**COLLEGE: CSS**

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# Chapter One

# Introduction

##  1.1, The Concept of Ecology and Agro ecology and Farming System

**Ecology**

Origin of the word…”ecology” that is, it is a Greek origin: OIKOS = household, **LOGOS = study. Therefore, Study of the “house/environment” in which we live.**

**Ecology is study of interactions between non-living components** in the environment such as light , water, wind, nutrients in soil, heat, solar radiation, atmosphere, etc. and Living organism, such as Plants, Animals, microorganisms in soil, etc. It views each locale/ environment as an integrated whole of interdependent parts that function as a unit. The interdependent parts are *Nonliving* such as dead organic matter, nutrients in the soil and water; Producers such as green plants; *Consumers* such as herbivores and carnivores; Decomposers such as fungi and bacteria.

**Then, ecology is an integrated and dynamic study of the environment; the study of living organisms in the natural environment. How they interact with one another how they interact with their non-living environment.**

**B, Agro ecology**

A wider understanding of the agricultural context requires the study between agriculture, the global environment and social systems given that agricultural development results from the complex interaction of a multitude of factors. It is through this deeper understanding of the ecology of agricultural systems that doors will open to new management options more in tune with the objectives of a truly sustainable agriculture.

**Different scholars’ definition**

**Gliessman 2000 defined:**  “The application of **ecological concepts and principles** to the **design and management** of **sustainable farming systems.**

* **Ecological concepts and principles**: understanding science
* **Design and management**: practice (technology)
* **Sustainable**: goal and motivation (What is sustainability? How does sustainability vary? What makes a farming system sustainable? Is sustainability always attainable?)
* **Farming systems**: techniques

**B. Boeken defined that:** The **application of ecological concepts and principles to farming systems**

* **Ecological concepts and principles**: ecological processes associated with farming
* **Farming systems**: All agro-systems (Conventional, traditional and Alternative agriculture)

The science of **agro ecology**, is defined as the application of ecological concepts and principles to the design and management of sustainable agro ecosystems, provides a framework to assess the complexity of agro ecosystems. **Agro ecology is the study of the interactions between living organisms and their environment in agricultural systems**. The idea of agro ecology is to go beyond the use of alternative practices and to develop agro ecosystems with the minimal dependence on high agrochemical and energy inputs, emphasizing complex agricultural systems in which ecological interactions and synergisms between biological components provide the mechanisms for the systems to sponsor their own soil fertility, productivity and crop protection.

**Agro ecology** is a discipline that defines, classifies and studies agricultural systems from an ecological and socio-economic perspective, and applies ecological concepts and principles to the design and management of sustainable agro ecosystems. Agro ecology is first and foremost a response to the negative ecological, social and economic impacts of industrial agriculture.

* The **ecological** perspective, focusing on how natural resources - soil and water are used and managed for sustainable agricultural production;
* The **economic** perspective, focusing on the marketing of agricultural products through competitive value chains which link farmers to the consumer; and
* The **social** perspective, focusing on how stakeholders interact, who controls change in agricultural practices, and how to ensure that the benefits of innovation are enjoyed by all sectors of society including the poor and previously disadvantaged

**Hot topics in agro ecology**

* Pesticide effects on biodiversity
* Mixtures of pesticides and effects on organisms
* Endocrine disrupting effects of pesticides and industrial chemicals
* Genetic engineering and “genetic pollution” in environment
* Soil food web- function of diversity
* Nutrient cycles
* Industrial waste--toxic waste and application to land of heavy metals and dioxin in fertilizers

**C, Farming system**

**A system** is a set of inter-related, interacting and interdependent elements acting together for a common purpose and capable of reacting as a whole to external stimuli. It is unaffected by its own output and it has external boundaries based on all significant feed backs.

**Farms are systems** because several activities are closely related to each other by the common use of the farm labour, land and capital, by risk distribution and by the joint use of the farmer’s management capacity. The analysis of farms is quite important to the subject of development.

**Farming systems** refers to an ordered combination of crops grown, livestock produced, husbandry methods and cultural practices followed.

An appropriate mix of farm enterprises and the means available to the farmers to raise them for profitability. It interacts adequately with environment without dislocating the ecological and socio-economic balance on one hand and attempt to meet the national goal on the other.

Farming system is a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirements of farm livelihood while preserving resource base and maintaining a high level of environment quality (Lal and Miller 1990).

## 1.2, Ecosystem and agro ecosystem

**A, Ecosystem**

An **ecosystem** is a [community](https://en.wikipedia.org/wiki/Community_%28ecology%29) of living organisms in conjunction with the [nonliving components](https://en.wikipedia.org/wiki/Abiotic_component) of their environment (things like air, water and mineral soil), interacting as a system. These biotic and [abiotic components](https://en.wikipedia.org/wiki/Abiotic_component) are regarded as linked together through nutrient cycles and energy flows. As ecosystems are defined by the network of interactions among organisms, and between organisms and their environment, they can be of any size but usually encompass specific, limited spaces (although some scientists say that the entire planet is an ecosystem).

**Energy, water, nitrogen and soil minerals** are other essential abiotic components of an ecosystem. The energy that flows through ecosystems is obtained primarily from the sun. It generally enters the system through [photosynthesis](https://en.wikipedia.org/wiki/Photosynthesis), a process that also captures [carbon](https://en.wikipedia.org/wiki/Carbon) from the atmosphere. By feeding on plants and on one another, [animals](https://en.wikipedia.org/wiki/Animal) play an important role in the movement of matter and energy through the system. They also influence the quantity of plant and [microbial](https://en.wikipedia.org/wiki/Microbe) [biomass](https://en.wikipedia.org/wiki/Biomass_%28ecology%29) present. By breaking down dead organic matter, [decomposers](https://en.wikipedia.org/wiki/Decomposer) release carbon back to the atmosphere and facilitate [nutrient cycling](https://en.wikipedia.org/wiki/Nutrient_cycling) by converting nutrients stored in dead biomass back to a form that can be readily used by plants and other microbes.

**A, Eco system** = the Community + Abiotic environment, interacting

Levels of Organization; - a hierarchy of organization in the environment:

* **Biosphere**; Surface of the earth and it composed of many ecosystems
* **Ecosystems**: communities of organisms interacting with each other and with their physical environment i.e. Community + Abiotic environment, interacting
* **Biodiversity:** the variety of organisms living in an ecosystem. The total number of different species in an ecosystem and their relative abundance
* **Organism** – simplest level of organization (e.g., fish)
* **Population** – one species live in one place at one time (e.g. many fish)
* **Community** – All populations (diff. species) that live in a particular area (e.g. many fish + other organisms).All the populations of the diffèrent species living and inter-acting in the same Eco system
* **Habitat** – physical location of community. The characteristics of the type of environment where an organism normally lives (e.g. a stoney stream, deciduous temperate woodland)

**B, Agro ecosystem**

**Agro ecosystems** are **communities of plants and animals interacting** with their physical and chemical environments that have been modified by people to produce food, fiber, fuel and other products for human consumption and processing. The main focus of **sustainable agro ecosystems** lies on the reduction or elimination of agrochemical inputs through changes in management to assure adequate plant nutrition and plant protection through organic nutrient sources and integrated pest management, respectively. **Agro ecology** is the holistic study of agro ecosystems, including all environmental and human elements. It focuses on the form, dynamics and functions of their interrelationships and the processes in which they are involved. An area used for agricultural production, e.g. a field is seen as a complex system in which ecological processes found under natural conditions also occur, e.g. nutrient cycling, predator/prey interactions, competition, symbiosis and successional changes. Implicit in agro ecological research is the idea that, by understanding these ecological relationships and processes, agro ecosystems can be manipulated to improve production and to produce more sustainably, with fewer negative environmental or social impacts and fewer external inputs

## 1.3, Fundamental principles of agro ecology

**1.3, Fundamental principles of agro ecology**

* Enhance recycling of biomass and optimizing nutrient availability and balancing nutrient flow.
* Securing favorable soil conditions for plant growth, particularly by managing organic matter and enhancing soil biotic activity.
* Minimizing losses due to flows of solar radiation, air and water by way of microclimate management, water harvesting and soil management through increased soil cover.
* Species and genetic diversification of the agro ecosystem in time and space.
* Enhance beneficial biological interactions and synergisms among agro biodiversity components thus resulting in the promotion of key ecological processes and services.
* promote agro-biodiversity, as the point of entry for the re-design of systems ensuring the autonomy of farmers and Food Sovereignty;
* foster and equip the multi-criteria steering of agro ecosystems in a perspective of long term transition, including arbitrations between short time and long time and attaching significance to resilience and adaptability properties;
* promote the spatio temporal variability (diversity and complementarities) of resources, i.e. take advantage of local resources and characteristics and work with diversity and variety rather than seek to overcome it;
* Stimulate the exploration of situations far removed from optima already known, e.g. “extreme” systems at very low levels of inputs and/or organic in livestock as well as in vegetable production
* Promote the construction of arrangements for participatory research that allow the development of “finalized” research while guaranteeing the scientificity of approaches. The design of sustainable systems indeed is complex and implies the acknowledgment of interdependence of actors, of their ambiguities, as well as of the uncertainty of socio-economic impacts of technological innovations;
* create knowledge and collective capacity of adaptation through networks including producers, citizens-consumers, researchers and technical advisers of public authorities, which promote deliberative forums, public debate and knowledge dissemination;
* promote possibilities of choices of autonomy compared with global markets by the creation of a public goods-friendly environment and the development of socio-economic practices and models which strengthen democratic governance of food systems, notably via systems managed by producers and citizens-consumers and via systems (re)territorialized highly labor intensive;
* Promote the diversity of knowledge to be taken into account: local or traditional knowledge and practices, ordinary knowledge in the construction of problems and the construction of publics concerned by these problems, than in the search of solutions.

# Chapter Two

## 2.1, Major Agro-ecological zones of the world and associated Farming system

##  Description of Koppen and Thornwaith’s methods of climatic classification

### A, Koppen’s methods of climatic classification

Köppen climate classification widely used vegetation-based empirical climate classification system developed by German botanist-climatologist Wladimir Köppen. His aim was to devise formulas that would define climatic boundaries in such a way as to correspond to those of the vegetation zones (biomes) that were being mapped for the first time during his lifetime.

Köppen’s classification is based on a subdivision of terrestrial climates into **five major types**, which are represented by the capital letters A, B, C, D, and E. Each of these climate types except for B is defined by **temperature criteria**. Type B designates climates in which the controlling factor on vegetation is dryness (rather than coldness).

**Aridity** is not a matter of precipitation alone but is defined by the relationship between the precipitation input to the soil in which the plants grow and the evaporative losses. Since evaporation is difficult to evaluate and is not a conventional measurement at meteorological stations, Köppen was forced to substitute a formula that identifies aridity in terms of a temperature-precipitation index (that is, evaporation is assumed to be controlled by temperature).

The Köppen Climate Classification System is the most widely used system for classifying the world's climates. Its categories are based on the annual and monthly averages of temperature and precipitation. The Köppen system recognizes five major climatic types; each type is designated by a capital letter.

* A - Tropical Moist Climates: all months have average temperatures above 18° Celsius.
* B - Dry Climates: with deficient precipitation during most of the year.
* C - Moist Mid-latitude Climates with Mild Winters.
* D - Moist Mid-Latitude Climates with Cold Winters.
* E - Polar Climates: with extremely cold winters and summers.

#### Tropical Moist Climates (A)

Tropical moist climates extend northward and southward from the equator to about 15 to 25° of latitude. In these climates all months have average temperatures greater than 18° Celsius. Annual precipitation is greater than 1500 mm. Three minor Köppen climate types exist in the A group, and their designation is based on seasonal distribution of rainfall.

* **Af or tropical wet** is a tropical climate where precipitation occurs all year long. Monthly temperature variations in this climate are less than 3° Celsius. Because of intense surface heating and high humidity, cumulus and cumulonimbus clouds form early in the afternoons almost every day. Daily highs are about 32° Celsius, while night time temperatures average 22° Celsius.
* Am a **tropical monsoon** climate. Annual rainfall is equal to or greater than Af, but most of the precipitation falls in the 7 to 9 hottest months. During the dry season very little rainfall occurs.
* The **tropical wet and dry or savanna** (Aw) has an extended dry season during winter. Precipitation during the wet season is usually less than 1000 millimeters, and only during the summer season.

#### Dry Climates (B)

The most obvious climatic feature of this climate is that potential evaporation and transpiration exceed precipitation. These climates extend from 20 - 35° North and South of the equator and in large continental regions of the mid-latitudes often surrounded by mountains. Minor types of this climate include:

* BW - **dry arid (desert**) is a true desert climate. It covers 12% of the Earth's land surface and is dominated by xerophytic vegetation. The additional letters h and k are used generally to distinguish whether the dry arid climate is found in the subtropics or in the mid-latitudes, respectively.
* BS - **dry semiarid (steppe**). Is a grassland climate that covers 14% of the Earth's land surface? It receives more precipitation than the BW either from the inter tropical convergence zone or from mid-latitude cyclones. Once again, the additional letters h and k are used generally to distinguish whether the dry semiarid climate is found in the subtropics or in the mid-latitudes, respectively.

#### Moist Subtropical Mid-Latitude Climates (C)

This climate generally has warm and humid summers with mild winters. Its extent is from 30 to 50° of latitude mainly on the eastern and western borders of most continents. During the winter, the main weather feature is the mid-latitude cyclone. Convective thunderstorms dominate summer months. Three minor types exist:

* Cfa - humid subtropical;
* Cs - Mediterranean; and
* Cfb - marine.

The humid subtropical climate (Cfa) has hot muggy summers and frequent thunderstorms. Winters are mild and precipitation during this season comes from mid-latitude cyclones. A good example of a Cfa climate is the southeastern USA.

Cfb marine climates are found on the western coasts of continents. They have a humid climate with short dry summer. Heavy precipitation occurs during the mild winters because of the continuous presence of mid-latitude cyclones.

Mediterranean climates (Cs) receive rain primarily during winter season from the mid-latitude cyclone. Extreme summer aridity is caused by the sinking air of the subtropical highs and may exist for up to 5 months. Locations in North America are from Portland, Oregon to all of California.

#### Moist Continental Mid-latitude Climates (D)

Moist continental mid-latitude climates have warm to cool summers and cold winters. The location of these climates is pole ward of the C climates. The average temperature of the warmest month is greater than 10° Celsius, while the coldest month is less than -3° Celsius. Winters are severe with snowstorms, strong winds, and bitter cold from Continental Polar or Arctic air masses. Like the C climates there are three minor types:

* Dw - dry winters;
* Ds - dry summers; and
* Df - wet all seasons.

#### Polar Climates (E)

Polar climates have year-round cold temperatures with the warmest month less than 10° Celsius. Polar climates are found on the northern coastal areas of North America, Europe, Asia, and on the landmasses of Greenland and Antarctica. Two minor climate types exist.

* ET or polar tundra is a climate where the soil is permanently frozen to depths of hundreds of meters, a condition known as permafrost. Vegetation is dominated by mosses, lichens, dwarf trees and scattered woody shrubs.
* EF or polar ice caps has a surface that is permanently covered with snow and ice.

Further subgroups are designated by a second, lower case letter which distinguishes specific seasonal characteristics of temperature and precipitation.

* f - Moist with adequate precipitation in all months and no dry season. This letter usually accompanies the A, C, and D climates.
* m - Rainforest climate in spite of short, dry season in monsoon type cycle. This letter only applies to A climates.
* s - There is a dry season in the summer of the respective hemisphere (high-sun season).
* w - There is a dry season in the winter of the respective hemisphere (low-sun season).

To further denote variations in climate, a third letter was added to the code.

* a - Hot summers where the warmest month is over 22°C (72°F). These can be found in C and D climates.
* b - Warm summer with the warmest month below 22°C (72°F). These can also be found in C and D climates.
* c - Cool, short summers with less than four months over 10°C (50°F) in the C and D climates.
* d - Very cold winters with the coldest month below -38°C (-36°F) in the D climate only.
* h - Dry-hot with a mean annual temperature over 18°C (64°F) in B climates only.
* k - Dry-cold with a mean annual temperature under 18°C (64°F) in B climates only

### B, Thornwaith’s methods of climatic classification

In 1931 Thornthwaite devised a complex and empirical classification, which is very close to Koppen's scheme. It also attempts to define climatic boundaries quantitatively and is based on plant associations. However, Thornthwaite's classification is based on precipitation effectiveness and thermal efficiency (temperature efficiency). Under this classification climatic types were subdivided by the use of a term to denote the seasonal distribution of precipitation. The climatic types and their boundaries were defined empirically by observing the characteristics of natural vegetation, soil, and the drainage pattern.

Thornthwaite established the fact that not only the amount of precipitation, but the rate of evaporation as well is significant for the growth of natural vegetation. Thus, besides the precipitation amount and the evaporation rate, temperature was made a very important basis for Thornthwaite's climatic classification. An expression for **precipitation efficiency** was obtained by relating measurements of pan evaporation to temperature and precipitation. For each month the ratio 11.5 (rt-10)10/9 where r=mean monthly rainfall (in inches) t=mean monthly temperature (in °F) is calculated.

The sum of the 12 monthly ratios gives the precipitation effectiveness (also called precipitation efficiency) index. In other words, the effectiveness of precipitation is taken to be a function of precipitation and evaporation and is calculated by dividing the monthly precipitation by the monthly evaporation to get the P/E ratio (precipitation effectiveness ratio).

On the basis of P/E indices and boundary values for the major vegetation regions, five humidity provinces were defined. Main Climatic groups based on precipitation effectiveness

**Humidity Province Vegetation P/E Index**

1. A (Wet) Rain Forest 127
2. B (Humid) Forest 64-127
3. C (Sub humid) Grassland 32-63
4. D (Semiarid) Steppe 16-31
5. E (Arid) Desert 16

Thornthwaite introduced an index of thermal efficiency which is expressed by the positive departure of monthly mean temperatures from the freezing point. The index is thus the annual sum of (t-32)/4 for each month. In other words, the sum of twelve monthly temperature-efficiency ratios (T/E) gives a T/E index

Again, the world was divided into 6 temperature provinces on the basis of T/E index. Main Climatic groups based on thermal efficiency

 **Temperature Province T/E index**

* A-Tropical 127
* B-Mesothermal 64-127
* C-Microthermal 32-63
* D-Taiga 16-31
* E-Tundra 1-15
* F-Frost 0

T/E Index-sum of 12 monthly values of (T-32)14, where T is mean monthly temperature in °;F.

On the basis of the seasonal distribution of precipitation the humidity provinces were subdivided into the following

* r-Rainfall adequate in all seasons
* s-Rainfall deficient in summer
* w-Rainfall deficient in winter
* d-Rainfall deficient in all seasons.

When precipitation effectiveness, seasonal distribution of rainfall, and thermal efficiency are taken together, there would be in all 120 climatic types, at least on theoretical grounds. However, Thornthwaite has shown only 32 climatic types on the world map depicting his 1931 climatic classification.

## World climatic Types

Based on the above classification there are three basic climate groups found in the world. These three major climate groups show the dominance of special combinations of air-mass source regions.

### Group I, Low-latitude Climates:

These climates are controlled by equatorial a tropical air masses.

#### Tropical Moist Climates (Af) rainforest

Rainfall is heavy in all months. The total annual rainfall is often more than 250 cm. (100 in.). There are seasonal differences in monthly rainfall but temperatures of 27°C (80°F) mostly stay the same. Humidity is between 77 and 88%. High surface heat and humidity cause cumulus clouds to form early in the afternoons almost every day. The climate on eastern sides of continents is influenced by maritime tropical air masses. These air masses flow out from the moist western sides of oceanic high-pressure cells, and bring lots of summer rainfall. The summers are warm and very humid. It also rains a lot in the winter

* Average temperature: 18 °C (°F)
* Annual Precipitation: 262 cm. (103 in.)
* Latitude Range: 10° S to 25 ° N

**Global Position**: Amazon Basin; Congo Basin of equatorial Africa; East Indies, from Sumatra to New Guinea.

#### Wet-Dry Tropical Climates (Aw) savanna

A seasonal change occurs between wet tropical air masses and dry tropical air masses. As a result, there is a very wet season and a very dry season. Trade winds dominate during the dry season. It gets a little cooler during this dry season but will become very hot just before the wet season.

* Temperature Range: 16 °C
* Annual Precipitation: 0.25 cm. (0.1 in.). All months less than 0.25 cm. (0.1 in.)
* Latitude Range: 15 ° to 25 ° N and S

Global position: India, Indochina, West Africa, southern Africa, South America and the north coast of Australia

#### Dry Tropical Climate (BW) desert biome

These desert climates are found in low-latitude deserts approximately between 18° to 28° in both hemispheres. these latitude belts are centred on the tropics of Cancer and Capricorn, which lie just north and south of the equator. They coincide with the edge of the equatorial subtropical high pressure belt and trade winds. Winds are light, which allows for the evaporation of moisture in the intense heat. They generally flow downward so the area is seldom penetrated by air masses that produce rain. This makes for a very dry heat. The dry arid desert is a true desert climate, and covers 12 % of the Earth's land surface.

* Temperature Range: 16° C
* Annual Precipitation: 0.25 cm (0.1 in). All months less than 0.25 cm (0.1 in).
* Latitude Range: 15° - 25° N and S.

Global position: south western United States and northern Mexico; Argentina; north Africa; south Africa; central part of Australia.

### Group II, Mid-latitude Climates:

Climates in this zone are affected by two different air-masses. The tropical air-masses are moving towards the poles and the polar air-masses are moving towards the equator. These two air masses are in constant conflict. Either air mass may dominate the area, but neither has exclusive control.

#### Dry Midlatitude Climates (BS) steppe

Characterized by grasslands, this is a semiarid climate. It can be found between the desert climate (BW) and more humid climates of the A, C, and D groups. If it received less rain, the steppe would be classified as an arid desert. With more rain, it would be classified as a tallgrass prairie. This dry climate exists in the interior regions of the North American and Eurasian continents. Moist ocean air masses are blocked by mountain ranges to the west and south. These mountain ranges also trap polar air in winter, making winters very cold. Summers are warm to hot.

* Temperature Range: 24° C (43° F).
* Annual Precipitation: less than 10 cm (4 in) in the driest regions to 50 cm (20 in) in the moister steppes.
* Latitude Range: 35° - 55° N.

**Global position**: Western North America (Great Basin, Columbia Plateau, Great Plains); Eurasian interior, from steppes of eastern Europe to the Gobi Desert and North China.

#### Mediterranean Climate (Cs) chaparral biome

This is a wet-winter, dry-summer climate. Extremely dry summers are caused by the sinking air of the subtropical highs and may last for up to five months. Plants have adapted to the extreme difference in rainfall and temperature between winter and summer seasons. Sclerophyll plants range in formations from forests, to woodland, and scrub. Eucalyptus forests cover most of the chaparral biome in Australia. Fires occur frequently in Mediterranean climate zones.

* Temperature Range: 7 °C (12 °F)
* Annual Precipitation: 42 cm (17 in).
* Latitude Range: 30° - 50° N and S

**Global Position**: central and southern California; coastal zones bordering the Mediterranean Sea; coastal Western Australia and South Australia; Chilean coast; Cape Town region of South Africa.

#### Dry Midlatitude Climates (Bs) grasslands biome

These dry climates are limited to the interiors of North America and Eurasia. Ocean air masses are blocked by mountain ranges to the west and south. This allows polar air masses to dominate in winter months. In the summer, a local continental air mass is dominant. A small amount of rain falls during this season. Annual temperatures range widely. Summers are warm to hot, but winters are cold.

* Temperature Range: 31 °C (56°F).
* Annual Precipitation: 81 cm. (32 in.).
* Latitude Range: 30° - 55° N and S

**Global Position**: western North America (Great Basin, Columbia Plateau, Great Plains); Eurasian interior.

#### Moist Continental Climate (Cf) Deciduous Forest biome

This climate is in the polar front zone - the battleground of polar and tropical air masses. Seasonal changes between summer and winter are very large. Daily temperatures also change often. Abundant precipitation falls throughout the year. It is increased in the summer season by invading tropical air masses. Cold winters are caused by polar and arctic masses moving south.

* Temperature Range: 31 °C (56 ° F)
* Average Annual Precipitation: 81 cm (32 in).
* Latitude Range: 30° - 55° N and S (Europe: 45° - 60° N).

**Global Position**: eastern parts of the United States and southern Canada; northern China; Korea; Japan; central and eastern Europe.

### Group III, High-latitude climates:

Polar and arctic air masses dominate these regions. Canada and Siberia are two air-mass sources which fall into this group. A southern hemisphere counterpart to these continental centres does not exist. Air masses of arctic origin meet polar continental air masses along the 60th and 70th parallels.

#### Boreal forest Climate ( Dfc) taiga biome

This is a continental climate with long, very cold winters, and short, cool summers. This climate is found in the polar air mass region. Very cold air masses from the arctic often move in. The temperature range is larger than any other climate. Precipitation increases during summer months, although annual precipitation is still small. Much of the boreal forest climate is considered humid. However, large areas in western Canada and Siberia receive very little precipitation and fall into the subhumid or semiarid climate type.

* Temperature Range: 41 °C (74 °F), lows; -25 °C (-14 °F), highs; 16 °C (60 °F).
* Average Annual Precipitation: 31 cm (12 in).
* Latitude Range: 50° - 70° N and S.

**Global Position**: central and western Alaska; Canada, from the Yukon Territory to Labrador; Eurasia, from northern Europe across all of Siberia to the Pacific Ocean.

#### Tundra Climate (E) tundra biome

The tundra climate is found along arctic coastal areas. Polar and arctic air masses dominate the tundra climate. The winter season is long and severe. A short, mild season exists, but not a true summer season. Moderating ocean winds keep the temperatures from being as severe as interior regions.

* Temperature Range: -22 °C to 6 °C (-10 °F to 41 °F).
* Average Annual Precipitation: 20 cm (8 in).
* Latitude Range: 60° - 75° N.

**Global Position**: arctic zone of North America; Hudson Bay region; Greenland coast; northern Siberia bordering the Arctic Ocean.

***Highland Climate (H) Alpine Biome***

Highland climates are cool to cold, found in mountains and high plateaus. Climates change rapidly on mountains, becoming colder the higher the altitude gets. The climate of a highland area is closely related to the climate of the surrounding biome. The highlands have the same seasons and wet and dry periods as the biome they are in. Mountain climates are very important to midlatitude biomes. They work as water storage areas. Snow is kept back until spring and summer when it is released slowly as water through melting.

* Temperature Range: -18 °C to 10 °C (-2 °F to 50°F)
* Average Annual Precipitation: 23 cm (9 in.)
* Latitude Range: found all over the world

**Global Position**: Rocky Mountain Range in North America, the Andean mountain range in South America, the Alps in Europe, Mt. Kilimanjaro in Africa, the Himalayans in Tibet, Mt. Fuji in Japan.

## 2.2. Various approaches to agro ecology

### 2.2.1. Ecosystems agroecology

This approach is driven by the ecosystems biology of [Eugene Odum](http://en.wikipedia.org/wiki/Eugene_Odum). This approach is based in the hypotheses that the natural systems, with its stability and resilience (flexibility), provide the best model to mimic (take off or copy) if sustainability is the goal. Normally, ecosystems agroecology is not actively involved in social science; however, this school is essentially based on the belief that large-scale agriculture is inappropriate (wrong).

### 2.2.2. Agronomic ecology

The basic approach in this branch is derived mostly from agronomy, including the traditional agricultural production sciences. This approach also does not actively involve social sciences in the agroecological analysis, but uses social sciences to understand the processes by which agriculture became unsustainable.

### 2.2.3. Ecological political economy

The driving force behind this form of agroecology is a political-economic critique of modern agriculture. The school believes that only radical changes in political economy and the moral economy of research will reduce the negative costs of modern agriculture. The works of [Miguel Altieri](http://en.wikipedia.org/wiki/Miguel_Altieri) (ecosystem biologist), John Vandermeer (population ecologist), [Richard Lewontin](http://en.wikipedia.org/wiki/Richard_Lewontin), and [Richard Levins](http://en.wikipedia.org/wiki/Richard_Levins) provide examples of this politically charged and socially-oriented version of agroecology.

### 2.2.4. Agro-population ecology

This approach is derived from the science of ecology primarily based on [population ecology](http://en.wikipedia.org/wiki/Population_ecology). Buttel explains the main difference between the two categories, saying that “the application of population ecology to agroecology involves the primacy not only of analyzing agroecosystems from the perspective of the [population dynamics](http://en.wikipedia.org/wiki/Population_dynamics) of their constituent species, and their relationships to [climate](http://en.wikipedia.org/wiki/Climate) and [biogeochemistry](http://en.wikipedia.org/wiki/Biogeochemistry), but also there is a major emphasis placed on the role of [genetics](http://en.wikipedia.org/wiki/Genetics).” David Andow and Alison Power are cited as examples of professionals espousing this view.

# Chapter Three

**3.1. Agro-ecological zones of Ethiopia**

## Traditional zone:

As a result of the diversified altitude and climatic conditions, Ethiopia possesses divers agroclimatic zones. These zones have traditionally been defined in terms of temperature. The Traditional Agro ecological Zones indicate major physical conditions that are grouped into relatively homogenous area having similar agricultural land uses. Under Ethiopian conditions elevation has a strong influence on temperature and rainfall. Therefore, this parameter (elevation) is the basis for traditional agro ecological divisions.

 This system divides the nation into five major climatic zones namely *Bereha, Kolla, Woina Dega, Dega* and *Wurch*. A description on each of the zones is presented as follows.

### **The Wurch Zone**

The Wurch-zone is an area having altitude higher than 3,200 meters above sea level and mean
annual temperature of less than 10oC. Mountains having typically fitting characteristics of this
zone include mountain systems of Ras Dashen, Guna, Megezez in North Shoa, Batu, Choke,
Abune Yoseph etc.

***Table 5.3: Agro Ecological Zones of Ethiopia***



*Source****:*** *NRMRD MoA, 1998*

### **Dega Zone**

This is a zone of highlands having relatively higher temperature and lower altitude compared to
the wurch Zones. In Ethiopia, the Dega-zone is long inhabited and has dense human settlement
due to reliable rainfall for agriculture and absence of vector-borne diseases such as malaria.

### **Weyna Dega Zone**

This zone has warmer temperature and moderate rainfall. It lies between 1500-2,300 meters
above sea level. It is the second largest zone covering more than 26% of the landmass of
Ethiopia. The temperature and rainfall of this category is highly suitable for majority of crops
grown in Ethiopia. Hence, the zone includes most of the agricultural land. The Weyna Dega zone
has also two growing seasons.

### Kolla Zone

In Ethiopia, the geographic peripheries in south, southeast, west and northeastern part are mainly
in this category. Kolla is the climate of the hot lowlands with an altitudinal range of 500 to 1500
meters above sea level. Average annual temperature ranges between 20oC and 30oC. Although
mean annual rainfall is erratic, it can be as high as 1500 mm in the wet western lowlands of
Gambella. Rainfall is highly variable from year to year. The region is boundary between the hot
arid (Bereha) and the humid climates (Woina Dega).

### Bereha Zone

Bereha is the hot arid climate of the desert lowlands. The Bereha agro-climatic zone is largely
confined to lowland areas with altitude of lower than 500 meters. Around Danakil depression,
the elevation goes below the sea level. Its average annual rainfall is less than 200 mm, and
average annual temperature is over 27.5oC. Strong wind, high temperature, low relative humidity, and little cloud cover usually characterize Bereha. Evapotranspiration is always in
excess of rainfall. Djibouti, majority of Somalia, and coastal areas of Eritrea are categorized
under Kolla and Bereha zones.



# Chapter Four

# 4, MAJOR CATEGORIES OF FARMING SYSTEM

The classification of the farming systems has been based on the following criteria:

* available natural resource base, including water, land, grazing areas and forest; climate, of which altitude is one important determinant; landscape, including slope; farm size, tenure and organization; and
* dominant pattern of farm activities and household livelihoods, including field crops, livestock, trees, aquaculture, hunting and gathering, processing and off-farm activities; and taking into account the main technologies used, which determine the intensity of production and integration of crops, livestock and other activities.

Based on these criteria, the following broad categories of farming system have been distinguished:

### Irrigated farming systems,

* embracing(includeing) a broad range of food and cash crop production;
* **Rain fed farming systems** in humid areas of high resource potential, characterized by a crop activity (notably root crops, cereals, industrial tree crops – both small scale and plantation – and commercial horticulture) or mixed crop-livestock systems;
* **Rain fed farming systems in dry or cold low potential areas**, with mixed crop-livestock and pastoral systems merging into sparse and often dispersed systems with very low current productivity or potential because of extreme aridity or cold;
* **Dualistic** (mixed large commercial and small holder) farming systems, across a variety of ecologies and with diverse production patterns;
* **Coastal artisanal fishing**, often mixed farming systems; and
* **Urban based farming systems**, typically focused on horticultural and livestock production.

There is also key distinguishing attributes, notably:

1. water resource availability, e.g. irrigated, rain fed, moist, dry;
2. climate, e.g. tropical, temperate, cold;
3. landscape relief/altitude, e.g. highland, lowland;
4. farm size, e.g. large scale;
5. production intensity, e.g. intensive, extensive, sparse;
6. Dominant livelihood source, e.g. root crop, maize, tree crop, artisanal fishing, pastoral;
7. dual crop livelihoods, e.g. cereal-root, rice-wheat (note that crop-livestock integration is denoted by the term mixed); and
8. Location, e.g. forest based, coastal, urban based

### There is also specific classification of farming system

Farm as a unit transfers input into agricultural output and which undergoes changes over time. In the process of adapting cropping patterns and farming techniques to the natural, economic and socio-political conditions of each location and the aims of the farmers, distinct farming systems are developed. For the purpose of agricultural development it is advisable to group farms with similar structures into classes

####  Collecting

This is the most direct method of obtaining plant products. It includes regular and irregular harvesting of uncultivated plants. Hunting goes hand in hand with collecting. It is still being practiced to provide additional to the normal subsistence food supply. It is only in few cases like wild oil palm in some parts of West Africa and gum Arabic in Sudan and wild honey in Tanzania that collecting is a major cash earning activity.

**Classification according to the degree of commercialization**

The 1970 World Census on Agriculture classified farms into three groups based on the destination of the agricultural output

1. Subsistence farming –if there is virtually no sale of crop and animal products,

2. Partly commercialized farming-- if more than 50% of the value of the produce is for home consumption

3. Commercialized farming--- If more than 50% of the produce is for sale.

**Classification according to grassland utilization**

 **a) Arable, Pastoral and Mixed Farming**

i. **Arable farming**:- the growing of crop; usually on flatten lands where soils of high quality. It has led the first permanent settlers in the Tigris-Euphrates, Nile and Indus valleys.

ii. **Pastoral farming:-** is the rearing of animals usually on land, which is less favorable to arable farming.

iii. **Mixed farming**:- is the growing of crops & rearing of animals together. It is practiced on a commercial scale in developed countries and subsistence level in developing countries.

**b) Subsistence and Commercial Farming**

**i. Subsistence farming**:- is the production of food by farmers for their own family or the local community-there is no surplus. Farmers rarely able to improve their product due to lack of capital, land and technology and not lack of effort or ability.

**ii. Commercial farming:-** it takes place on large profit making scale. Farmers produce cash crops and seek to maximize yields/hectares. Cash crops operate successfully where transport is well developed, domestic markets are large & expanding and there are opportunities for international trade.

**C) Shifting cultivation and sedentary farming**

Shifting cultivation is now limited to a few place where there are low population densities and a limited demand for food. However, most of the farming systems of the world is now sedentary way of farming where farmers remain in one place to look after their crops and rear their animals. It is a more advance form of subsistence agriculture in tropical lowlands, where the fallowed fields are frequently reused.

**D) Extensive and Intensive cultivation:**-

On the basis of amount of labor, capital and land involved in the farming system, agriculture is divided in to extensive and intensive farming.

i. **Intensive farming:** is best defined as farming in which much capital is expended or much labor is applied to a given area of land in order to increase its productivity.

ii. **Extensive farming**: is a method of farming in which the amount of capital and labor applied to a given area is relatively small. In contrast to intensive farming where the aim is to get the maximum return per unit of land area, extensive farming aims at producing the maximum product per unit of man power. Therefore, extensive farming is carried out on large scale while intensive farming is usually relatively on small scale.

Generally, intensive farming is practiced where land is scarce and the population density is higher while extensive farming is practiced in the reverse situation.

## Agriculture

Agriculture is the art, science, and industry of managing the growth of plants and animals for human use. In a broad sense agriculture includes cultivation of the soil, growing and harvesting crops, breeding and raising livestock, dairying, and forestry.

conserved.

**Types of agriculture**

Based on different guidelines, agriculture may have various types. It can constituent all rain -fed, irrigation, fish, Forestry etc.

**Rain-fed and irrigation agriculture**

Rain -fed agriculture is commonly known as dry land agriculture. It is a type of agriculture which mainly depends on the rainfall bestowed from the nature.

Since it is nature oriented weather induced problems are the major constraints in this type of agriculture. Problems include:

* Recurrent flood
* Drought
* Excessive run off

Characteristics of rain -fed/dry land agriculture:

* The area is less densely populated than irrigated area in the country level.
* High proportion of landless households and agricultural laborers.
* Low land and labor productivity mainly due to the tenure system.
* High poverty concentration.
* Low infrastructural development in the regions.

Irrigation is the provision of a supply of water from a river, lake or underground source to enable an area of land to be cultivated. It is needed where:

* Rainfall is limited and where evapotranspiration exceeds precipitation.
* There is a seasonal water shortage due to drought.
* Amount of rainfall is unreliable as in case of Sahel countries.
* Farming is intensive either subsistence or commercial despite high annual rainfall to fall.

In economically more developed countries, technology based large dams may be built for irrigation purpose, where as in less developed and developing countries, lack of capital and technology force them to design their schemes for extremely labor intensive as they have to be constructed and operated by hand.

**Fish farming**

It is impossible to overstate the importance of fish to human populations around the world. Throughout history, humans have used fish protein as a food source, with wild caught fish providing the bulk of fish protein. Fish have also been farmed in large quantities for more than 2000 years in China. Recent advances in fish farming, especially with some African cichlids have alleviated hunger in many parts of the world. In industrialized countries, farm - raised fish provide relief for overfished stocks of wild fish. Fish also have served as a source of recreational pleasure for many people. The catches from sports fisheries are far larger than commercial catches from most freshwaters and in marine waters close to large population centers. Aquariums provide an intimate acquaintance with the aquatic world. More than 20 million home aquariums are kept in the United States alone. Among the many fish kept in aquariums, the most common are minnows, characins, and cichlids.

 **Forestry**

Forestry is management of forestlands for maximum sustained yield of forest resources and benefits. Although forestry originally concerned mainly timber production, it now also involves the management of grazing areas for domestic livestock, the preservation of wildlife habitats, watershed protection, and the development of recreational opportunities. The management of forestlands therefore helps to ensure that wooded areas are used for maximum benefit according to their nature.

# Chapter Five

## 5.1. Factors affecting farming system

The location of different types of agriculture at all scales depends upon the interaction of physical, cultural and economic factors.

* **Physical factors**

Although there has been a movement away from the view that agriculture is controlled solely by physical conditions, it must be accepted that environmental factors do exert a major influence in determining the type of farming practiced in any particular area. These factors include:

**Temperature**

This is a critical for plant growth because each plant or crop and animal type requires a minimum growing temperature and a minimum growing season. In temperate latitudes, the critical temperature is 6ºC. Below this figure, members of the grass family, which include most cereals, cannot grow- an exception is rye, a hardy cereal, which may be grown in many northerly latitudes. For instance, in tropics, there is a continuous gr owing season, provided moisture is available. As well as decreasing with distance from the equator, both temperatures and the length of the growing season decrease with height above sea -level.

**Altitude**

The growth of various crops is controlled by the decrease in temperature with height. As height increases, so too does exposure to wind and the amount of clouds, snow and rain while the length of the growing season decreases. Soils take longer to develop as there are fewer mixing agents as well there is a high tendency of soil erosion.

Example:

* In tropical rainforest- subsistence/shifting cultivation;
* In mixed forest- some subsistence agriculture;
* Dwarf forest- very little agriculture;
* In grass lands- herding; and
* In ice and snow- almost no agricultural activities except hunting and fishery.

**Precipitation and water supply**

The mean annual rainfall for an area determines whether its farming is likely to be based up on tree crops, grass or cereals, or irrigation. The relevance and effectiveness of this annual total rainfall depends on temperatures and the rate of evapotranspiration. However the seasonal distribution of rainfall is usually more significant for agriculture than is annual total.

The type of precipitation is also important. For instance, long, steady periods of rain allow the water to infiltrate into the soil, making moisture available for plant use. On the other hand, short, heavy downpours can lead to surface runoff and soil erosion and so are less effective for plants. Hail, falling during the heavy convectional storms in summer, can destroy crops. In the absence of rain, cops also fail disastrously. In regions like Sahel and Sub -Saharan Africa a fluctuation of precipitation from the mean can ruin harvests and causes the death of many animals.

**Wind**

Strong winds can increase evapotranspiration rates which allow the soil to dry out and to become vulnerable to erosion. Several local winds also have harmful effects on farming. Hurricanes and tornadoes can all destroy crops by their sheer strength. Bu t it is better to understand that some other winds are important for farming activities.

**Angle of slope (gradient)**

Slope affects the depth of soil, its moisture content and it’s PH, and hence the type of crop which can be grown on it. It influences erosion and is a limitation on the use of machinery. Until recently, a 5º slop was the maximum for mechanized ploughing but technological improvements have increased this to 11º.

**Aspect**

Aspect is an important part of the micro climate. South facing and north facing slopes in northern hemisphere, that are wind ward and lee ward respectively, can influence cropping. Crops and trees both grow to higher altitudes on the wind ward slopes as they have the chance to get high er temperature and drier soils.

**Soils (edaphic factors)**

Farming depends up on the depth, stoniness, water -retention capacity, aeration, texture, structure , PH, leaching and mineral content of the soil. For instance:

* Clay soils tend to be heavy, acidic, poorly drained, cold and ideally should be le ft under permanent grass.
* Sandy soils tend to be lighter, less acidic, perhaps too well drained, warmer and more suited to vegetables and fruits.
* Lime soils (chalk) are light in texture, alkaline, dry and give high cereal yields.

**Global warming**

Scientists agree that the green house effect will not only lead to an increase in temperature but also to changes in rainfall patterns. The global increase in temperature will allow many parts of the world to grow crops which at present are too cold for them.

* **Cultural (human) factors affecting farming**

**Land tenure**

Farmers may be owners-occupiers, tenants, landless laborers, or state employees on the land which they farm. For instance in cash tenancy, farmers have to give as much as 80 percent of their income or a fixed pre arranged rent to the land owner where as share cropping is when the farmer has to give 50 percent for the land owner. In sum tenure security affects the farming system because farmers are expected to invest more when they feel the land the y use belongs to them in permanent manner.

**Inheritance laws and land fragmentation**

In several countries, inheritance laws have meant that on the death of a farmer the land is divided equally among all his sons (rarely among daughters). This tradition has led to the sub -division of farms in to numerous scattered and small fields. Fragmentation results in much time being wasted in moving from one distant field to another.

**Farm size**

As indicated above, inheritance laws tend to reduce the size of individual farms so that they can operate only at subsistence level or below. Differences in farm size also affect types of land use.

* **Economic factors affecting farming**

However favorable the physical environment may be, it is of limited value until human resources are added to it.

 **Transport**

This includes the type of transport available, the time taken and the cost of moving raw materials to the farm and produce to market. For perishable commodities like milk and fresh fruit, the need for speedy transport to market demands an efficient transport network, while for bulky goods, like potatoes, transport costs must be lower for output to be profitable. In both cases, the items should ideally be grown as near to their market as possible.

**Market**

The role of markets is closely linked with transport (perishable and bulky goods). For further understanding, read the von Thünen least cost theory.

**Capital**

Developed countries have large reserves of readily available finance, which over time have been used to build up capital-intensive types of farming such as dairying, market gardening and mechanized cereal growing. On the other hand, farmers in developing countries, often with limited capital resources, have to resort to labor intensive methods of farming. In addition, purchasing and using of modern and expensive farming machineries will be difficult for such countries.

**Technology**

Technological developments such as new strains of seeds cross -breeding of animal s, improved machinery and irrigation may extend the area of optimal conditions and the limits of production. Lacking in capital and expertise, developing countries are rarely able to take advantages of these advances and so the gap between them and the economically developed world continuous to increase.

 **Government**

In centrally planned economies it is the state, not the individual, which makes the major farming decisions. This can affect the overall profitability of the farming business. For instance, the developed countries’ governments provide a sustainable subsidy to their farmers; this in turn lowered the competitiveness of developing countries’ farmers in international markets, who do not have any kind of subsidy.

# Chapter Six

## 6.1.Agricultural Policy

**Policy** is guiding principle leading to a course of action that is pursued by the government.

The term ‘policy’ has various definitions:

* Everything that a Government decides to do or not to do
* A set of interrelated decisions, including the identification of objectives and the tools to achieve them taken by a political actor(s) to address a certain issue
* A set of principles and directives that guide the decisions of an organization

**Policy making**

‘Policy making’ is a long-term, interactive, and multi-stakeholder process to develop a framework to implement a certain policy, and to evaluate and modify its implementation on a regular basis. It also refers to elaborating a policy document or a policy statement.

Policy or guidelines for actions and decisions” establish the setting in which an entity exists and operates. However, “policy” is not equivalent to “regulations” or “a legal framework”, since they represent only one of a number of possible tools for policy implementation.

**Policy development basic terms**

* **Pólice –** a set of principles and directions that guide the decisions and actions of an organization.
* **Objectives** – a desired situation or outcome that one wants to achieve. Objectives can be general or specific, the latter defining the necessary components to achieve the general objective.
* **Strategy** – an outline how to achieve identified objectives. Includes broad guidelines (‘basic principles’) to develop an action plan.
* **Action plan –** specifies the steps necessary to implement a strategy. An action plan sets out what will be done, who will do it, when, with what resources, and what are the expected results
* **Programmes** – components of an action plan related to specific topics, such as financing, energy efficiency, sectoral initiatives, etc.
* **Projects** – smallest operational components of programmes

**What is Agricultural Policy?**

A subset of public policy directed primarily but not exclusively at the farm and agribusiness sectors of society.

**Agricultural policy applies to two markets**

1. Agricultural input markets

* Use of land and other natural resources
* Agricultural credit and finance
* Labor
* Industrial products

2. Agricultural output markets

* Production
* Consumption
* Marketing
* International trade

**Agricultural Policy in ethiopia**

**Policy Framework – agriculture**

Ethiopia has a consistent set of policies and strategies for agriculture and rural development that reflect the importance of the sector

* The policy framework is based on the concept of the strategy of Agricultural Development-Led Industrialization (ADLI),
* ADLI has been the central pillar of Ethiopia’s development vision since the 1990s.
* ADLI envisages an economically transformed society within which agriculture will grow rapidly,
* The Rural Development Policy and Strategies (RDPS, 2003) presents specific policies and strategies to guide agricultural and rural development
* The Plan for Accelerated and Sustainable development to End poverty (PASDEP 2005/06 to 2009/10) also gave high priority to agriculture and rural development.

**The Five Year growth and Transformation plan (FYGTP**)

* FYGTP recognizes the pivotal role of agriculture, and plans for accelerated growth for the sector on the basis of solid performance in the previous plan period as well as growing demand for food and industrial raw materials.
* Increasing male and female smallholder productivity and production is the main thrust of the plan and will be achieved in three major ways.
* First, by scaling up best practices used by leading farmers whose productivity is 2-3 times higher than the average.
* Second, by improving the management of natural resources with a focus on improving water utilization and the expansion of irrigation.
* Third, by encouraging farmers to change from low value to high value products in order to increase their cash incomes,

These initiatives will be supported by farmer training and measures to improve access to agricultural inputs and product markets using cooperatives as the delivery mechanism.

* Encourage Private sector participation

The FYGTP envisages differentiation among the three main agro-ecological zones.

* Adequate moisture areas
* Moisture deficit areas
* Pastoral areas