra meal each day during pregnancy
- Two extra meals each day during lactation
- ✓ De-worming during pregnancy
- ✓ Vitamin A Supplementation within 45 days of delivery

Promote and support optimal infant and young child feeding (IYCF)

The following important IYCF and care practices need to be applied for optimal child nutrition.

- ✓ Immediate initiation of breastfeeding after birth (within one hour of delivery)
- ✓ Exclusive breastfeeding for the first 6 months of life (no other food than breast milk)
- ✓ Starting at 6 months appropriate complementary feeding (e.g., divers diet) together with continued breastfeeding to 2 years or beyond

- Complementary food needs to be prepared from at least four of the six food groups to ensure adequate macro and micro nutrient intake
- Increase number of feedings with age, Increase density & quantity with age
- ✓ Adequate care and feeding of sick children to prevent both acute malnutrition and stunting
- Increase frequency of breast feeding and complementary food during times of child illness
- After recovery, provide the baby with good amount of food for catch-up growth
- ✓ Ensure water, sanitation and hygiene practice

iii. Adolescent nutrition

Poor nutrition starts before birth, and generally continues into adolescence and adult life and can span generations. Chronically malnourished girls are more likely to remain undernourished during adolescence and adulthood, and when pregnant, are more likely to deliver low birth-weight babies. Total nutrient needs are higher during adolescence than any other time in the lifecycle. Nutrition and physical growth are integrally related; optimal nutrition is a requisite for achieving full growth potential. Failure to consume an adequate diet at this time can result in delayed sexual maturation and can arrest or slow linear growth. Currently the Ethiopian National nutrition program incorporated adolescent nutrition among the areas of intervention to break the intergeneration cycle of malnutrition.

The following are key activities, which are important to improve adolescent nutrition in Ethiopia

Ensure consumption of diverse diet from different food groups

Supporting adolescents for nutritional assessment and counselling services in health facilities

Integrate adolescent nutrition services into youth centers and related community based programs

Regular monitoring of the nutritional status of school-age children/students

Improving access to school based biannual de-worming.

Improving access to biannual de-worming for out of school adolescents

Ensuring access to iron folic acid supplementation for adolescent girls at schools and health facilities

Delay first pregnancy

2. Nutrition Sensitive agriculture

Nutrition-sensitive agriculture is a food-based approach to agricultural development that puts nutritionally rich foods, dietary diversity, and food fortification at the heart of overcoming malnutrition and micronutrient deficiencies. Food-based approaches include food production, dietary diversification and food fortification, as sustainable strategies for improving nutrition. This approach stresses the multiple benefits derived from enjoying a variety of foods, recognizing the nutritional value of food for good nutrition, and the importance and social significance of the food and agricultural sector for supporting rural livelihoods. The overall objective of nutrition-sensitive agriculture is to make the global food system better equipped to produce good nutritional outcomes. The Ethiopian Ministry of Agriculture and Natural Resource produced National Nutrition Sensitive agriculture strategy to direct and lead the sector's agricultural practices to be nutrition sensitive. Nutrition sensitive agriculture works in three main ways to contribute for improved nutrition:

- ✓ Making food more available and accessible: Increasing agricultural production makes more food available and affordable, which improves both the health and the economic status of the community. Sustained income growth in turn has a sizeable effect on reducing malnutrition.
- ✓ Making food more diverse and production more sustainable: Increasing diversity in food production and promoting sustainable production practices like conservation agriculture, water management and integrated pest management can improve nutrition levels without depleting natural resources. Family farming, home gardens and homestead food production projects can make a wider variety of crops available at the local level.
- ✓ Making food itself more nutritious: Fortification (Bio-fortification, Agronomic bio-fortification and artificial fortification) can prevent micronutrient deficiencies by enhancing micronutrient content in foods through processing, plant breeding and improved soil fertility.

In the national nutrition sensitive agriculture strategy of ministry of agriculture and natural resource three important pathways are depicted to show agriculture contribution for nutrition.

These pathways depict how diversified agricultural production, increased household income from agriculture, and women empowerment impact for improved maternal and child nutrition (see the detail in Chapter 2). All the three factors depicted in the pathways improve food availability, access and utilization there by contributing to improved food and nutrition security. It is important that you refer the National Nutrition Sensitive Agriculture Strategy for more information but here we will be presenting you the highlights of each of the strategic objectives.

Strategic Objective # 1: To leverage nutrition into agriculture and livestock sector policies, strategies, programs and work plans at all level.

The agriculture sector policies, strategies and programs did not explicitly aim to improve the nutritional status of communities and households, incorporation of nutrition objectives into the agricultural policies, strategies, programs and investments documents was taken as the first step in mainstreaming nutrition into agriculture sector and to ensure agricultural interventions are done with due consideration and with nutrition lens.

Strategic Objective # 2: To establish/strengthen institutional and organizational structure and capacity responsible for implementing nutrition sensitive agriculture.

This strategic objective of the National Nutrition Sensitive Agriculture Strategy (NNSAS) aimed at generally to build the capacity of the agriculture sector to implement NSA. The core activities include establish and/or strengthening food and nutrition structure at all level, building the capacity of NSA implementers, and revision of curricula of agriculture graduates. This course is also the result of consensus among different parties due to the anticipated potential benefit for sustainable integration of nutrition sensitivity of the agriculture sector through incorporation of NSA in pre-service training curricula of agriculture graduates.

Strategic Objective # 3: Increase year-round availability, access and consumption of diverse, safe and nutritious foods

This strategic objective in the NNSAS aims at ensuring improved production and consumption of diverse nutrient dense foods by all population groups. Traditionally Ethiopian rural households use

cereals as staple diets, which are, usually low in micronutrients and do not contribute to dietary diversity. The consumption and production is seasonally affected consumption of diversified diet is very much restricted. To curb this problem, this strategic objective states various intervention strategies for diversified production and consumption. We advise you to refer the NNSAS of Ethiopia.

Strategic Objective # 4: Enhance resilience of vulnerable agrarian, agro-pastoral and pastoral communities and households prone to climate change and moisture stress.

The rain fed agriculture and chronic and transitory food insecurity has created nutrition insecurity in moisture stress areas of the country. This strategic objective of the strategy focuses on strengthening resilience of food insecure and vulnerable households and communities by incorporating nutrition sensitive agriculture interventions and practices into the resource transfer programs/projects.

Strategic Objective # 5: Ensure women and youth empowerment and gender equality

Gender has been reported as the cause and consequence for hunger and malnutrition and associated with higher levels of acute and chronic under-nutrition. So addressing the issue of cultural and traditional hurdles and also making women to be at the center of nutrition related interventions both in the rural and urban settings is an important measure to improve maternal and child nutrition. In light of these, the NNSAS has emphasized empowering women and youth for improved maternal and child nutrition. You are advised to refer the NNSAS for detailed actions and focus areas of the strategy.

Strategic Objective # 6: To establish/strengthen strong multi-sectorial coordination within the agriculture sectors and with signatories of NNP and other development collaborates

This is the last strategic objective of the NNSA strategy. As the problem of malnutrition demands action from different sectors, the intra and inter sectoral collaboration is vital to have significant improvement in the state of nutrition of the country. In Chapter 6 you will be touching different aspects of multi-sector coordination.

3. Caring Practice

Care practice specifically focuses on the care given to mothers and children for improved nutritional outcome. In the UNICEF conceptual framework, inadequate care and feeding practice is depicted as an underlying cause for malnutrition. Caring practices such as breastfeeding, appropriate complementary feeding, as well as hygiene and health-seeking behaviours support good nutrition.

These practices can be severely disrupted in various conditions like during high burden of work on the mother, which could limit the time that she needs to spend caring for herself and her baby. This condition could result in poor dietary intake and increased infection, both of which are immediate causes of under-nutrition. In order to tackle this problem, involvement of other family members mainly the husband has to be promoted in the caring as well as participation on other daily household activates specially during times of pregnancy and lactation of the mother.

4. Water, Sanitation and Hygiene (WASH)

In 2014, an estimated 159 million children under five years of age were stunted, and 50 million were wasted around the world. Based on WHO 2015 report 2.4 billion individuals lack access to improved

sanitation and 663 million lack accesses to a protected water source. The report showed that more often communities affected by under-nutrition also have limited access to safe water and sanitation. There are evidence-based interventions, which are proven to work in improving nutrition of individuals implemented along with other intervention measures. These WASH interventions include use of improved water supply, safe household water management treatment and storage, improved household toilets or latrines, and hand washing with soap. Keeping food safe through safe handling, preparation and storage and prevention of contamination is among the important measures, which need to be addressed all the time. In Ethiopia WASH is one of the major areas of intervention for improved health and nutritional status.

Summary

Nutrition is the science of foods, the nutrients, and other substances they contain, and of their actions within the body. Food is a product derived from plants or animals that can be taken into the body to yield energy and nutrients. Nutrients are chemical substances obtained from food and used in the body to provide energy, structural materials, and regulating agents to support growth, maintenance, and repair of the body's tissues. Based on function and source there are six different types of nutrients (carbohydrate, fat, protein, vitamin, mineral and water). We can classify food groups in to six (Staple, legume, animal source, vegetable, fruit, fats, and oils).

Malnutrition refers to abnormal nutrition condition, both under-nutrition and over nutrition. Malnutrition is not caused by a single factor. Causes of malnutrition are classified at three levels as immediate, underlying, and basic causes of malnutrition. From the perspective of developing countries, malnutrition results from inadequate intake of nutrients and/or from disease factors. Protein energy malnutrition, iron deficiency anaemia, vitamin A and iodine deficiency disorders are the most common forms of malnutrition.

As per the UNICEF conceptual framework for the causes for malnutrition, we can see that there needs to be customized different intervention approaches to break each of the casual pathways. In general, different intervention measures need to be used both nutrition sensitive and specific approaches to effectively address the problem of interest. We have seen the lifecycle approach for prevention of maternal and child under-nutrition which include preconception nutrition, nutrition for pregnant and lactating women and IYCF from nutrition specific intervention point of view. Regarding nutrition sensitive approaches, we have raised NSA and WASH which are critical for improved maternal and child nutrition. To impact on nutrition, the agriculture sector needs to ensure that food produced is more available and accessible, more diverse and nutritious. The sector has also responsible to promote consumption of diversified food items.

Chapter 2: Diversified Agricultural Food Production and Consumption

2.1. Introduction

Availability and affordability of diversity of foods for all individuals at all times is a precondition of good nutrition. However, the global food system is currently not meeting requirements for these preconditions. Excessive intensification (i.e. monoculture) does not ensure universal access to diverse diets and, in some cases, endanger the long-term sustainability of the agricultural resource base. Over the last 50 years, agricultural modernization has contributed to narrowing global production patterns with a focus on a limited number of major crop plants.

Diversification of food production is one of the strategies to improve the availability and affordability of diverse foods. In addition, diversification can offer a seasonal coping strategy in the contexts where income streams and availability of nutritious foods vary within annual cropping cycles. Hence, it also contributes to sustainable intensification of agriculture, better eco-system service and climate resilience.

In Africa and Asia, the majority of the undernourished people live in rural areas as smallholder farmers. In these continents optimal farm production diversity is positively associated with dietary diversity. Hence, several recent development initiatives have promoted smallholder diversification through introducing additional crop and livestock species. The strategy can be applied at different scales, from the national and regional level to the farming system and backyard garden level. Farm diversification should also be combined with other strategies like better market linkage for sustainable dietary diversification and nutrition education to improve consumption of diversified foods. Therefore, this chapter is focused to address the meaning and importance of dietary diversity; dietary diversification strategies, food enrichment methods and Agriculture Nutrition impact pathways.

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

- Define dietary and agricultural food production diversity
- Describe agriculture-nutrition impact pathways
- Explain the nutritional value of plant and animal source foods
- Explain the importance of diversifying diet with a variety of agricultural food products
- Discuss the dietary diversification strategies
- Suggest appropriate agricultural food diversification strategies for a particular household and community

- Explain diversified agricultural food production interventions as the main dietary diversification strategies
- Explain how to enrich/enhance the nutrient content of the family foods using different food groups
- Promote the production and consumption of diversified foods

2.2. Definitions and Concepts

Dietary Diversity refers to the number of food groups consumed over a given period of time. Various scholars and international organizations have classified foods into different groups.

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. The level of dietary diversity is also a good indicator of people's broader nutritional status in many situations. Increasing dietary diversity is therefore an important strategy to improve nutrition and health.

There are various strategies for dietary diversification, which include agricultural production diversification, reducing post-harvest loss and improve post-harvest processing, designing nutrition behavior change communication, and income generation activities.

Agricultural diversified food production is the practice of producing a variety of crops or animals, or both, on one farm, as distinguished from specializing in a single commodity. Agricultural diversification involves movement of resources from low value commodity mix to high value commodity mix. It focuses mainly on horticulture, dairy, poultry and fisheries sector.

2.3. Nutritional values of plant and animal origin foods

2.3.1. Nutritional value of plant source foods

Plant source foods are the major agricultural produce in terms of production types and volume compared to animal source foods. Plant based foods constitute more than 80 percent of the daily food consumption in Ethiopia. From the six food groups recommended, five (i.e., staples, legumes and nuts, vegetables, fruits and fats) are

plant-based foods where fats can also be obtained from animal-based foods (refer subtopic.1.4 for detail information on plant source food).

2.3.2. Nutritional value of animal source foods

Animal source food (ASF) tend to be richer sources of the six nutrients of concern. It is generally nutrient dense and is considered as high value commodity both for farmers and consumers. Animal proteins tend to contain a good balance of all the amino acids that we need, some plant proteins are low in certain amino acids. For example, some key plant proteins are often low in methionine, tryptophan, lysine and isoleucine. In addition, ASF is high in many micronutrients, and the nutrients often are more available. Foods that contain animal protein tend to be high in several nutrients that are often lacking in plant foods are the following:

- **Vitamin B12:** Vitamin B12 is mainly found in fish, meat, poultry and dairy products. Many people who avoid animal foods are deficient in Vitamin B12. All requirements for this vitamin have to be met from ASF, as there is virtually no vitamin B-12 in almost all plant source foods.
- **Vitamin D:** Vitamin D is found in oily fish, eggs and dairy. Some plants contain it, but the type found in animal foods is better used by your body
- **DHA:** Docosahexaenoic acid (DHA) is an essential omega-3 fat found in fatty fish. It's important for brain health and is hard to get from plant sources.
- **Heme-iron:** Heme-iron is predominantly found in meat, especially red meat. It is much better absorbed in the body than non-heme iron from plant foods.
- **Zinc:** Zinc is mainly found in animal protein sources, such as beef, pork and lamb. It is also more easily absorbed and used from animal protein sources.

As indicated in Table 2.1 below ASF can fill multiple micronutrient gaps at a lower volume of intake than can plant source foods. Just 100 g of cooked beef provides an entire day's recommended intake of protein, vitamin B-12 and zinc and contributes substantially to meeting the riboflavin and iron recommendations. Likewise, 100 g of milk also can provide substantial amounts of calcium, vitamin B-12, vitamin A and riboflavin. Thus, small amounts of ASF added to a vegetarian diet can compensate for many of the vitamin and mineral inadequacies.

Table 2.1. Composition of selected foods (per 100g) compared with requirements for a school age child

Nutrient	Maize, cooked	Kidney beans, cooked	Kale, Cooked	Carrots, raw	Mil, whole, unfortified	Beef, medium fat, cooke d	Recommend intake2
Energy(kJ)	497	531	134	188	213	1124	668
Protein(g)	2.7	8.	1.	1.1	3.3	24.9	17.3
VitaminA(mgR	0	0	370	971	55	0	400
VitaminB-	0	0	0	0	0.39	1.87	1.2
Riboflavin(mg)	0.07	0.06	0.07	0.06	0.16	0.15	0.6
Calcium(mg)	2	28	72	31	119	4	800
Available iron(0.12	0.15	0.14	0.06	0.01	0.32	1.86
Available zinc(0.12	0.11	0.02	0.14	0.18	2.05	1.44
Fat(g)	1.	0.	0.	0.2	3.9	18	N/A
Saturated fat(g)	0.	0.	0.	0.0	2.4	8.4	N/A
Cholesterol (mg	0	0	0	0	14	75	N/A

Source: Suzanne *et al*, 2003

Furthermore, ASF provide multiple micronutrients simultaneously, which may be important in diets that are marginally lacking in more than one nutrient. For example, vitamin A and riboflavin are needed for iron mobilization and hemoglobin synthesis, and iron supplements may not reduce the prevalence of anemia if intakes of these other nutrients are low. Thus, foods such as liver that contain substantial levels of both iron and preformed vitamin A may be more effective than single nutrient supplements in alleviating poor micronutrient status.

On the other hand, there are plenty of nutrients found in plants that are lacking in animal foods. ASF also tend to be sources of macronutrients that may not be desirable in the diet, such as saturated fat and cholesterol, although lean alternatives contain less of these macronutrients. ASF also may be undesirably high in total fat, energy and protein. For children in developing countries, a concentrated source of these macronutrients often is desirable, although for children (and adults) in more affluent countries, excessive consumption of energy-dense foods may lead too very consumption of energy. Although meat intake has been associated with an increased risk of colon cancer in several studies, processed meats appear to be stronger predictors than unprocessed meats. Particularly in developing countries, the contribution of meat to improved nutrient intake more than offsets this uncertain association with colon cancer.

Generally, all six micronutrients richly found in ASF, vitamin A, vitamin B12, riboflavin, calcium, iron and zinc play a critical role in the growth and development of children.. Inadequate stores of these micronutrients, either resulting from inadequate intake or poor absorption, is associated with poor growth, anemia (iron deficiency anemia and macrocytic anemia), rickets, night blindness, impaired cognitive functioning, neuromuscular deficits, diminished work capacity, psychiatric disorders and death. Some of these effects, such as impaired cognitive development from an iron deficiency, are irreversible. However, if ASF foods are consumed in excess quantities, they have been shown to raise the risk of heart disease, diabetes, cancer, obesity and other preventable diseases due to the high levels of saturated fat and cholesterol. On the other hand, poultry, fish and low-fat dairy were associated with a lower risk of heart disease. People who eat fish regularly are also likely to have a lower risk of heart attacks, strokes and death from heart disease,

Therefore, eating balanced amounts of both is the best way to get all the nutrients you need. Thus, improving animal productivity with better feed, breeding and health care will increase productivity thereby increase availability of animal products, which would in turn increase affordability of dietary diversity.

2.4. Importance of consumption of diversified foods

Different foods from each food group provide more of some nutrients than others, and can complement each other for essential micronutrients. Dietary diversity provides balanced diet that improve the quality of nutrients consumed by the family. For instance, cereals lack certain amino acids and these are present in pulses while pulses lack some other amino acids that are present in cereals. On the other hand, while animal source foods are poor in some of the nutrients such as vitamin E, they are rich sources of high quality protein and some essential nutrients like Iron and Zinc, though excess consumption of some ASF might negatively affect human health. Nutrients from different food sources can interact to increase the intake, absorption and bioavailability of other nutrients. Dietary diversification creates opportunity for children and pregnant mother better food item preferences which will increase daily food consumption. Variety diet is generally important because it ensures adequacy and balance of a diet to achieve better nutrition. Combining foods from different food groups is the easiest way of eating all nutrients. .

2.5. 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. Strategies for food and dietary diversification at the community and

household levels include a range of food-based activities that can maximize the availability of adequate amounts and greater variety of nutritious foods. These interventions are grouped in to four main strategies as follows:

1. Diversified Food Production,
2. Reducing post-harvest loss and improve post-harvest processing
3. Designing nutrition behavior change communication
4. Income generation activities

2.5.1. Diversified food production strategies

Producing variety and nutritious agricultural foods, helps to alleviate lack of adequate amounts of foods that are rich in the nutrients needed for health and a productive life. Diversified foods need to be produced that are rich in all the essential micronutrients, available in sufficient quantities and accessible to people all year round. Increased food production and access are crucial to achieving major nutritional improvement.

Farming practices that improve the regular flow of a variety of different foods into the household throughout the seasons enhance food security for its members. This requires the collaboration of people working in agriculture, fishery, forestry, small animal husbandry, industry, marketing, communications, women's participation, home economics and nutrition. Strategies for food and dietary diversification at the community and household levels include a range of food-based activities that can maximize the availability of adequate amounts and greater variety of nutritious foods. These activities include:

1. Integrated farming systems
2. Home gardening
3. Forestry products for household consumption
4. Promoting underexploited traditional foods
5. Small livestock and poultry raising
6. Fish Farming
7. Improve soil fertility to increase yield and nutrient content of plant foods

1. Integrated farming systems

Integrated farming system is the practice of producing multiple agricultural products from different farm enterprises that share available resources. The system integrates not only different crop production enterprises, but also it integrates different livestock

enterprises that might also be integrated with the crop enterprises. These systems have positive implications for food security, dietary balance and nutrition.

Mixed cropping is one type of integrated farming systems in which different crops are grown on the same land in one or different periods. Such characteristics offer gains in sustainability and in stability for the food supply system. It offers increased protection from disease and pest damage and reduces the risk of crop failure thus potentially increasing profitability and income. Mixed cropping can also reduce erosion risks by providing increased soil cover and additional crop residues for use as green manure and mulch. All of these attributes reduce risk in the food supply system and thus favorably influence food security.

More sustainable food diversification is achieved by further integration of mixed cropping systems with various livestock production systems. For instance, integration of small livestock, poultry, fish, and horticultural crops, both at the farmstead and field level, is found to be a strategy for this sustainable food diversification. This is mainly due to the related high resource use efficacy, and risk management, and environmental protection achieved by resource sharing, waste recycling, and distribution of risks among the various enterprises.

2. Home gardening

Home gardening can often supplement family food supplies during lean periods and can generate added income when other sources of employment and income may be limited, provided enough water is available. Home gardens have mostly been maintained by women, who often water and manure them from domestic wastes and use them to produce early crops such as green maize and the fruits, spices and vegetables needed to prepare relishes. Through careful selection, a range of fruit and vegetable crops can be cultivated throughout the year to provide a constant supply of micronutrients. Access to home-grown fruits, vegetables, small animals and/or fish ensures a more balanced diet for rural and urban families with limited purchasing power and increases their selfreliance.

3. Forestry production for household consumption

Forests and trees provide foods that supplement and complement traditional agricultural food sources. However, nutritionists and foresters have until recently paid insufficient attention to forest foods. In many parts of the world, non-wood forest products (NWFPs), which include goods of biological origin other than wood, derived from forests and allied land uses have an important role in local food systems. They can contribute substantially to nutrition, either as part of the family diet or as a means of achieving household food security. Forest foods can constitute an important element of sustainable diets. They can broaden the food base and diversify the diet, thus preventing nutrient deficiencies and ensuring dietary balance. Forest foods contain many essential nutrients. Seeds, nuts, roots and tubers found in forests supply fats and carbohydrates. Mushrooms, gums and saps provide protein and minerals. Wild animals from the forest often supply most of the meat consumed by people living in or near forest areas. Other forest resources have a major role in the economy of many

households, such as timber for building, fuel wood and inputs for agricultural production, as well as generating income, thereby contributing to household food and nutrition security.

4. Promoting of underexploited traditional foods

Traditional food crops are those accepted by a community, through habit and tradition, as appropriate and desirable sources of food. People are accustomed to them, know how to cultivate and prepare them and enjoy eating dishes made from them. It is not possible to list traditional food crops, as distinct communities have evolved their own food preferences and habits. Traditional foods provide a varied diet, often rich in minerals and vitamins including vitamin A, iron and calcium. They have numerous advantages, for household food and nutrition security, as they are particularly important in the cropping strategies and consumption patterns of poor people. However, the use of these foods is not known in most other communities, for example **staples** such as cassava, yam, plantain is restricted in the SNNPR of Ethiopia. Therefore the use of these foods in wider part of the community should be promoted for better food and nutrition security.

5. Small livestock and poultry keeping

Animal foods are not regularly served as a main component of meals, as they tend to be too expensive for regular use by the poorer sectors of the community. Small animals such as sheep and goats, and poultry can be produced with small investment, and they require relatively small inputs to produce. In addition, due to short reproductive cycles they can provide quick return to investment. Thus products from these animals can be supplied with relatively lower price for farmers and consumers to diversify their diets and meet their nutrient requirements. For instance, eggs and chickens contribute for diversified diet, which is especially important for children, pregnant women, lactating mothers and sick people.

6. Fish Farming

Fish has an important role in world protein supplies, particularly in developing countries. Besides protein, fish provides energy, essential fatty acids from fat, vitamins and minerals. Fish species vary considerably in composition as well as in size and appearance. Though marine fish are slightly more beneficial than freshwater species by virtue their higher iodine content, it is not easily accessible for most people. Therefore, fish farming with fresh water or pond water offer an either alternative for such people.

7. Improve soil fertility to increase yield and nutrient content of plant foods

Improving and maintenance of soil fertility through appropriate soil and water conservation methods and using organic fertilizer helps to improve the nutrient contents food products. Applying soil test based fertilizer and agronomic recommendation for each crop and type and the use of improved and nutritious

varieties with better yield and marketability helps to produce diversified and nutritious foods.

2.5.2. Reducing post-harvest loss and improve post-harvest processing

There is significant loss of produce and nutrients due to post-harvest loss resulting from lack of preservation facilities and infrastructure, and knowledge and skill. Adopting improved preservation and storage of food products especially animal source foods helps to reduce waste, post-harvest losses and effects of seasonality. Improved storage preserves the nutrients in foods, avoids spoilage and increases the availability of nutritious food for extended periods of time. At the household level, better cooking methods like avoiding overcooking can also help to reduce postharvest loss.

Seasonality is another barrier to obtaining the benefits of food production diversification strategies, especially in tropical countries like Ethiopia. For example, horticultural products mature during a short season, most of them simultaneously, in quantities much higher than local markets can absorb. Low prices during the harvest season cause farmers to refrain from selling their produce; as a result, considerable amounts go to waste. Drying of nutrient-rich foods (e.g. mango and green leaves) can improve the nutritional status and income of families, since dried foods can bring a good market price.

2.5.3. Nutrition education

This will both increase dietary diversity and generate more demand for marketing of nutritious foods, improving opportunities to generate income through production of nutritious foods, and lowering market prices through time.

2.5.4. Income generation

It is generally accepted that better income contributes to better nutrition of households. However, the effect of income on nutrition is not direct or easily predictable; it is always modified by what is available, affordable, and convenient to purchase; who decides; what is purchased; and the myriad factors that drive that decision. Therefore, it is important to integrate this strategy with others, particularly with nutrition education.

2.6. Factors to consider in the diversification of food production and consumptions

There are important factors to consider in adopting any policy for food diversification and the major ones include:

- Labor requirements for production
- The acceptability of the product
- The availability of markets for the surplus.

Labor requirements

Labor is an important factor that should be carefully assessed when introducing new crops or production systems, such as home gardens, into a community. The labour consideration is especially important in regard to women's time and the investment of available resources into other activities with a comparatively greater advantage. For example, if the major objective of an intervention in a food diversification strategy is to improve the nutritional status of women and preschool children, in some circumstances this could be achieved most effectively by reducing the work burden of women through the provision of a new well and a grinding mill before trying to establish home gardens or to grow more millet. Thus it is helpful to understand fully the existing production processes and the gender division of labour and to appreciate the perceptions, priorities and constraints of the producers and the consumers through community participation in the planning stages of the proposed strategy.

The acceptability of the product

It is important to insure the acceptability of foods produced through the various diversified production strategies as they may not be readily accepted by the community. For instance, many small-grained cereals are nutritionally and ecological advantageous in terms of protein quality, and reliability of production under conditions of low inputs and poor distribution of rainfall; however, they are difficult to process in comparison with maize or rice, and although technology has been developed for mechanical processing using abrasion milling, this possibility is not often readily available at village level.

The availability of markets for the surplus

Market for surplus outputs produced through diversification strategies should be given due attention. This is particularly important for animal source foods as they are not only relatively more expensive to produce and generally more perishable than plant source foods.

2.7. Nutrient enrichment/modification strategies

Nutrient enrichment is the addition of essential nutrients to a food in order to maintain or improve the nutrient content of the foods. Nutrients such as iron, niacin, riboflavin and thiamine may be added back to foods for restoration of nutritional value of foods lost during manufacturing practice, storage, handling and processing. The nutrients are restored in amounts which will result in the presence of the nutrient(s) in the level present in the edible portion of the food before processing, storage or handling. In some cases, foods may also be fortified with nutrients not normally present, such as addition of Vitamin E in animal products and addition of Zinc in plant based foods.

2.7.1. Food fortification

Food fortification is defined as the practice of “deliberately increasing the content of essential micronutrients in a food so as to improve the nutritional quality of the food supply and to provide a public health benefit with minimal risk to health”. The Codex General Principles for the Addition of Essential Nutrients to Foods defines fortification (or synonymously “enrichment”) as “the addition of one or more essential nutrients to a food whether or not it is normally contained in the food, for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the populations or specific population groups”

“Essential micronutrients” in this context are those vitamins, minerals and trace elements that are normally consumed as a constituent of food and which are needed for growth and development and the maintenance of healthy life and which cannot be synthesized in adequate amounts by the body

Nutrients can be added to foods at different points along the value chain from the foods’ production, its processing and finally to its ingestion “from field to mouth”. At farm level, nutrients can be added through plant breeding or soil and water; they can also be added at virtually any stage of processing both home-based or in factories, or at the household and individual level such as home-based fortification with micronutrient powders.

Types of food fortification

Mass (or universal) fortification fortifies foods that are widely consumed by the general population and is usually mandatory and regulated by government, which has often instigated the intervention.

Targeted fortification fortifies foods for specific population groups such as complementary foods for young children or rations for displaced populations, and can be mandatory or voluntary.

Voluntary, market-driven fortification allows food manufacturers to voluntarily fortify foods available in the marketplace but which are subject to regulatory limits

Basic Principles of Food Fortification

1. The essential nutrient should be present at a level which will not result in either an excessive or an insignificant intake of the added essential nutrient considering amounts from other sources in the diet”,
2. The addition of an essential nutrient to a food should not result in an adverse effect on the metabolism of any other nutrient

In general, developing modified or enriched foods require due consideration of the safety and quality of the products. In additional enriched or modified foods should be guaranteed and consistent product quality so that consumers should be sure of receiving in these products. The indications and information’s in this regard must

be stated on the packaging. The future of such products may be with the modified or enriched foods.

2.7.2. Bio-fortification

Bio-fortification is the process of adding nutrients on plant and animal source foods through breeding and biotechnology or by adding nutrients to fertilizers, water supplies and other production inputs. It is mostly aimed at increasing the density of minerals, vitamins and other nutrients in food staples, and it is a potential good way to reduce micronutrient deficiencies. Biofortification, through plant breeding approach of food crops, has been promoted as a sustainable, and ultimately cheaper, alternative to more usual fortification interventions and has had some considerable technical success, particularly in increasing iron, beta-carotene (provitamin A), zinc, and folate contents in staple foods. Basically, bio-fortification involves the breeding and genetic modification of plants to improve their (micro)nutrient content and/or absorption.

Fortification of Animal Source Food

Though fortification of plant source food is highly promoted, there is relatively limited initiative to promote fortification of animal source food. These are apparently due to higher density of most of the essential nutrients in animal source foods, and the associated higher cost needed for their fortification. However, some efforts have been made to fortify various animal source foods such as meat, milk and eggs. This has particularly focused not only on adding some of the nutrients that are deficient in the foods, but also to reduce those nutrients that might cause human health problems. This helps to reduce free radicals in blood, which helps to decrease risk of cancer, ageing process, heart disease and also to act as antioxidant that results in delay of the development of odors. Fortification of ASF can be achieved by manipulation of the genetic makeup and diets of the animals.

Fortified Animal source Foods

Relatively more research is done on the fortification of egg as compared to other animal source foods; these include

Omega-3 fatty acid fortified eggs: At present health conscious consumers are suffering from cholesterol phobia thus the demand of low cholesterol eggs is very high which can be achieved either by reducing the amount of cholesterol per egg, by reducing the size of the yolk or by altering the **lipid profile** of the yolk

The total amount of the fat of the egg yolk cannot be changed by the feeding. However, the composition of **fatty acid** can be altered by changing the type of oil used in hen diet. For that purpose, different type of feeds are being used such as flax seed (Linseed), marine algae, fish oil and rapeseed oil. These contents increase the omega-3 **fatty acid** content in the omega-3 **fatty acid** enriched eggs. Therefore, modified or

enriched eggs production is mainly concentrated on the enrichment of egg lipids with n-3 **fatty acids** low cholesterol fortified eggs:

Vitamin-E enhanced eggs: Vitamin E enriched eggs can be produced with a higher amount of vitamin-E as compared to normal eggs by feeding hens on diet high in vitamin-E. The higher contents of vitamin-E can be obtained by supplementation of poultry feed in the form of natural sources found in butter, milk, vegetable and nut oils.

Pharmaceutical fortified eggs: Now a day, researchers are producing genetically modified chickens through the genetic manipulation which are capable to produce certain pharmaceutical compounds and these compounds can be harvested through eggs i.e., insulin which are used for treatment of diabetes. Other techniques are also adopted for the development of antibody enriched eggs. For that the hens are given an antigen and after its administration, hens develop antibody against the antigen which are then concentrated in eggs. This technique can be further expended for development of antibodies in the eggs and through which modified eggs will be able to treat the patients against snake venoms etc.

Immuno-modulating eggs: The eggs naturally contain certain specific compound like lysozyme (G1-globulin), G2 and G3-globulin, ovomacro etc. The globulin antibodies are natural antimicrobials and immune-stimulants in the egg that can be utilized in the cure of immunosuppressed patients like AIDS patient. These eggs have not only high in **nutritional value** but also good immune-stimulant and antiviral properties. Like other component of eggs modification, the levels of immunoglobulins in the egg can be improved by dietary manipulation. Certain herbs like rosemary, turmeric, garlic, fenugreek, spirulina, ashwagandha are also possessing immune-modulating properties so by the use of that kind of herb in the feed of the hen also improve the efficiency of the immune-modulating properties of the eggs.

Mineral enriched eggs: Many types of minerals can also be enriched in the production minerals enriched designer eggs. Among these selenium and iodine are one of them followed by chromium and copper. This can be achieved by the dietary manipulation of hen's diet. These trace minerals are very important for human health because the deficiency of these trace minerals leading to development of certain deficiency disease.

Selenium enriched eggs: Nowadays, selenium enriched eggs are available in more than 25 countries in the world. Among these Russia is the most advanced country for the production of these eggs. The selenium content of eggs can be easily modified by the supplementation of organic selenium rich feed to the hens.

Iodine-enriched eggs: In developing country like India, Africa, China and in many other countries of the world, some people are suffering from iodine deficiency diseases therefore, iodine enriched eggs could be a good source of iodine in human diet.

Organoleptically improved modified eggs: In general, the acceptability of these eggs are diminished in relation to the aroma and flavor caused by dietary

modifications. These off-flavors can be concealed by the use of flax seed in combinations of antioxidants in the hen's diet.

In addition to the above, mentioned type of fortified eggs there are also as discussed above Vitamin C enriched eggs, Fiber enriched eggs, choline enriched egg etc. Moreover, there are also fortification of other animal source foods. For example, as meat is low in Calcium, antioxidants such as vitamin C and E; there are growing research in fortification of these compounds in meat products is underway using other sources of calcium such as finger millet flour, calcium gluconate and citrate. Similarly, as milk does not naturally contain Vitamin D, it fortified by adding vitamin D. Animal source foods are also included in new and/or modified food commodities to enhance the quality of the ration, particularly for groups with specific needs, for example, milk is included in new and/or modified food commodities to enhance the quality of the ration, particularly for groups with specific needs.

Though, several initiatives are ongoing around the world, bio- fortification, is not a universal remedy as it presents technical and ethical challenges; some bio-fortified crops particularly that are GMO have shown, up to now, modest results in terms of impact on the nutritional status, thus it requires acceptance from farmers and consumers.

2.8. Agriculture-nutrition impact pathways

Agricultural livelihoods affect nutrition of individual household members through multiple pathways and interactions as depicted in the figure 2.1. The pathways are not always linear, and there are many interactions among them. In general, they can be divided into three main routes at the household level:

2.8.1 Food production pathways

Household food production can be critically important to the diets and nutrition of individuals in smallholder farmer households. Food production can affect the type, quantity, and seasonality of food available in the household for consumption. At the same time, production may also influence the availability and prices of diverse food in local markets.

2.8.2. Agricultural income pathway

The agriculture income pathway assumes that nutritious, diverse foods are available and affordable in local markets. Increasing the agricultural income enables expenditures on food and health care, affecting diet and health status.

2.8.3. Women's empowerment pathway

Women's empowerment incorporates multiple aspects, including the decision-making power related to income, time, labor, assets, and knowledge or preferences of female community members. Women's decision-making also affects what is produced on the farm, and women's control of income and assets can affect productivity. Increasing the

agricultural income that women can control strengthens the income pathway to nutrition as such income is more frequently used on food and health care for the family, particularly for children

Agricultural development interventions can strongly affect women's use of time as well as their labor burden. Women are typically responsible for a wide range of household and agricultural tasks, including child and infant care and feeding and their own self-care. Activities that influence the amount of time or labor women spend on agriculture-related tasks can affect their own health and energy expenditure, and in turn their capacity to feed and care for infants, young children, and themselves. Generally, a vital step in improving nutrition in a household with an agricultural livelihood requires that farming business decisions give attention to how women are involved.

The Enabling environments

The pathways between agriculture and nutrition are influenced by several key contributors to the enabling environment, which are factors at the community, regional, or national level affecting the household-level pathways.

Food Market Environment

The food market environment affects the kinds of foods that are available and likely to be purchased, as well as those that are likely to be produced by farm households as a response to price signals and market incentives. Purchase decisions are affected not only by the relative price of different foods, but also factors such as convenience of purchase and preparation, available information about foods, and related perceptions of quality and safety. The food environment therefore interacts with household decision-making and food purchases in many ways and has a significant influence on household and individual nutrition.

Natural Resources Environment

All pathways between agriculture and nutrition are affected by natural resources: water, soil, climate, and biodiversity. Natural resource endowment affects agricultural production potential and, therefore, management strategies for income generation and food availability. Appropriate management of scarce natural resources, such as sustainable harvesting, use and drainage of water, soil fertility management, and managing access to productive land, is critical to a successful farming business.

In general, successful interventions along any of the pathways will require purposeful planning toward nutritional goals while mitigating ever-changing natural resource constraints.

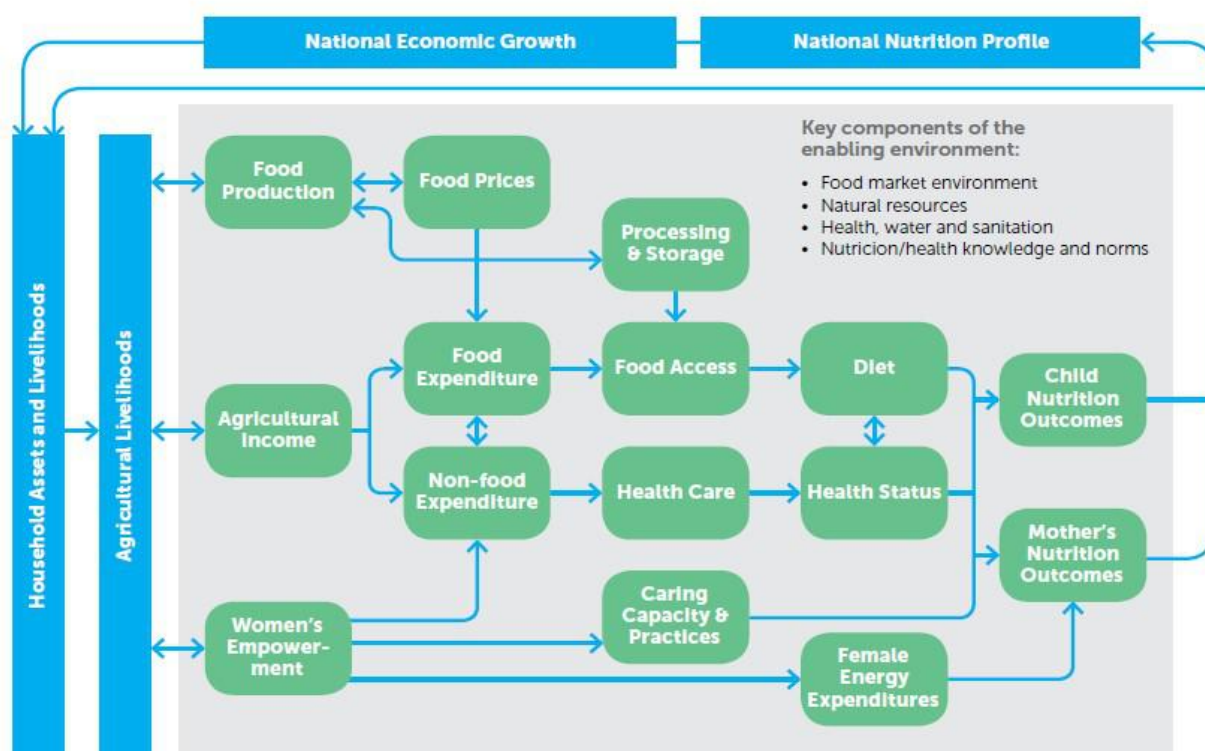
Health, Water, and Sanitation Environment

Nutritional status is strongly influenced by the health, water, and sanitation environment and access to health services. A key component of nutrition-sensitive agriculture therefore includes consideration of the activities' potential effects on the health, water, and sanitation environment.

Nutrition/Health Knowledge and Norms

The knowledge held by key family and community members has a major bearing on the decisions made within households related to agriculture and nutrition. Interventions that promote knowledge of nutrition and health may affect decisions around food production, purchase, and consumption to enhance positive outcomes for both the agriculture and nutrition sectors while avoiding negative impacts.

Figure 2.1. Conceptual pathway between agriculture and Nutrition



Source: Feed the future (2014) Understanding and Applying Primary Pathways and Principles

Summary

Dietary Diversity refers to the number of food groups consumed over a given period of time. Different foods from each food group provide more of some nutrients than others, and can complement each other for essential micronutrients. Dietary diversity therefore provides balanced diet that improve the quality of nutrients consumed by the family. There are four dietary diversification strategies: producing variety and nutritious agricultural foods, reducing post-harvest loss and improve postharvest processing, designing nutrition behavior change communication, income generation activities.

Agricultural diversified food production is the practice of producing a variety of crops or animals, or both, on one farm, as distinguished from specializing in a single commodity. Excessive agricultural intensification does not ensure universal access to diverse diets and, in some cases, endanger the long-term sustainability of the agricultural resource base. Therefore, several recent development initiatives have promoted smallholder diversification through introducing additional crop and livestock species with the intention to improve household nutrition. In adopting any policy for food production diversification the factors to consider include, labor requirements for production, the acceptability of the product, the availability of markets for the surplus.

In addition to production diversification, the nutrition value of foods can be enriched by various mechanism such as food and bio fortification, food fortification is the practice of “deliberately increasing the content of essential micronutrients in a food so as to improve the nutritional quality of the food supply and to provide a public health benefit with minimal risk to health methods. There are different types of food fortification which include; Mass (or universal) fortification, targeted fortification, Voluntary, market-driven fortification.

Bio fortification is one of the methods of food fortification which applies agricultural or horticultural process of adding nutrients through plant breeding of or by adding nutrients to fertilizers or water supplies. Though fortification of plant source food is highly promoted there is relatively limited initiative to promote fortification of animal source food. However, some efforts have been made to fortify various animal source foods such as meat, milk and eggs. This has particularly focused not only on adding some of the nutrients that are deficient in the foods, but also to reduce those nutrients that might cause human health problems.

Self-assessment questions

1. Define diet diversity and agricultural diversified food production and discuss the basic concepts of each terms.
2. Compare and contrast the nutritional values of plant and animal source foods in terms of their nutrient content and bioavailability.
3. Describe the various dietary and food production diversity strategies?
4. Discus the importance of agricultural food production diversity for diet diversity?

5. Define food fortification and bio-fortification mechanisms and explain their roles in nutrition security.
6. Give examples of fortified plant and animal source foods.

Learning activity: Case Study

Objective: Students will be able to analyze and suggest household dietary diversity strategies

Instruction: Students will discuss for 15 min in small group and present to the larger group

Case Scenario

Hailu and Yenatfanta are smallholder farmers with 4 children living in one of the highland areas of Ethiopia. They used to grow wheat and barley on their 1.5 hectares of land, and get 13 quintals of the crop every year. They also have two lactating cows. They usually sell milk and rarely butter.

They send their children to school. The common household food is ‘enjera’ and bread made of these cereals. Recently, they have shifted to grow eucalyptus tree and ‘khat’ on half of their land.

From the scenario, discuss in a group the following questions:

1. How do you evaluate the dietary diversity of this family?
2. How can this family improve production and consumption of diversified food?

Reflection: ask participants to think about how they can integrate food diversification interventions into their daily work.

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Chapter 3: Safe Production and Post-Harvest Handling of Agricultural Products

3.1. Introduction

Food safety is a scientific discipline describing handling, preparation and storage of food in ways that prevent food borne illness. This comprises a number of practices that should be followed to avoid possible health risks. The pathways within this route of thought are safety among food value chain (production, industry, the market and then between the market and the consumer). In seeing industry to market practices, food safety concerns contain the origins of food including the practices relating to food labelling, food hygiene, food additives and pesticide residues, as well as rules on biotechnology and food and guidelines for the management of governmental import and export inspection and certification systems for foods. In considering market to consumer practices, the usual thought is that food must be safe in the market and the concern is safe delivery and preparation of the food for the consumer.

Postharvest handling is the stage of production immediately following harvest, including cooling, cleaning, sorting and packing. The instant agricultural produce is removed from the ground, or separated from its parent plant, soon it begins to deteriorate. Post-harvest treatment largely determines final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product. The most important goals of post-harvest handling are keeping the product cool, to avoid moisture loss and slow down undesirable chemical changes, and avoiding physical damage such as bruising, to delay spoilage. Sanitation is also an important factor, to reduce the possibility of pathogens that could be carried by fresh produce, for example, as residue from contaminated washing water.

Learning Objectives

At the end of this chapter students will be able to

Apply safe production and post-harvest handling of agricultural produce

Describe Good Agricultural Practice (GAP) and Good Hygienic Practice (GHP)

Identify the effect of post-harvest handling, processing and preservation on nutrient content of foods

3.2. Safety of Agricultural Products

3.2.1. Definition of food safety and related terms

Food Hygiene: All measures necessary to guarantee the safety of food at all stages of the food chain.

Food-borne Illness: Sickness or injury caused by eating food containing a microbiological, chemical or physical hazard(s).

Foreign Material: Any substance or object that does not naturally or normally belong in a food product.

Good Agricultural Practices (GAP's): refers to an integrated management system and the resulting 'best-practices' designed to ensure the efficient production of safe agricultural products.

Good Manufacturing Practices (GMP's): General procedures to reduce food safety hazards.

Good Hygienic Practices (GHP): The basic rules for the clean and healthy handling, storage, processing, distribution and final preparation of all food along the food production chain.

Hazard Analysis Critical Control Point (HACCP): a systematic food safety assurance method to identify, evaluate and control of food hazards.

Hygiene: Conditions and practices followed to maintain health including sanitation and personal cleanliness.

Pesticide: A substance used to prevent, destroy or repel any insect, nematode, rodent, predatory animal, parasite, bacteria, fungus, weed or other form of plant or animal life.

3.2.2. Food quality versus food safety

Food safety and food quality are two important terms which describe aspects of food products and the characters of the processors. The terms food quality and food safety are important in any food manufacturing environment, and often used interchangeably, but there is a distinct relationship between food quality and food safety.

Food quality

Food quality can be defined as a total of traits and criteria which characterize food as regards its nutritional value, sensory value, convenience as well as safety for a consumer's health. Good quality exists when the product complies with the requirements specified by the client. This means quality is a term defined by the consumer, buyer, grader, or any other client based on a number of subjective and objective measurements of the food product.

Food safety

Food safety is a component of quality and an assurance that food will not cause adverse harm to the consumer when it is prepared and/or consumed according to its intended use to final consumers. Food safety is not negotiable. All requirements relating to the safety characteristics of a food must be met; there must be no unacceptable health risk associated with a food. Safety differs from many other quality attributes since it is a quality attribute that is difficult to observe. A product can appear to be of high quality, i.e. well colored, appetizing, flavorful, etc. and yet be unsafe because it is contaminated with undetected pathogenic organisms, toxic chemicals, or physical hazards. On the other hand, a product that seems to lack many of the visible quality attributes can be safe.

3.2.3. Food safety hazards

The safety of a food can be related directly to certain harmful substances that are present in the food; these substances are food safety hazards. Any substance that is reasonably likely to cause harm, injury or illness, when present above an established acceptable level, is a food safety hazard. An unacceptable level of a food safety hazard in a food presents a health risk to the consumer. There are three recognized categories of food safety hazards: biological, chemical, and physical hazards. The origin of these hazards in foods can be from naturally occurring substances or agents in foods, from deterioration or decomposition of foods, or from contamination of the foods with the hazard at various stages of their production, harvesting, storing, processing, distribution, preparation, and utilization.

i. Biological hazards

Raw product can become contaminated with pathogenic and non-pathogenic microorganisms at a number of different stages, by several means, from production to consumption. Biological hazards occur in foods includes bacteria, fungi, virus and parasites. Pathogens can contaminate at any point along the food chain, at the farm, packing shed, processing plant, transportation vehicle, retail store or food service operation, and at home. The foods that are commonly involved in these food poisoning incidents include meat and poultry and their products, seafood and seafood products, egg and egg products, milk and dairy products, fruits and vegetables and their products, cereals, legumes, oilseeds/ low-acid canned foods, and water.

ii. Chemical hazards

Chemical hazards occur when a chemical enters the food and person ingests it. These chemicals include cleaning agents, sanitizer, pesticides, certain metals, or unapproved food containers and naturally occurred toxins like oxalate in rhubarb, alkaloids in potatoes, toxins in mushrooms and in shellfish. Agricultural and industrial inputs are source of chemical hazards. Agricultural residues are a group of residual chemical or biochemical substances found in foods and are directly attributable to certain substances that have been approved for use in the production of crops and livestock for food. They include residues of permitted pesticides, herbicides, fungicides, drugs, hormones, and antibiotics. Some of these residues are considered as added harmful substances attributable to human actions and are regulated by governments.

Several harmful chemicals that enter the environment as a result of industrial activity have been shown to be present in foods. These substances include heavy metals (lead, mercury, arsenic), organo-chlorinated compounds such as polychlorinated biphenyls (PCBs), and are considered as industrial or environmental contaminants.

iii. Physical hazards

Physical hazards include organic or inorganic substances, commonly referred to as foreign objects, foreign matter, or extraneous materials. Hard and sharp physical hazards are of particular concern. Depending on their size and dimensions, hard and sharp physical hazards can cause injury to the mouth or teeth, or can cause serious injuries if swallowed. In addition, some physical hazards, depending on their size, shape, and texture, have the potential to cause choking if swallowed. Physical hazards in foods can be particularly harmful to infants. Certain hard and sharp foreign objects that are natural components of food (e.g., prune, date or olive pits; fish bones nutshells) are not considered physical hazards since it is expected that the consumer will be aware that these objects are natural components of the foods. However, if the food carries a label stating that the hard and sharp object has been removed (e.g., pitted prunes), the presence of the hard and sharp object in the food represents a hazard, since it is not expected by the consumer. The common hazards considered as avoidable physical hazards in foods include broken glass, pieces of hard or soft plastic materials, stones, pieces of metal, pieces of wood and personal articles. A variety of personal articles can become foreign objects in foods, resulting from unintentional adulteration by employees during preparation, handling, processing, and packaging. Personal articles that have been found in foods include jewelry, pens or pencils or their parts, Band-Aids, and ear plugs.

3.2.4. Safety and Quality Management Systems

In order to preserve the various quality features in food products, various safety and quality assurance systems have been developed. Some of the systems are obligatory by law and some voluntary to be implemented by the food chain members. The distinction between obligatory and voluntary systems is based on the safety (hazard-free products) being the quality of food required by law. Thus, obligatory systems have been established to assure food safety, and are subsequently called “safety assurance systems”. These include Good Hygiene Practices (GHP), Good Agricultural Practice and Good Manufacturing Practices (GMP) which are generally called accepted best practices and Hazard Analysis and Critical Control Point (HACCP), which is preventive methods applied, to different extents, by most enterprises that export food in order to reduce the risk of microbial, chemical and physical contamination

i. Good agricultural practice (GAP)

GAP focuses on the best practices to be used for producing agricultural products to ensure the quality and safety of the final product. GAP is guidelines, which ensure that all agricultural practices, in particular pest and disease control are in accordance with Integrated Crop Management (ICM) and Integrated Pest Management (IPM) practices. GAP aims at ensuring sustainable agriculture by minimizing hazards for the workforce, other actors along the food chain, consumers and the environment while ensuring economically viable production. With the increasing need for food quality and safety through the chain, the trend goes towards integrating HACCP and traceability concepts into GAP systems.

ii. Good hygienic practice (GHP)

Guidelines for GHP aim at establishing processing, handling, transport and distribution procedures that are appropriate to prevent perishing due to micro-organisms, growth of pathogens on food stuff, contamination with chemical residues or contaminants (e.g. mycotoxins). Basic rules are set out in the ‘Codex General Principles of Food hygiene. They include requirements for the design of facilities, control of operations (including temperature, raw materials, water supply, documentation, and recall procedures), maintenance and sanitation, personal hygiene and training of personnel. Hygienic

practices form an integral part of all food safety management systems, as for example within the HACCP system.

iii. Good manufacturing practices (GMP)

There are many reactions occurring during processing and manufacturing of raw materials that cause changes in composition, nutritional value, physical structure and sensory properties. The objectives of GMP are to control these changes so as to develop the desired qualities in the product, to ensure food safety and to stop or slow down any deterioration in the food. Good Manufacturing Practices means understanding, analyzing and controlling the manufacturing process.

iv. Hazard Analysis and Critical Control Point (HACCP)

HACCP is a common sense approach to identify, quantify and control food safety hazards. It sets up a framework allowing the detailed examination of a process to identify hazards and where the hazards can be controlled. HACCP system is a food safety management strategy which has been widely tested and established as an effective means of preventing food-borne diseases were correctly implemented. It is considered a scientific and systematic for assuring food safety, which can be applied throughout the whole food chain. HACCP further strengthen preventive and systematic approaches to assuring food safety. It is a management system in which food safety is addressed through the analysis and control of biological, chemical and physical hazards from raw material production, procurement and handling to manufacturing, distribution and consumption of the finished product. HACCP, which is recognized for its science-based approach, consists of a set of seven principles that have been adopted internationally through the work of Codex Alimentarius Commission. The seven principles of HACCP are:

1. Assesses the hazard, list the steps in the process where significant hazards can occur and describe the prevention measures;
2. Determines critical control points (CCPS) in the process;
3. Establishes critical limits for each CCP;
4. Establishes procedure to monitor each CCP
5. Establish corrective actions to be taken when monitoring indicates a deviation from the CCP limits;
6. Establish record keeping for the HACCP system; and
7. Establish procedures to verify that the HACCP system is working correctly.

3.2.5. Food safety and nutrition linkage

Access to safe and adequate food is a basic human need. Food safety is the assurance that food will not cause harm to the end user. Food can be unsafe at different points from farm to plate. Unsafe food is not food because contaminated food could cause disease, immune suppression and stunting. When contaminated agricultural product is withdrawn from the supply chain the quantum of food is directly impacted and affects access to markets and rural incomes, access to food and economic well-being. Food-borne and waterborne diarrheal illnesses murder an estimated 2.2 million people yearly, mostly children are affected. Diarrheal is the most common food-borne illness caused by pathogens. The Vicious cycle of disease and malnutrition, particularly affecting most vulnerable groups affects productivity.



Figure 3.1. Diarrhoea malnutrition cycle

Chemical or toxin contamination cause acute poisoning or chronic diseases, cancer. Foods rich in trans-fats, saturated fats, sugars and salt/sodium - increased risk of non-communicable diseases, e.g. diabetes and high blood pressure. Food safety, nutrition and food security are inseparably linked. Food safety affects food security pillars

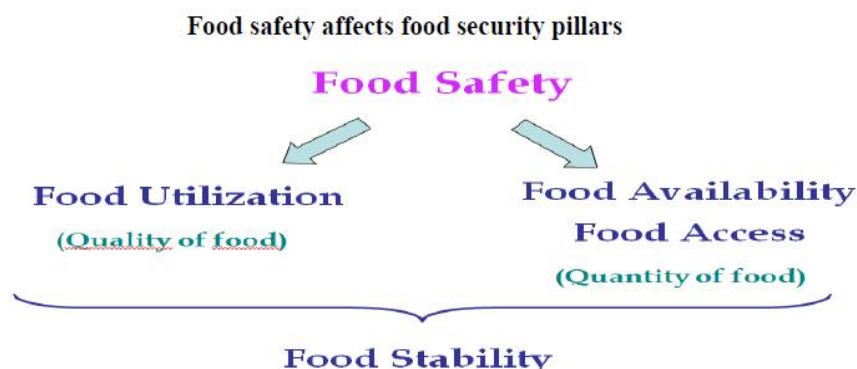


Figure 3.2. Food safety and food nutrition security linkage

Food-borne diseases have negative economic consequences for individuals, families, communities, businesses and countries by imposing substantial burden on health-care systems, trade and tourism, reduce economic productivity and threaten livelihood. Full spectrum of burden of food-borne diseases is challenging to quantify because they are underreported. Thus Policy makers at all levels need science-based, reliable estimates on burden of food-borne disease to make informed decisions and mobilize resources. Food safety is not negotiable. All requirements relating to the safety characteristics of a food must be met; there must be no unacceptable health risk associated with a food.

3.3. Postharvest Handling

The post-harvest or post-production operations of agricultural and horticultural products include a wide range of functions between production and consumption. These functions have to be carried out efficiently by different agencies/ individuals in the post-harvest chain in order to supply food of good quality to keep transaction costs low and to deliver high quality and safe raw material for further processing and value addition. Post-harvest operations deserve high priority since they contribute in several ways to the overall goal of sustainable development in agriculture and impact on its profitability. A substantial part of the consumer price for agricultural products, depending on the commodity, the type of post-harvest operation and the organizational structure, is attributable to processing, marketing, transport, storage and handling of the raw product. Therefore, efficient post-harvest handling, storage and marketing can tremendously contribute to social and economic aspects of rural communities. A considerable part of post-production activities is actually or may be potentially fulfilled on-farm by members of farm households. This adds to the value of the farm product and therefore the income of the household. There is a pressing need to establish efficient, time-cost-energy saving post-harvest technology systems, which reduce losses and optimize produce suitability and quality for market requirements. Among the critical areas that urgently require attention are: loss minimization, handling production surpluses, safe transport, transit or longer time storage, market access and creating favorable conditions for higher acceptance of high quality and competitively priced processed food.

3.3.1. Basic principles of post-harvest handling

The post-harvest system should be thought of as encompassing the delivery of agricultural produce from the time and place of harvest to the time and place of consumption, with minimum loss, maximum efficiency and maximum return for all involved. The term "system" denotes a dynamic, complex aggregate of logically interconnected functions or operations within a particular sphere of activity. The term "chain" or "pipeline" highlights the functional succession of various operations but

tends to ignore their complex interaction. In considering the system or the agro-food chain as a whole, harvesting can be seen as the centre, or as a point between the pre-harvest slope, corresponding to production activity and the post-harvest slope, extending from harvesting to consumption. These ideas are illustrated in the following diagrams, which give Bourne's graphic representation of the food pipeline.

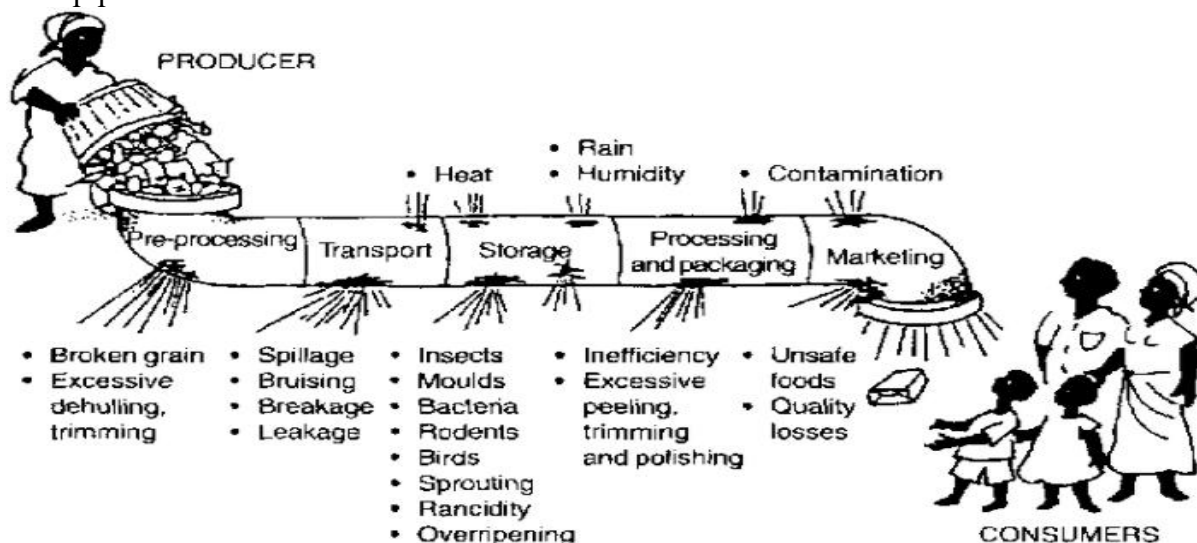


Figure 3.3. The Food Pipeline(Source: Bourne, 1977)

3.3.2. Postharvest loss

Postharvest loss can be defined as the deprivation in both quantity and quality of a food in the postharvest system. This scheme includes interrelated activities from the time of harvest through crop processing, marketing and food preparation, to the final decision by the consumer to eat or discard the food. Postharvest losses can be categorized as: a) direct losses: caused by waste or consumption by non-human agents, such as insects, rodents, birds, fungi, bacteria and others; b) indirect losses: because of worsening in quality or acceptability of the product up to the point of complete rejection by the consumer, which changes in its appearance, texture, and colour caused by climate, mishandling, transportation, or infrastructure; and c) economic losses are losses brought about by changes in market conditions and expressed in economic terms that is losses due to changes in demand and supply.

Food and Agriculture Organization of U.N. predicts one-third of food produced that is about 1.3 billion tons of food are internationally wasted or lost per year. Minimization of these losses would increase the quantity of food obtainable for human consumption and improve global food security the increasing worry with escalating food costs due to growing consumer demand, increasing demand for biofuel and other industrial uses, and increased weather variability. In addition, crop production contributes significant proportion of typical incomes in certain regions of the world (70 percent in Sub-Saharan Africa) and reducing food loss can directly increase the real incomes of the producers.

Currently, one of the key worldwide challenges is how to ensure food security for a world growing population at the same time as ensuring long-term sustainable development. According to the FAO, food production will need to grow by 70% to feed world population which will reach 9 billion by 2050. One important complementary factor food loss and food waste (postharvest loss) which has great importance to solve the problem of feeding the projected population is overlooked but food availability and accessibility can be increased not only by increasing production, improving distribution but also by reducing post-harvest losses. Thus, reduction of post-harvest food losses is a critical component of ensuring future global food security. The asset needed to minimize post-harvest loss is relatively modest and the return on that investment rises rapidly as the price of the commodity increases. An important factor in developed countries is that a large amount of the food

produced is not eaten but discarded, for reasons such as it was left on the plate after a meal or it passed its expiry date. In contrast, failure to consume available food in Less Developed Countries (LDCs) is not a reported concern; instead the issue in LDCs is inefficient postharvest agricultural systems that lead to a loss of food that people would otherwise eat, sell or exchange to improve their livelihoods.



Figure 3.4. Food Loss and Food waste

3.3.3. Causes of postharvest losses

Postharvest losses differ significantly amongst produces and production areas and seasons. As a product moves in the postharvest chain, post-harvest loss can happen from a number of reasons that can be categorized as follows: physical or mechanical are losses that can be occurred because of improper harvest methods, poor packaging, and transportation resulting in cuts, abrasions, bruises, breakage or leakage and biological factors and non-biological factors which affect the quality of agricultural produce.

Table 3.1. Generic food supply chain and examples of food waste (Parfitt et al., 2010)

Stage	Example of waste
1. Harvesting, handling at harvesting	Edible crops left in field, ploughed into soil, eaten by pests; timing of harvest not optimal; crop damaged during harvesting
2. Threshing	Loss due to poor technique
3. Drying, transportation and distribution	Quality and quantity loss during drying, poor transport infrastructure; loss owing to spoiling/bruising
4. Storage	Pests and disease attacks, spillage, contamination
5. Primary processing, cleaning, classification, hulling, pounding, grinding, packaging, soaking, winnowing, drying, sieving, milling	Process losses; contamination in process causing loss of quality.
6. Secondary processing, mixing, cooking, frying, molding, cutting, extrusion	Process losses; contamination in process causing loss of quality
7. Product evaluation and quality control	Product disregarded /out-grades in supply chain
8. Packaging	Inappropriate packaging damages produces; grain spillage from sacks; attack by pests
9. Marketing, selling, distribution	Damage during transport; spoilage; poor handling; losses caused by poor storage
10. Post-consumer	Poor storage/stock management; discarded before serving; poor food preparation; expiration
11. End of life disposal of food waste/loss at different stages in supply chain.	Food waste discarded may be separately treated, fed to animals, mixed with other wastes/landfilled

Smallholder farmers manage approximately 500 million small farms and provide over 80 % of the total food consumed in sub-Saharan Africa. The peak area of food losses reported are pre-farm gate where poor harvesting, drying, processing and storage of crops occur. There is confirmation from other developing regions where enhanced farm management practices and storage technologies have

resulted in intense food loss reductions which helped farmers to stop the repeated cycle of poverty, created by pressure to sell crops quickly when prices are low to avoid losses, only to buy grain later in the season at higher prices to meet their family's consumption requirements. Food is lost because of many reasons, which range from natural shrinkage (e.g. moisture loss), mold, pests, inadequate climate control and food waste. Food loss can be qualitative or quantitative. Qualitative losses are reduction of nutrient value and undesirable changes to taste, texture, or color while quantitative loss is measured by decreased weight or volume.

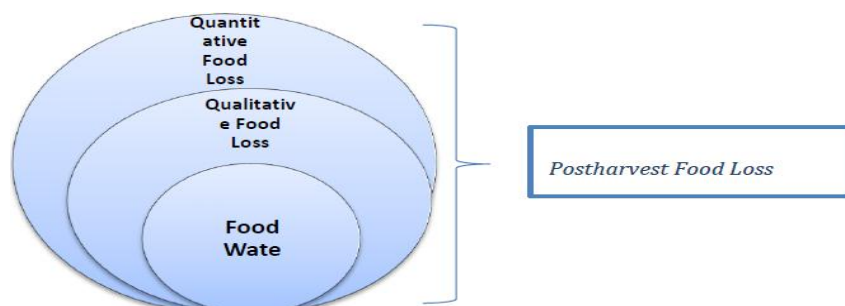


Figure 3.5. Postharvest Loss food components

3.3.4. Postharvest loss of animal source foods(ASF)

Post-harvest losses of ASF occur during animal and product handling, food processing, distribution and consumption; and it varies with the type of animal. Handling losses for bovine, pork and poultry meat refer to death during transport to slaughter and condemnation at slaughterhouse. For fish, it refers to spillage and degradation during icing, packaging, storage and transportation after landing. For milk, handling losses is related to spillage and degradation during transportation between farm and distribution. Processing losses for bovine, pork and poultry meat, refer to trimming spillage during slaughtering and additional industrial processing, e.g. sausage production. For fish, it refers to industrial processing such as canning or smoking. For milk, losses are related to spillage during industrial milk treatment (e.g. pasteurization) and milk processing to, e.g., cheese and yoghurt.

Distribution losses includes losses and waste in the market system, at e.g. wholesale markets, supermarkets, retailers and wet markets. Consumption losses includes losses and waste at the household level. Hence, different ASF require different postharvest handling and storage practices corresponding the type of losses associated with the type of product.

Table 3.2. Weight percentage of food losses and waste (in percentage of what enters each steps)

Estimated/assumed waste percentages for each commodity group in each step of the FSC for sub-Saharan Africa.

	Agricultural Production	Postharvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals	6%	8%	3.5%	2%	1%
Roots & Tubers	14%	18%	15%	5%	2%
Oilseeds & Pulses	12%	8%	8%	2%	1%
Fruits & Vegetables	10%	9%	25%	17%	5%
Meat	15%	0.7%	5%	7%	2%
Fish & Seafood	5.7%	6%	9%	15%	2%
Milk	6%	11%	0.1%	10%	0.1%

3.3.5. Impacts of postharvest loss on food and nutrition security

World Food Program special operation SO 200671 summary report notes that post-harvest food loss (PHFL) is one of the major underlying factors to food insecurity in Africa, directly influencing the lives of millions of smallholder farming families every year. Worldwide food production, supply and consumption schemes are not working to optimal productivity, with food losses in sub-Saharan Africa alone exceeding 30 % of total crop production and representing more than US\$4 billion in value every year. These annual food losses far exceed the total amount of international food aid provided to sub-Saharan African countries each year. In addition, such losses are projected to be equivalent to the annual caloric requirement of 48 million people.

3.3.6. Pre and post-harvest food safety problems and associated health risks

Controlling the food safety hazards during production, harvesting, slaughtering and postharvest handling (trimming, grading, packing, transport, processing, marketing etc.) of fresh produce is important to protect consumers' health and to gain access to markets. From the perspective of growers many agricultural inputs require careful thought about their use, and careful management and control of their use, because they are potentially hazardous when applied purposely to agriculturally produced food products. A case in point is found in the use of pesticides, herbicides, insecticides and fungicides, animal drugs, hormones and antibiotics. Pesticides are toxic compounds used in the growing of fruits and vegetables (as well as cereals and flowers) to reduce or eliminate target organisms, thereby increasing crop yield and quality. Public health authorities express concern about the ability of some pesticides to act as endocrine disruptors, causing, for instance, the impairment of brain and other bodily functions, disruption in the development of the brain and reproductive system, weakening of the immune system and the development of behaviour disorders. Also of concern is the degree to which pesticides are absorbed by the body and deposited in fatty tissues and the liver, as was demonstrated by the organochlorine compound, DDT, amongst others. Apart from concerns about the toxicity of some active agents in pesticides and their effects on human health, there may also be reason to be concerned about other compounds present in pesticides for technical purposes. Some pesticides contain polyacrylamide to aid the adhesion of the active agents to plant leaves. Polyacrylamide is converted to acrylamide at high temperatures such as those used in food processing and cooking. Recently the presence of acrylamide in fried and baked foods has caused concern because of its carcinogenic potential.

Plenty of food is lost in our system during postharvest handling of agricultural products because the quality deteriorates beyond what is acceptable for human consumption. But sometimes spoilage or contamination is not perceptible to the human senses and goes undetected, leading to adverse health effects when food is consumed. Several well-publicized outbreaks of acute aflatoxicosis in Sub-Saharan Africa, including the death of 125 Kenyans in 2004, suggest undetected food spoilage with very severe human health implications. Mycotoxins, in the forms of fumonisin and aflatoxins, can lead to slow-developing esophageal and liver cancers (respectively) and are growth-retarding and immune suppressive even in doses well-short of the more sensational, and often deadly, acute aflatoxicosis. These food safety concerns, arising from fungal or pest infestations, have major disease and global health implications. The mycotoxin in the food is occurred during the storage, in which the fungi produce an aflatoxin, and also in other livestock products if their feeds are contaminated with aflatoxin.

i. Handling and Safety of animal food items

Food items if unsafe can be source of various food borne illnesses. For the safety of animal food items, it is imperative that good animal husbandry (GAH) or good veterinary practices (GVP) be practiced to assure consumers that foods derived from animals meet acceptable levels of quality and safety. Along with this safe animal feed, that is, free from any threats should be provided to all animals. Improved nutritional content of livestock feed may lead to direct health benefit for animals, improving their welfare, and also indirectly benefit consumers. Animal welfare and health also plays a vital role in the overall quality of food.

Well-fed and rested animal or poultry is essential requirement for getting safe and good-quality foods of animal origin. Up to six middlemen are involved in procurement and transportation of meat animals for slaughter, which exerts stress and adversely affects safety and quality of meat. Veterinary inspection of meat animals and meat from farm to plate is essential to prevent most foodborne illness and diseases, which is not being done adequately in India. Consumers should follow WHO's five keys to keep food safer at domestic level.

Safety issues of foods of animal origin, similar to other foods, begin at the primary production stage and continue till consumption. The application of Good Agricultural Practices can reduce microbial and chemical hazards, which requires written operating and monitoring procedures to ensure production of wholesome foods of animal origin. All processes and operations should be carried out as per operating procedures to maintain safety and quality of such foods. Cooking temperature affects both taste and safety of food. Hotter temperatures at the core of the meat make it safer. Safe cooking temperatures at the core of meats must be attained. Hot foods should be kept above 60°C and cold foods, below 4°C, always. The understanding and adoption of safe handling, storage, and cooking practices for foods of animal origin in home kitchens are essential for achieving adequate safety of food before consumption.

Gaps between production, consumption, and inability of regulatory authorities to check adulteration are big temptation for fraudsters to make easy money through food adulteration, at the cost of nutrition and health of consumers. Milk adulterants include water, skim milk powder, cane sugar (sucrose), starch, fat, ammonium sulfate, etc. In Ethiopia, there are information published on the presence of mycotoxin specially aflatoxin in different agricultural food commodities including grains, and milk and products. This aflatoxin was occurred in store grain, fresh milk and milk products collected from the sources.

Summary

Food safety is a scientific discipline describing handling, preparation and storage of food in ways that prevent food borne illness.

Unsafe food is not food because contaminated food could cause disease, immune suppression and stunting.

Food quality and food safety requirements are addressed through the use of systems and programs that include quality management, quality assurance, quality control, the hazard analysis HACCP system, GAP, GHP and GMPs.

Postharvest losses can be categorized as: Direct losses, indirect losses and Economic losses.

Post-harvest loss highly affects food and nutrition security: the food loss in sub-Saharan African countries far exceeds the total amount of international food aid provided to each year.

Losses are projected to be equivalent to the annual caloric requirement of 48 million people.

Chapter 4. Gender and Nutrition

4.1.Introduction

In Ethiopia, the role of women in food production and consumption is under estimated and it required empowerment mechanisms. This chapter therefore introduces the concepts of gender in relation with production and consumption for family nutritional security.




4.2.Basic Gender related terminologies

Gender refers to the socially constructed roles and responsibilities assigned to men and women in a given culture or location. These roles are learned, they vary between cultures and they change over time. In most instances, gender is equated with women. However, paying attention to gender does not mean focusing on women as beneficiaries, but focusing on incorporating the needs of girls, boys, men and women at all levels of interventions.

Sex refers to biological attributes that identify a person as a male or female. These attributes are generally permanent, universal and cannot be changed over time.

Gender roles: Gender roles are the roles both women and men are expected to fulfill in the society as defined by the virtue of being female or male. Men and women get messages about their role and division of labor from family, schools, media and society at large. Gender roles show society's rule for how men and women are supposed to behave. These rules are sometimes called gender norms. They dictate what is "normal" for men and women to think, feel and act. Many of these differences are created by society and are not part of our nature or biological make-up and many of these expectations help us enjoy our identities as either men or women.

Triple role of Gender

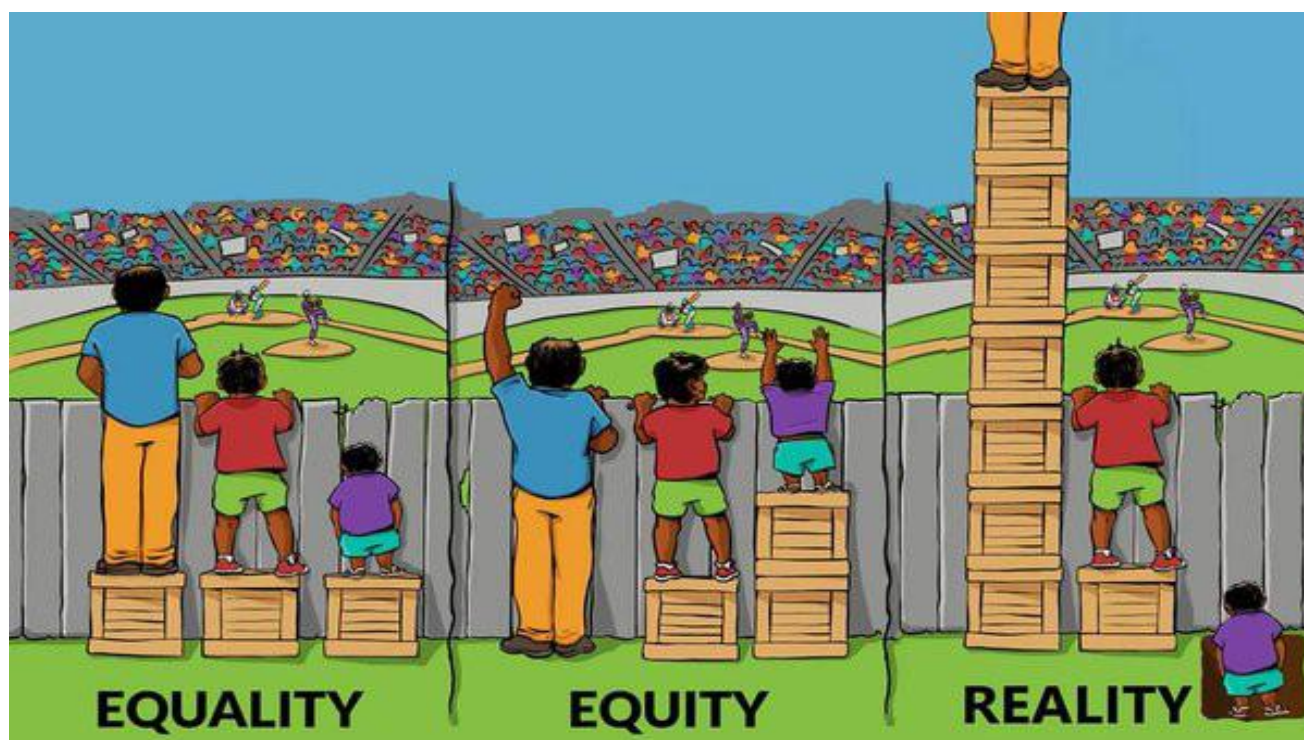
-  **Productive role:** Tasks which contribute to the economic welfare of the household through production of goods. Women's role as producers is usually undermined and undervalued.
-  **Reproductive role:** Activities performed for reproduction and caring for the household, water and fuel/wood collection, child care, health care, washing, cleaning, etc.
-  **Community management or socio-cultural activities:** Activities primarily carried out by men and women to ensure the co-existence of themselves as well as their family in their social environment. Examples of such activities include *Idir*, mutual help among neighbours/relatives, community groups, etc. which boosts their social capital.

Multiple roles

Both men and women **play multiple roles in society**. The major difference is that: men typically play their roles *sequentially*, focusing on a single role → productive role whereas women usually play their roles *simultaneously* by balancing the demands of each within their limited time constraints.

Gender equality: Gender equality means that women, men, boys and girls have equal opportunities, resources, rights and access to goods and services.

Gender equity: Gender equity refers to fairness of treatment by gender, which may be equal treatment or treatment which is different but which is considered equivalent in terms of rights, benefits, obligations and opportunities.



Access to resources means having the opportunity to use resources without having the authority to decide on the output and the exploitation methods.

Control over resources or benefits means having full rights to use and authority to decide what the outputs should be and how they should be used.

Gender disparity or gap: a specific difference or inequality between girls and boys, or men and women in relation to their conditions, or how they access or benefits from resource. In other words, it is a measure of gender inequality on any socio-economic indicator (e.g. men's and women's access to health service, school drop-out rate girls and boys).

Gender Sensitive: properly aware of the different needs, roles and responsibilities of men and women. Understand that these differences can result in difference for women and men in: access to control over resources; and level of participation in and benefit from resources and development.

Gender Blindness - refers to the unwitting or deliberate failure to

- Perceive that there are different gender roles, responsibilities, problems and profits and consequences
- The failure to realize that any development has gendered implications

4.3. Gender role in food production and consumption

A gender lens encourages a holistic understanding of the different roles of women and men and their ability to negotiate on production, distribution and consumption of food. The gender analysis concepts in food production and consumption can be seen in terms of division of labour; access and control over resources; decision-making; and norms and values. For example, it is not possible to only look at the division of roles between men and women without looking at how that influences access and decision-making, and vice versa.

A gender lens helps us to consider at community and household levels:

1. The roles men and women play in agricultural production and consumption
2. Access and control over resources men and women have (in relation to commercial and subsistence production), access to health services, clean water and hygienic toilets);
3. Intra-household decision-making around production and consumption (including care practices for children);
4. Norms and values and how these shape what people are supposed to do (role performance), their access to resources and how decisions are made in relation to food production and consumption.

4.4. Gender equality and equity for nutrition

Why gender matters

Malnutrition is one of the greatest threats to public health in the world. More often women face malnutrition problem than male. In households which are vulnerable to food insecurity, women are at greater risk of malnutrition than men. Malnutrition in mothers, especially those who are pregnant or breastfeeding can set up a cycle of deprivation that increases the likelihood of low birth weight, child mortality, serious disease, and low work productivity. Despite their vulnerability to malnutrition, women are in a unique position to improve nutrition in their households. B/c they are responsible for growing, purchasing, processing and preparing most of the food which is consumed. Gender matters because initiatives to improve **nutrition cannot achieve** without taking into consideration the social, economic and biological differences between men and women. Good nutrition and gender equality are mutually reinforcing. How? E.g Girls with access to good nutrition are better able to learn that enables her to know her right and responsibility (fight for their right). On the other hand gender equality enables girls to improve their nutrition via improved productivity and increased income.

Promoting gender equality and equity in nutrition sensitive agriculture requires taking into consideration the social, economic and biological roles, needs and differences between men and women and addressing the inequalities which are barriers to good nutrition. Inequities in access to and control of assets have severe consequences for women's ability to provide food, care, and health

and sanitation services to themselves, their family members. Women with less influence or power within the household and community will be unable to guarantee fair food distribution within the household. Any reduction in gender inequality benefits the entire family. Substantial evidence demonstrates that more equal access to and control over assets raises agricultural output, increases investment in child education, improves visits to health facilities for infants, raises household food security, and accelerates child growth and development. It also offers important economic payoffs for the entire society. Women's contribution to food production, food preparation, and child care are critical underpinnings for the social and economic development of communities, yet efforts in this direction are hampered by malnutrition.

4.5. Empowering women in food production and consumption

Women's empowerment refers to improving the social, economic, political and legal strength of women so that they gain power and control over their own lives. The pathway from women's empowerment to improved nutrition consists of three interrelated components: women's use of income for food and non-food expenditures; women's ability to care for themselves and their families; and women's energy expenditure.

Empowering women farmers can improve food security and nutrition both through increased food production as well through better use of food and income. Larger disparities in food production often exist between men and women farmers in access to land, security of tenure, education, credit, extension and other services. This makes it harder for women farmers to achieve the same yields and levels of production as men can, since they cannot get the inputs or technical knowledge needed to match their labour. A particular concern is that women often have less control over household resources, such as labour and manure, than men do. Women empowerment also includes enhancing women's socio-economic status such as education, nutrition awareness and knowledge, health-related practices, decision-making power, income, and access to and use of productive assets. Empowering women in food production and consumption requires increasing women's access to and control over assets (agricultural income) would change the allocation of household expenditures to improve household nutritional outcomes.











Focusing on food crops grown by women and improving women's access to extension, rural advisory and financial services as well as to information and markets are some examples of how women can be supported to access and gain control over productive resources and increased income. Targeting women for income-generating opportunities and ensuring equitable access to decent employment and control over earned income are equally important. 2016 National Nutrition

Sensitive Agriculture Strategy of Ethiopia recommends three mechanisms of women empowerment: women's access and control over assets and promotion of labour, time and energy saving technologies for women, discussed below.

4.5.1. Women's access and control over assets

Ensuring asset transfers or asset building interventions which properly target women can empower women for better nutritional outcomes. Empirical evidence shows that increasing women's control over land, physical assets, and financial assets serves to raise agricultural productivity, improve child health and nutrition, and increase expenditures on education and hence contributing to overall poverty reduction. It includes women's access to land and other productive assets, women's control over cash from agricultural activities (e.g. intra-household allocation of income between men and women, or the extent of women's ability to make decisions about purchases).

The main policy recommendation by FAO includes:

-  Focus on food crops grown by women
-  Securing land rights for women
-  Policies to increase access to water
-  Legal and policy support for the poor to access employment opportunities
-  Policies to increase extension services, financing, access to inputs and appropriate technologies for smallholders adapted to reach women and ethnic minorities
-  Investment in agricultural research that reflects the interests of smallholders, particularly women
-  Credit and financial services, including insurance
-  Increasing smallholders' (and women's in particular) access to markets
-  Increasing access to productive assets such as livestock, seeds and storage facilities
-  Social protection measures such as cash, food transfers and child care services

4.5.2. Labor, time and energy saving technologies for women

Women perform productive as well as reproductive roles. Therefore, the trade-offs between child care and agricultural production should be carefully assessed. Time and labour demands should be evaluated to avoid negative impacts on care, health and nutritional status that might result from women's increased workloads. Moreover, promoting the adoption of labour-saving technologies and practices can reduce women's workloads and free up valuable time for child care, food preparation

and women's health and leisure. For example: Higher-yielding and pest-resistant crops, use of draft animals, conservation agriculture and no-tillage methods, and transport facilities to and from fields can all decrease labour needs for agriculture production. Women are usually in charge of primary processing; therefore, women's work can be facilitated by the introduction of appropriate post-harvest technology, such as small pounding and dehusking machines. Women in rural communities also spend significant time on tasks such as collecting water and firewood; water-source construction and rehabilitation is thus a labour-saving investment, as are programmes to widen the use of fuel-saving technologies and fuel-efficient stoves for food preparation.



4.5.3. Involvement of Male in Feeding and Caring Practices

Childcare and feeding has been regarded as female's domestic role on health and nutritional outcome of children. The role of the father, though acknowledged, is the most neglected part in child health care. A child health care is 'mother centric', and less effective in participating father.

Men's greatest motivator for improved infant and child nutrition is their strong sense of responsibility as the heads of their households. While the economics of their households may dictate the quality and variety of food they can provide, fathers generally hold themselves accountable for providing food for their families. As part of the provision of nutritious food, some husbands monitor their wives' and children's diets to make sure they are eating right.

Chapter 5: Social Behavioral Change Communication (SBCC) for Nutrition

5.1. Introduction

Improved agricultural productivity is an important intervention to achieve food security but it does not necessarily translate into improved nutrition security either for producers or consumers. In Ethiopia where most of the society is bounded by culturally oriented food consumption, the culture and behavior of diversified production and consumption has to be challenged through communicative interventions. This chapter is therefore about social behavior change communication for nutrition.

5.2. The culture of food consumption in Ethiopia

Ethiopians, particularly rural households, use cereals as staple diets which are usually low in micronutrients and also do not contribute to dietary diversity. Though animal foods are dense in nutrient content, they are not widely used by the society because of accessibility and affordability and associated culture of the community. Culture, religion and traditional knowledge affect food and nutrition security by shaping a community's diet, food preferences, intra-household food distribution patterns, child feeding practices, food processing and preparation techniques, health and sanitation practices, traditional medicine and the accessibility and use of biomedical public health services. The food and nutrition security impact of culture, religion and traditional knowledge is inherently localized. Certain beliefs and practices may be harmful for one community and beneficial for another, depending on the specific diet and the social, economic and ecological environment (e.g. labour division, local food availability). Significant life events such as pregnancy and childbirth are generally characterized by numerous cultural or religious beliefs and practices regarding food and health. These beliefs and practices substantially affect health seeking behaviour and traditional

medicine. Diets and eating behaviours are influenced by many factors at individual, family, community and national levels.

5.2.1. Food preferences and nutrition

Individual, family and community have different food preferences. Food preference could be the result of many factors including socio-economy, culture, growth stage, physiological need and exposure experience for different food types. Food preference in most case is individual attribute on which people do have their own choices of available foods, which will have direct impact on nutritional status. Food preference is common in pregnant women and children, which in most cases is driven by their physiological needs. The peer influence, availability, familiarity and palatability could also be the factor for food preference of children.

5.2.2. Food taboos and nutrition

Food taboos refer to the restriction of specific foods as a result of social or religious customs. In many traditional societies, cultural norms and customs govern behaviors including during different life stages like pregnancy. Pregnancy is a particular period when physiological nutrient demands are substantially increased. To meet this increased nutrient requirement for both the woman and the fetus, a pregnant woman is supposed to increase the amount and quality of foods she consumes. Nevertheless, when misconceptions or food taboos exist, the pregnant women and children ability to meet such increased demands can even be more compromised, hence putting them at a greater risk of adverse pregnancy outcomes. Various forms of taboos, misconceptions, and cultural beliefs towards certain foods exist in various countries. For example, foods consumed cold like fruits and vegetables were reported to be taboo among nursing mothers in Mexico. Similarly, snails and grass cutter meat are taboo among pregnant women and eggs among children in South Eastern Nigeria. The study conducted in Hadiya Zone, Ethiopia revealed that milk and cheese were regarded as taboo foods by nearly half of the women (44.4%) followed by linseed and fatty meat (16% 11.1% respectively). The reasons for avoiding foods include fear of difficult delivery (51%), discoloration of the fetus (20%) and fear of abortion (9.7%).

5.2.3. Food sharing among family members

Many other animals actively share food; however, the patterning and complexity of food sharing among humans is truly unique. Food sharing is a human universal trait that forms the centerpiece of economic and social life. Human livelihoods require sharing at all life stages to support pregnancy, infancy, childhood, and adolescence, and to help reduce risk of daily food shortfalls in adulthood. Food sharing could also be between intra-household and inter-households based on the objectives.

Food sharing varies from one community to the other depending on specific culture. In many part of rural Ethiopia, food sharing is prevalent during holiday ceremonies and other social events. Food sharing at the household level is very important to achieve nutritional outcome among the members. Depending on culture, specific event, availability and types of food prepared at the household, there is disparity of food sharing among family and family members. In the case of some specific food types like “DeroWot” and other foods with high nutritional values, the sharing among the family members not equal. The father or male along with guest if any are the first to be served whereas the female and children come to be served at the last. The nutrition extension intervention by the rural extension workers should give due attention to change the practice of food sharing among the family member on the basis of equity. Priority should be given for member like pregnant women, lactating mothers, children and disabled persons.

5.3. Nutrition education, counseling and communication

Nutrition education: is any combination of educational strategies, accompanied by environmental supports, designed to facilitate voluntary adoption of food choices and other food- and nutrition-related behaviors conducive to health and well-being. Nutrition education is delivered through multiple venues and involves activities at the individual, community, and policy levels. Effective education is a key factor in improving nutrition and health, yet nutrition education continues to be overlooked in health and food security interventions, and is often weak or absent in professional training. Long-term nutrition education develops popular capacity to make good dietary choices and builds self-reliance. Nutrition education’s main goal is to make people aware of what constitutes a healthy diet and ways to improve their diets and their lifestyles. It helps individuals, families, and communities make informed choices about food and lifestyles that support their physiological health, economic, and social well-being.

Nutrition counseling: is a two-way interaction through which a client and a trained counselor interpret the results of nutrition assessment, identify individual nutrition needs and goals, discuss ways to meet those goals, and agree on next steps. Nutrition counseling aims to help clients understand important information about their health and focuses on practical actions to address nutrition needs, as well as the benefits of behavior change. Nutrition counselors may be nurses or other facility-based providers or community health workers or volunteers.

Nutrition communication: Nutrition communication is recognized as a primary form of intervention in national food and nutrition programs. The ultimate goal of nutrition communication is to produce nutritionally literate decision makers who are motivated, knowledgeable, skilled and willing to choose proper nutrition alternatives. Nutrition communication is a two-way process, where

participants can freely exchange knowledge, values and practices on nutrition, food, and related areas. It ensures the active involvement of those who could and should take part in decision-making, and in motivating and providing users with easy access to nutrition related information, resources, and services. Rural Extension workers and agriculture cadres are responsible for coordinating and supporting all nutrition communication activities at individual, household and community levels.

5.4. Nutrition Social behavioral change communication (NSBCC).

NSBCC is a set of interventions that systematically combines elements of interpersonal communication, social change and community mobilization activities, mass media, and advocacy to support individuals, families, communities, institutions, and countries in adopting and maintaining high impact nutrition-specific and nutrition sensitive behaviors or practices. Effective nutrition SBCC leverages enablers of behaviors and reduces barriers to adopting and maintaining behaviors over time. Human behavior is complex and profoundly influenced by social norms, access to resources, self-efficacy, structural constraints and opportunities, and habits. Systematically addressing the range of behaviors that have a direct or indirect impact on nutrition as well as the social and environmental factors that influence the adoption and maintenance of these behaviors is critical to the implementation of the Multi-Sectoral Nutrition Strategy.

Why do behaviors matter for nutrition?

Virtually all the immediate and underlying causes of malnutrition are behavioral – influenced by the behaviors of individuals and their household members. Nutrition is also influenced, however, by the behaviors of many other actors. These actors range from healthcare providers and school teachers to farmers and other agricultural agents, from religious and community leaders to private sector companies and policymakers, who collectively directly or indirectly influence care and feeding practices, household food security, the household environment, and healthcare services

How do behaviors change?

There are a large number of theories and approaches towards behavioural change derived from disciplines such as psychology, sociology, communication and political science. Given the range of theories and models that discuss behaviour change, no single behaviour change method is universally applicable.

Theory of planned behavior

Behaviours are more likely to be influenced when: individuals have positive attitudes about the behaviour; the behaviour is viewed positively by people who influence the individual and the individual has a sense that he/she can control the behavior.

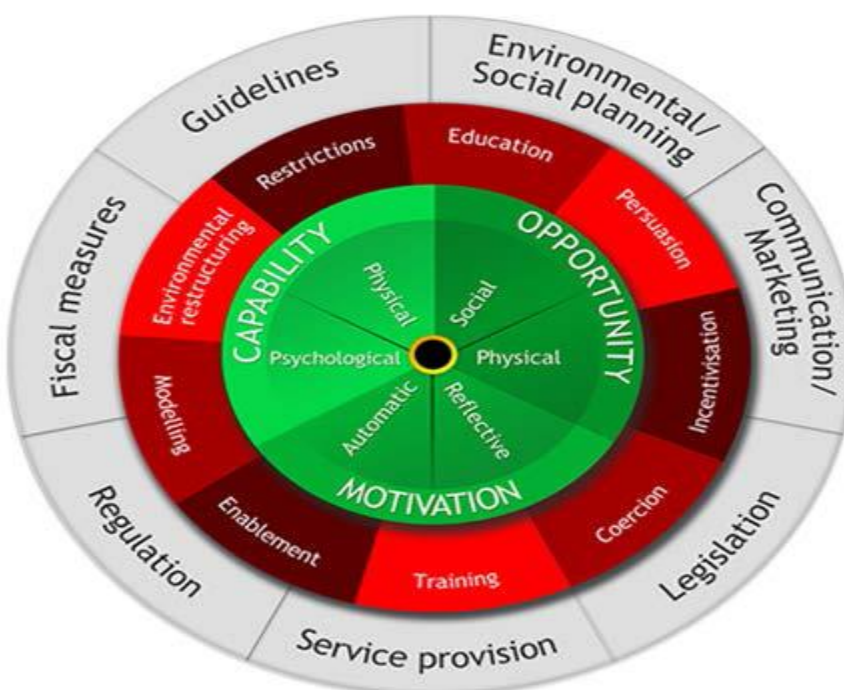
Open theory models

The behaviour change wheel

The Behaviour Change Wheel (BCW) was developed from 19 frameworks of behaviour change identified in a systematic literature review (Michie et al., 2011). It consists of three layers. The central hub identifies the sources of the behaviour that could prove fruitful targets for intervention. It uses the COM-B ('capability', 'opportunity', 'motivation' and 'behaviour').

- The COM-B model brings together concepts from multiple behavior change theories.
- The model states that a person will perform a behavior if they have sufficient **capability**, **motivation**, and opportunity at the right time and place.
- If any of these elements are not present or are insufficient, the person will not perform the behavior—no matter how compelling the messages!

Behaviour Change Wheel

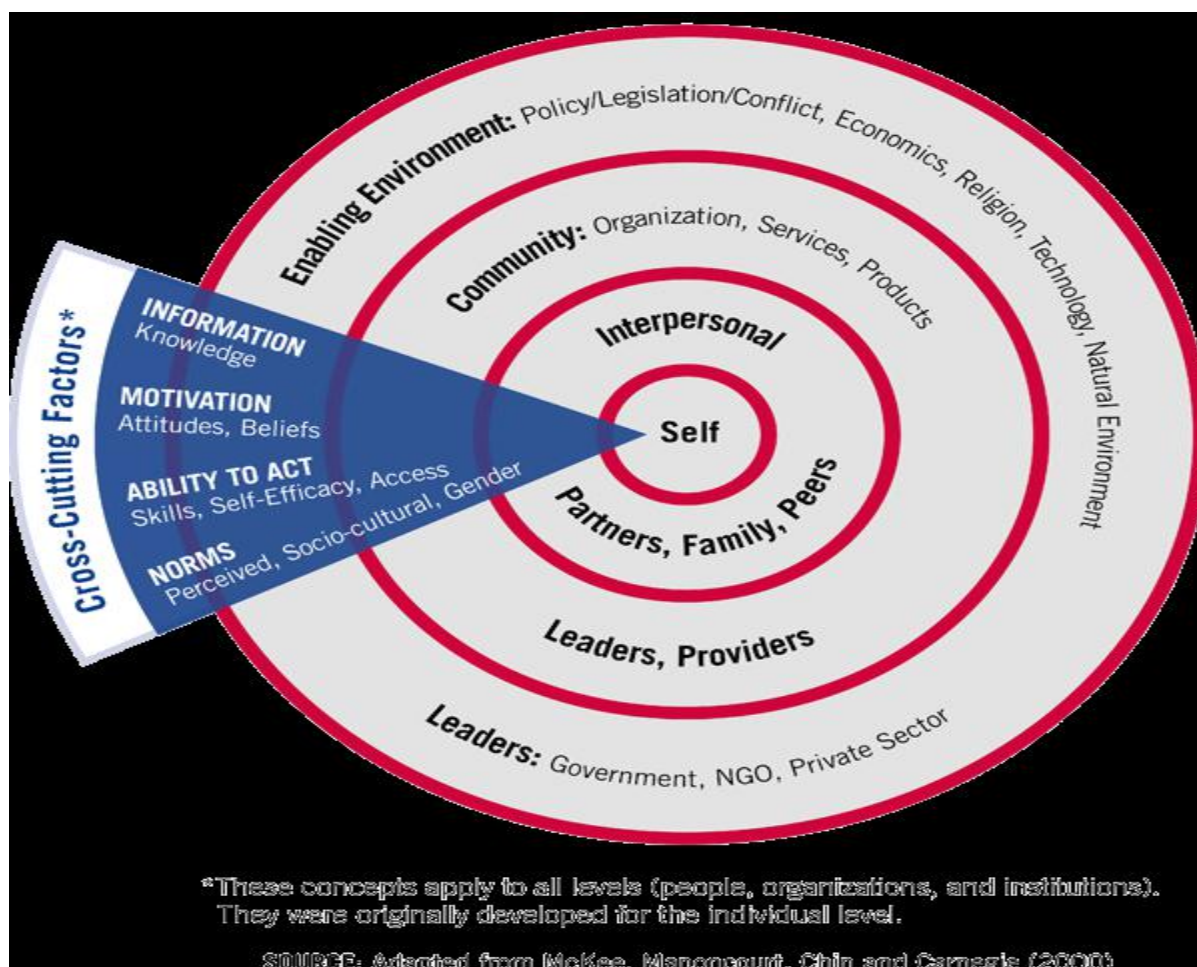


The Socio-Ecological Model.

Over the years, there has been a shift in thinking about human behavior. For example, 20 years ago, health communication practitioners largely believed that behavior change would result directly from giving correct information about prevention. While providing correct information is an important

part of behavior change, information alone has proved to be insufficient. Four key facts about human behavior are now widely acknowledged:

1. People make meaning of information based on the context in which they live.
 2. Culture and networks influence people's behavior.
 3. People cannot always control the issues that determine their behavior.
 4. People are not always rational in deciding what is best for their health and well-being.
- In the Socio-Ecological Model, the self is at the center of a series of concentric rings. This model suggests that each human being is influenced by layers of society, like an onion. The “rings of influence” are—
 - Interpersonal: this includes partners, family, and friends.
 - Community (leaders and providers): this includes organizations, services, and products.
 - Enabling environment: made up of higher-level leaders, such as government, nongovernmental organizations (NGOs), and the private sector. This includes policies, legislation, politics/conflict, economics, religion, technology, and the natural environment.



In this model, levels of analysis are represented by the rings, which show domains of influence as well as the people representing them at each level. The “self” ring represents those most affected by the issue. The next two rings represent those that have direct contact with those most affected and influence their attitudes, beliefs, and actions. They may shape community and gender norms and/or access to and demand for community resources and existing services. The outermost ring includes those that indirectly influence those most affected by the issue and represent the enabling environment. Components of this ring may facilitate or hinder change and include government policies and regulations, political forces, prevailing economic conditions, the private sector, religion, technology, and the natural environment.

Each level is influenced by four main cross-cutting factors that SBCC interventions may be able to modify to generate change. These factors may act in isolation or in combination and are discussed below.

Information: People need information that is timely, accessible, and relevant. With such information, some individuals, groups, or communities may be empowered to act. For most people, however, information is not enough to ignite change.

Motivation: Motivation, represented by attitudes and beliefs about the issues, is needed. Motivation can be affected by SBCC through effective counseling, peer education, or radio programs, for example. If done well, such communication can foster individual attitudinal and behavioral change, as well as social norm change. However, even motivation may not be enough.

Norms: Finally, norms, as expressed in perceived, socio-cultural, and gender norms, have considerable influence. Norms reflect the values of the group and specify those actions that are expected of the individual by its surrounding society. Perceived norms are those that an individual believes others are holding and therefore are expected of him or herself. Socio-cultural norms are those that the community as a whole is following because of social status or cultural conventions. Gender norms shape the society’s view on what is expected of males and females.

Ability to Act: In particular circumstances, especially those that may pose a threat or that involve strong gender or social norms against the behavior, people need the ability to act. Skills needed for the ability to act include problem solving, decision making, negotiation, critical and creative thinking, and interpersonal communication (IPC), for example. Efficacy, the confidence of individuals and groups in their own skills to affect change, access to services and transportation, and the ability to buy a diversity of foods, for example, are important elements in the ability to act.

Stages of change/ Transtheoretical model

This model focuses on stages of individual motivation and readiness to change behaviours.

	Steps	Appropriate interventions	Specific Tools
1	Pre-contemplation Never heard about the behaviour	Build awareness/provide information	<ul style="list-style-type: none"> ✓ Drama, fairs ✓ Community groups ✓ Radio ✓ Individual counselling ✓ Mother-to-mother support groups
2	Contemplation Heard about the new behaviour or knowing what it is	Encourage/discuss benefits	<ul style="list-style-type: none"> ✓ Group discussions or talks ✓ Oral and printed word ✓ Counselling cards ✓ Breastfeeding and Young Child Feeding Support Groups
3	Intention (Preparation phase) Thinking about new behaviour to take action	Negotiate and help to overcome obstacles	<ul style="list-style-type: none"> ✓ Home visits, use of visuals ✓ Group of activities for family and the community ✓ Negotiate with the husband and mother-in-law (or other influential family members) to support the mother
4	Action Trying new behaviour	Praise/reinforce the benefits	<ul style="list-style-type: none"> ✓ Congratulate mother and other family members as appropriate

			<ul style="list-style-type: none"> ✓ Suggest support groups to visit or join to provide encouragement ✓ Encourage community members to provide support (radio programmes)
5	Maintenance Continuing to do new behaviour or maintaining it	Provide support at all levels	<ul style="list-style-type: none"> ✓ Reinforce the benefits ✓ Praise ✓ Tell others

5.5. Tools for nutritional behavioral change communication

Behavior change communication (BCC): is any communication (e.g., interpersonal, group talks, mass media, support groups, visuals and print materials, videos) that helps foster a change in behaviour in individuals, families, or communities. It is a multi-level tool for promoting and sustaining risk-reducing behaviour change in individuals and communities by distributing tailored nutrition messages in a variety of communication channels. It includes careful and focused listening, understanding, and then negotiating with individuals and communities for long-term positive nutrition behaviours. BCC can be used as strategic use of communication to promote positive nutrition outcomes, based on proven theories and models of behaviour change. In using BCC for nutrition, it can be started by a systematic process 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.




The BCC process includes identifying, understanding, and segmenting audiences and providing them with relevant communication through well-defined strategies using appropriate mix of inter-personal, group, and media channels including interactive methods.

Social and behavior change communication (SBCC): Social and behavior change includes not only communication, but also actions to create an enabling environment for sustained behavior change. The actions may be formulation of policy, provision of needed systems, services, or infrastructure, social support, or measures to sway social norms. Social change is understood as a process of transformation in the way society is organized within institutions, and in the distribution of power within various social and political institutions. For behaviors to change on a large scale, certain harmful cultural practices, societal norms and structural inequalities have to be taken into consideration. Social change approaches, thus, tend to focus on the community as the unit of change.

Nutrition Behavior Change Communication (NBCC): is used to change nutrition related behaviors in a community. It involves not only health related messages but also educating the community about a wide range of Nutrition sensitive activities and multi-sectoral collaborations.

5.6. Nutrition extension through SBCC/NBCC

Nutrition extension through behavior change communication (BCC) improves household nutrition. It influences caregivers' preferences towards more nutrient-rich foods, intra-household allocation of food to benefit pregnant and lactating women and children, and other practices related to child feeding, care giving, sanitation and hygiene, and use of health services. Agriculture & Nutrition SBCC is a strategic package of behaviourcentred interventions (activities, programs and policies) aimed at supporting individuals, households, groups, and communities to adopt and sustain high impact ag& nutrition practices by:

-  promoting specific individual and group behaviors – among mothers, fathers, caregivers, nutrition and health service providers, farmers, peer networks, and others
-  shifting social attitudes, structures, and norms
-  creating enabling environments that promote and provide support for social change & positive change in agriculture & nutrition behaviors and that above all ... aim to DO NO HARM

Chapter 6: Multi-Sectoral Coordination for Nutrition

6.1. Introduction

Coordination is one strategic objective focusing on multi-sectoral coordination and linkages for nutrition. The purpose is to enhance the nutritional impact at a grass root level by concerted action of

various sectors. Evidence indicates that the factors that hinder progress in improving nutrition are multi-faceted and multi-sectoral. Therefore, these need to be counteracted by equally powerful, multi-sectoral, multi-stakeholder forces that combine nutrition-specific, nutrition-sensitive and environment enabling actions at all levels across sectors. To ensure viable linkages and harmonization among relevant sectors, the Federal Ministry of Health is mandated to house and manage the organizational and management structure of the NNP II. Seqota declaration is another big nutrition movement in Ethiopia with aim of ending child under nutrition by 2030. It also brings a number of parties (no less than 11 ministries and additional development partners) for joint action against malnutrition. Therefore, this chapter will cover the multi-sectoral nature of nutrition and the roles of different sectors for nutrition.

6.2. Multi-sectoral nature of nutrition

Nutrition has a multi-dimension and multi-sectoral nature in terms of both effect and outcome. The multi-sectoral nature of nutrition requires individual, institutional and system-level capacities to operationalize effective interventions through collaborative engagement across sectors and stakeholders. Effective implementation further requires coherence both vertically (within sectors and stakeholder institutions) and horizontally (across sectors and stakeholders). In order to ensure effective multi-sectoral coordination among different stakeholders, a common structure was already established by the government in the National Nutrition Programme II (NNP II).

6.3. The Ethiopian National Nutrition Program

The National Nutrition Program (NNP) is a national multi-sectorial program with strategic objectives to improve the nutrition condition of the country. The NNP I has been implemented during the first Growth and Transformation Plan (GTP I) and a follow on NNP II is launched in December 2016 to be implemented during GTP 2 and will be in place up to 2020. The health sector is assumed the coordination while agriculture and livestock, education, women and child, water, irrigation and electricity sectors are main sectors working to achieve the program through both mainstreaming and direct implementation of the program in their respective areas.

Strategic objectives of the NNP II are:

1. Improve the nutritional status of women (15–49years) and adolescents (10–19 years),
2. Improve the nutritional status of infants, young children and children under 5 years,
3. Improve nutrition service delivery for communicable, lifestyle related or noncommunicable diseases affecting all age groups,
4. Strengthen implementation of nutrition sensitive interventions in various sectors,

5. Improve multi-sectoral coordination and capacity to ensure implementation of the NNP.

6.4. Roles and responsibilities of various sectors

The National Nutrition Coordination body remains the main mechanism for leadership, policy decisions and coordination of the NNP. Similar multi-sectoral nutrition coordination framework and program implementation arrangements are provided at regional, Woreda and Kebele levels. The terms of reference, membership, frequency of meetings and the roles and responsibilities of NNP implementing sectors have been detailed in the Guideline for Multi-sectoral Nutrition Coordination.

Ensuring good nutrition requires the contributions of many different sectors. The ranges of sectors that are involved in efforts to reduce under-nutrition are in total 13 and presented below in the figure (Fig 6.1.)



Figure 6.1. Different sectors involved in implementation of nutrition program (Adopted from NNP II).

Each sector has a role to play in NNP II and its implementation according to their mandates (table 6.1). In order to have effective coordination, each sector needs to properly understand the importance of nutrition and what is expected of them. Assigning a responsible body is a second step towards implementation of the strategy. The agriculture sector serves as co-chair of the NNP II and primarily takes the lead in the provision of food for the household and community. It also plays a pivotal role in reaching the rural population through strong extension system.

Table 6.1. Major roles and responsibilities of nutrition signatory sectors

Sectors	Major Roles and Responsibilities
Health	<ul style="list-style-type: none"> • Strengthen the community level linkage and capacity of women based structures & associations at all levels to promote optimal adolescent, maternal, infant and young child nutrition (AMIYCN) and caring practices
Agriculture & Natural resource	<ul style="list-style-type: none"> • Increase year-round availability, and access to and consumption of fruits and vegetables, nutrient-dense cereals and pulses. • Promote technologies for post-harvest food processing, handling, preservation and preparation to help ensure that food is both nutritious and diverse. • Improve nutrition-sensitive agriculture (NSA) knowledge and practice among farmers. • Promote production and consumption of bio-fortified crops.
Livestock & fishery	<ul style="list-style-type: none"> • Increase year-round availability, access to and consumption of animal-sourced foods. • Promote technologies for post-harvest food processing, handling, preservation and preparation to help ensure that food is both nutritious and diverse • Improve nutrition-sensitive livestock and fishery development knowledge and practice among farmers through behavior change communication.
Industry	<ul style="list-style-type: none"> • Conduct awareness creation events for the private sector on nutrition related requirements and standards for local manufactured food items.
Trade	<ul style="list-style-type: none"> • Ensure the quality and safety of imported food items as per the national standard. • Conduct awareness creation events for the public/consumers on the benefits of fortified food.

Water, Irrigation & Energy	<ul style="list-style-type: none"> • Increase access to safe and clean water. • Increase access to small- and large-scale irrigation schemes. • Increase access to and availability of renewable energy
Government Communication	<ul style="list-style-type: none"> • Create public awareness on healthy dietary practices, healthy lifestyles, and lifestyle related non-communicable diseases. • Utilize available media outlets to promote optimal nutrition behavior
Youth & Sport	<ul style="list-style-type: none"> • Promote the provision of credits, grants, microfinance services and other income generating initiatives to support increased access to nutritious foods among vulnerable groups
Disaster risk management	<ul style="list-style-type: none"> • Strengthen and scale up early warning systems for food and nutrition information from the community level up to the national level. • Improve knowledge and practice of nutrition- sensitive disaster risk management among farmers, using behavior change communication.
Labor & social affairs	<ul style="list-style-type: none"> • Promote the implementation of gender- sensitive social safety net program and other social protection instrument in urban settings to protect vulnerable groups from food insecurity and under nutrition.
Women & Children	<ul style="list-style-type: none"> • Incorporate a gender analysis as part of the regular nutrition situation analysis, analyzing the needs, priorities and roles of men and women. • Mainstream gender equality within all nutrition training programs. • Engage and mobilize women's groups in nutrition advocacy and skills transfer. • Promote meaningful male involvement in nutrition interventions.
Education	<ul style="list-style-type: none"> • Promote and scale up school feeding programs. • Promote school health and nutrition (SHN) interventions through collaboration with other sectors.
Finance & economy	<ul style="list-style-type: none"> • Mobilize resources for nutrition and making sure public resources allocated for nutrition are properly utilized.

6.5. Role of agriculture and livestock sector in the NNP II

Agriculture in general and more specifically agriculture and natural resource and livestock and fishery sectors are responsible to provide food for the society and generate income for the rural population engaged in agriculture. Therefore, the core responsibility of the sector in terms of nutrition security is making nutritious food available and accessible. Due to agro-ecological diversity and difference in suitability, each area can only produce selected type of commodities. This naturally limits availability of various foods among localities leading to commodity specialization. On the other hand, some communities rely on narrow range of foods while others can have diverse. Culture and religion also influence preferences which type of food can and cannot be consumed.

There are two ways to diversify availability of food. The first is through developing the marketing systems in the local market where the farmers can sell their produce and buy what they do not have from others. This will eventually expand the local market and encourage farmers to specialize in certain commodities that they found to be more productive and fetch good prices. As the market expands it attracts traders to bring different products not grown in the area creating more opportunities. This will enhance farmers' specialization and thereby create further opportunities in expanding non-agricultural jobs and eventually some level of value addition. The second way is through production of diverse types of food by the household through homestead gardening and engaging in various types of agricultural and livestock production depending on the suitability of the agro-ecology and resource endowment of the family.

Various programs and projects are formulated and being implemented in the agriculture sector. Most of these projects have nutrition either as an objective or a component to address. The most important ones are Agriculture Growth Program (AGP) and Productive Safety Net Program (PSNP) being implemented in agricultural potential and food insecure areas, respectively. Generally, nutrition security is captured as an important strategic focus area in the GTP 2 enabling all programs to mainstream and ensure program implementation addresses nutrition security.

6.6. Strengthening multi sectoral coordination

Advancing nutrition in countries requires capable human resources, effective institutions, and functional systems to plan, manage, and evaluate programs. Strong country commitment and government leadership along with the active engagement of communities, the private sector, and civil society are essential for achieving and sustaining nutrition outcomes. The commitment of country leadership to nutrition at all levels, including larger and sustained resource allocations for nutrition, is essential to creating and sustaining momentum and for conversion of that momentum into results on the ground.

Building national, multi-stakeholder commitment to nutrition will foster coordination across government ministries, promote public-private partnerships, build country capacity, set strong policy foundations, and increase the ease and likelihood of being able to expand availability and utilization of nutrition services. Effective multi-sectoral coordination along with collaborative planning and programming across sectors at national, regional, and local levels are necessary to accelerate and sustain nutrition improvements. Programming nutrition-specific and nutrition sensitive interventions in the same geographic areas can also be effective to improve nutrition outcomes. Given that the nutrition, their risk factors and social determinants have roots and implications for sectors beyond health, a multi-sectoral response is critical to tackle them in a comprehensive manner. The

experiences of similar public health concerns suggest that multi-sectoral coordination mechanisms can go a long way in providing a synergistic response to nutrition in countries.

In order to realize food and nutrition security at national and household levels and to accelerate the reduction of malnutrition, the Government of Ethiopia opted for an approach that would see nutrition integrated into various sectors through a well strengthened and integrated multi-sectoral approach. Several reviews have shown that in order for a multi-sectoral coordination mechanism to succeed, it should have a strong institutional arrangement within the NNP implementing sectors. To execute its mandate of coordinating the sectors and fulfilling the aims of NNP II and the Seqota Declaration, the National Nutrition Coordinating Body (NNCB) needs to be well strengthened and functional up to the kebele levels, along with the necessary resources and accountability. Sectoral members would therefore be held accountable, both institutionally and collectively, for the achievement of the nutrition goals and targets set by the National Nutrition Program.

✦ The following are proved measures to strengthen multi sectoral coordination at different levels:

Increased political will and resources for nutrition programs

- ✦ Support joint assessments, gap analyses, and program reviews between inter-office teams
- ✦ Improved systems to plan, manage, monitor, and evaluate nutrition programs
- ✦ Increased professional and institutional capacity
- ✦ Strengthen planning and coordination for effective convergence of interventions in geographical areas, as appropriate, for increasing nutrition outcomes
- ✦ Increased stakeholder engagement around national nutrition goals
- ✦ Establish joint planning mechanisms between development and humanitarian assistance agencies at the country and/or regional levels
- ✦ Intensify coordination and strategic planning of both humanitarian and development assistance programs to target high risk communities, reduce vulnerabilities, and increase development opportunities
- ✦ Document best practices in transitioning emergency response to development opportunities
- ✦ Reinforce advocacy efforts for government and donor support of multi-sectoral nutrition planning, programming, and dissemination of results
- ✦ Strengthen and expand project and program learning associated with multi-sectoral activities
- ✦ Strengthened engagement with the private sector to improve nutrition

- ✦ Work with the private sector to develop stronger communications and marketing approaches in support of improved nutrition for mothers and children and increase demand for safe and nutritious foods

Chapter 7: Planning, Monitoring and Evaluation of Nutrition Sensitive Agriculture Interventions

7.1. Introduction

Though the agriculture sector has the larger potential in feeding people well by increasing availability, affordability, and consumption of diverse, safe, nutritious foods and diets, aligned with dietary recommendations and environmental sustainability, the Ethiopian agricultural system is at its infant stage to be explicitly nutrition sensitive and this affected the agriculture sector ability to impact fully on the nutritional situation of the country. The idea of nutrition-sensitive agriculture has not yet been internalized by agriculture project planners and managers. With respect to monitoring and evaluation, agriculture project planners and managers are facing considerable difficulty even with their existing orientation. This chapter addresses the basic planning principles, monitoring, evaluation and indicators of nutrition sensitive agriculture intervention.

7.2. Basic principles of planning for NSA interventions

The basic principle of planning to make agriculture system nutrition sensitive can be classified as program principles and policy principles. The components of each principle are presented as follows:

7.2.1. Program principles

At program level, agricultural programs and investments can strengthen impact on nutrition if they are designed considering the following:

1. Assess the context at the local level to design appropriate activities to address the types and causes of malnutrition.

During designing a nutrition-sensitive intervention, a thorough analysis of the context, in particular of the nutritional problems that affect different parts of the population, their multiple causes, and the social and institutional contexts that shape the food and nutrition security situation is paramount important.

2. Incorporate explicit nutrition objectives and indicators into their design, and track and mitigate potential harms

Nutrition-sensitive agricultural investment programs should not only seek to improve nutritional outcomes, they should, at least, ensure that they do no harm to the nutritional status of the project stakeholders, including producers and consumers.

Types of harm that may arise from agricultural interventions:

- Employment levels have remained static or deteriorated;
- Small producers have been excluded;
- Women are not able to participate;
- Intra-household equity of income has declined;
- The labor burden of women has increased;
- In irrigation/water use projects, changes in water-borne diseases;
- When agrochemical inputs are used, possible risks to health

During planning, we have to consider the following questions:

- ✚ What is/are the program's main objective(s)?
- ✚ Is nutrition considered as part of the objective(s)? How?
- ✚ What nutrition indicators can be used to measure the achievement of these objectives?
- ✚ What is/are the impact pathway(s) through which the program is likely to impact nutrition?

3. Target the vulnerable and improve equity

During planning of our agricultural intervention, target the vulnerable (women of reproductive age group, children, youth, the landless, and others) and improve equity is paramount important.

Agricultural planner should address the following question.

- Who will benefit from the program?
- How is the project or investment expected to reach women of childbearing age and young children?
- Is it possible that the intervention may benefit one group while harming another?

4. Collaborate and coordinate with other sectors

Impact on nutritional status cannot necessarily be achieved by food and agriculture programs alone. Access to health, water and sanitation, education and social protection programs are usually required. It is therefore important to seek synergies with operations from other sectors like health, environment, social protection, water and sanitation, education, and other development partners through joint strategies with common goals, to address the multiple underlying causes of malnutrition. As an agricultural planner, we should consider the following questions during planning to collaborate with other sectors.

- Are existing or proposed mechanisms for facilitating coordination and communication among stakeholders available?
- Who is involved in this process?

5. Maintain or improve the natural resource base

During planning, our activities should consider to use the natural resources in a sustainable way, contribute to climate change adaptation, and take measures to ensure that wild biodiversity is maintained and neither crops nor agricultural practices degrade the natural resource base. Water, soil, air, climate and biodiversity are critical to the livelihoods and resilience of vulnerable farmers and to sustainable food and nutrition security for all.

We should also take into consideration the following question during planning

- Does our agricultural intervention include measures to protect or improve soil quality and biodiversity?
- Is our agriculture intervention likely to affect the quantity and quality of water available to households with malnourished individuals?

6. Empower women

Women's income and decision-making power is linked to improved nutrition for household members because of the role women play across cultures as providers and gatekeepers of household nutrition, child care, and health. Furthermore, gender equity takes into account women's central role in translating agricultural inputs and outputs into nutrition impacts. Our planning should answer following questions:

- ✚ How will women be involved and benefit from the agriculture program interventions?
- ✚ Are they likely to control income generated by the program?
- ✚ Are there labor-saving technologies for women's tasks that could be included in the project to reduce the time women spend on agricultural or household tasks?

7. Facilitate production diversification, and increase production of nutrient-dense crops and small-scale livestock

Diversified production systems is important for small holder farmers to ensure resilience to climate and price shocks, more diverse food consumption, reduction of seasonal food and income fluctuations, and greater and more gender-equitable income-generations. Therefore, during planning, we have to consider the following questions:

- Do farmers reside close enough to their fields that diversifying production is likely to influence own-consumption?

- Do farmers have access to markets where they would be able to sell perishable foods?
- What local resources or underutilized foods could be grown to improve diets and nutrient intake?
- How can market access to nutritious food be increased for both local rural and urban populations?

8. Improve processing, storage and preservation

Appropriate processing, storage and preservation are essential to reduce post-harvest losses and improve or prolong access to and consumption of micronutrient-rich foods. Processing and storage techniques can preserve the nutrient content of food, and certain processing techniques can even increase it, e.g. roasting, germination and fermentation. Therefore, we have to answer the following questions during planning for agriculture interventions:

9. Expand markets and market access for vulnerable groups, particularly for marketing nutritious foods.

Market opportunities may be an incentive for farmers to produce and potentially consume nutritious foods they otherwise would not. An important contribution that investments in agricultural value chains can make to nutrition is by improving market access: • For producers, processors and retailers, to help them sell their products and generate income which can be invested in better health, care and food consumption; and • For consumers, to improve availability and affordability of nutrient-dense foods.

10. Incorporate nutrition promotion and education

It is important to include measures in program design to build on existing local knowledge, attitudes and practices of the community on nutrition. Nutrition knowledge can enhance the impact of production and income in rural households, especially important for women and young children, and can increase demand for nutritious foods in the general population.

7.2.2. Policy principles

Agriculture programs and investments need to be supported by an enabling policy environment if they are to contribute to improving nutrition. Food and agriculture policies can have a better impact on nutrition if they:

1. Increase incentives (and decrease disincentives) for availability, access, and consumption of diverse, nutritious and safe foods through environmentally sustainable production, trade, and distribution: The focus needs to be on horticulture, legumes, and small-scale livestock and fish –

foods which are relatively unavailable and expensive, but nutrient-rich – and vastly underutilized as sources of both food and income.

2. Monitor dietary consumption and access to safe, diverse, and nutritious foods. The data could include food prices of diverse foods, and dietary consumption indicators for vulnerable groups.

3. Include measures that protect and empower the poor and women: Safety nets that allow people to access nutritious food during shocks or seasonal times when income is low;

land tenure rights; equitable access to productive resources; market access for vulnerable producers (including information and infrastructure). Recognizing that a majority of the poor are women, ensure equitable access to all of the above for women. (refer to Ethiopian PSNP 4 document)

4. Develop capacity: Capacitate human resources and institutions to improve nutrition through the food and agriculture sector, supported with adequate financing.

5. Support multi-sectoral strategies to improve nutrition: within national, regional, and local government

7.3. Monitoring and evaluation indicators for NSA activities

The idea of nutrition-sensitive agriculture has not yet been internalized by agriculture project planners and managers. So, proper monitoring and evaluation of agricultural projects for their impact on household food security and nutrition is important. The monitoring data that should be collected for NSA interventions are;

- Information indicating participation and the extent to which households have been reached/affected by the agriculture project
- Data on household food insecurity levels and on the dietary quality
- Data on child and maternal nutritional status
- Income level of the household
- Information on women's empowerment (qualitative and quantitative)
- Information on any harmful effects of the project on food security or nutrition.
- On-farm availability, diversity, and safety of foods
- Data on natural resource management practices