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Agricultural Systems in IGAD Region — A Socio-Economic Review

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1. Introduction

Agriculture is defined to be the management of natural environment in an attempt towards its domestication. The goal of this domestication is to provide humankind with an adequate, controlled, and reliable source of food and fiber. To achieve this goal, agriculture deals with the management of living systems at many scales [1].

The quality and availability of land and water resources, together with important socio-economic and institutional factors is essential for food security [2]. “How to feed the world” is an increasingly urgent rising concern voiced by many people, from local community groups to national and international communities. Agriculture is in crisis. Although the world’s agricultural lands continue to produce at least as much food as they have in the past, there are abundant signs that the foundations of their productivity are in danger [3].

Preserving productivity of agricultural land over a long term requires sustainable food production. This could be possible through alternative agricultural practices with consideration to social, cultural, political and economic systems [4]. High productivity levels usually come at high environmental and social costs when farmers along the globe practiced the so called conventional agriculture which is the type of farming where some technological advancement is used to gain those high levels. This use of advanced techniques, according to Gliessman [3] is based on science and research (fertilizers, new varieties, irrigation techniques), but this happened at the expense of degrading the basis of natural resources which are

the key pillars of agricultural production. These natural resources like water, soil and natural genetic diversity have been undermined by the current technological advancement and in addition to their degradation, there is also the dependence on nonrenewable fossil fuels and help to forge a system that increasingly takes the responsibility of growing food out of the hands of farmers and farm workers who are in the best position to be stewards of agricultural lands [5]. Factory-farm livestock production is another manifestation of the specialized trend in agriculture. The rise in factory farming is coupled with a world-wide trend toward diets higher in meat and animal products. As demand for meat increases, industrialized methods for animal food production become more profitable and wider spread, replacing more sustainable pastoral and mixed crop-livestock systems [3]. On the other hand, with the development of research on natural resources, the term of eco-efficiency originates. Eco-efficient agriculture means increases productivity while reducing environmental impacts. It meets economic, social and environmental needs of the rural poor by being profitable, competitive, sustainable and resilient. The increased food insecurity and vulnerability of a large number of people worldwide point to a broken food production and distribution system. We need to look at the contribution agriculture should make not only to feed a growing population but also to impact less on the planet's resources. The future food supply equation needs to consider the current reality of lower growth rates for major crop yields in conventional agriculture, eco-efficient approaches to diminish impacts on natural resources, the climate change challenge and the volatility of energy prices [6]. This implies that adoption of eco-efficient practices, approaches and eco-efficient farming systems will surely lead to higher productivity levels while maintaining lesser negative environmental impacts. More clearly, Koohafkan *et al.* [7] reported that, there are many competing views on how to achieve new models of a bio-diverse, resilient, productive, and resource-efficient agriculture that humanity desperately needs in the immediate future. Conservation agriculture, sustainable intensification production, transgenic crops, organic agriculture, and agro-ecological systems are some of the proposed approaches, each claiming to serve as the durable foundation for a sustainable food production strategy [7].

Therefore, one of the current widely used ideas about food systems is what is called by Francis *et al.*, (2003) the use of integrating approach that combines ecology of these food systems with the economic and social dimensions [8]. Hence, agroecology has been defined as linking ecology, culture, economics, and society to sustain agricultural production, healthy environments, and viable food and farming communities [9]. It has been reported that, socio-economic, technological and ecological components constantly interact, creating a complex feedback mechanism that through time has selected for the type of food production systems that we observe today [10]. According to Francis *et al.* [8], agro-ecology is defined as the study of the whole food system, embracing both natural and social sciences, and emphasizing systems thinking and ecological principles [8].

In Africa, Andriessie *et al.*, [11] has emphasized that agricultural productivity must be increased to meet the demands of an increasingly urban population, as much as to support sustainable rural population [11]. Most of Africa's poor are rural, and most rely largely on agriculture for

their livelihoods. The now widely-shared view is that improving agriculture, particularly smallholder agriculture, is fundamental to overcoming the seemingly intractable problem of African poverty. But how? During the past decade Africa has also experienced several episodes of acute food insecurity, with tragic loss of lives and livelihoods. Recently, the Sahelian and the Horn of Africa encountered yet another food crisis that has severely affected millions of people. Droughts, crop failures and other disasters often trigger these crises. But the real causes go deeper and they are diverse [12].

In Africa in general, there is a growing debate based on the fact that population growth has exceeded the carrying capacity of land at the current technological levels, which will have bad consequences such as environmental and ecological deterioration, wide spread poverty, malnutrition and famine. As well, in some countries this may lead to conflicts and political instability. The horn of Africa or what is also known as IGAD region is not an exception from that situation, if not is more severe and deteriorated. It has been emphasized by Giessen [13] that, in the Horn of Africa increasing scarcity and degradation of natural resources seriously threatens human well-being. The population in the region has increased fourfold in the past 50 years and continues to go rapidly. Farmers need to feed more mouths and extra areas of land are needed, at the expense of forest and pasture lands. With a high and stable number of pastoral communities and decreasing amount of pasture land, pressure on land and water grows. The mounting needs for fertile soils and irrigated land is intensified by high international demands for food and energy [13].

2. Conceptualizing farming systems

Farming systems, and ways of thinking about them, evolved in space and time. Rapid evolution took place in the last two decades when crop and livestock yields increased, together with concerns about their socio-economic and biophysical tradeoffs [14].

Systems in all sectors of the society, including agriculture need to be examined through the system approach. The term system can imply different things such as a process, procedure or unit [14].

Generally, systems could be classified into natural, social and artificial systems. Natural systems are those that exist in nature. Such an apparent example of these natural systems on which agriculture depends, is rock weathering to form soil, plants sustained by such soil; animals sustained by such plants. The second type of systems is the social form which essentially consists of the entities forming animate population, the institutions or social mechanisms created by such entities, and the interrelationships among/between individuals, groups, communities, expressed directly or through the medium of institutions. The third type is the artificial systems, which are created by humans to serve their purposes. Thus agricultural systems are examples of such artificial systems which are directly dependent on either or both natural and social systems, or indirectly on natural systems through the dependence of social systems themselves on natural systems [15].

Any farm as a unit could be a factory for decision making, it can be a production unit for either crops or livestock or a mixture from both of them. The farmer and other human elements of the farm, the physical and biological environment are the boundaries where this farm as a system operate, and it may change, so it is dynamic. So as pointed out by Dixon *et al.* [16] farming system approach considers both biophysical dimensions and socio-economic aspects at the level of the farm, where most of the agricultural production and consumption decisions are taken. The power of this approach lies in its ability to integrate multidisciplinary analysis of production and its relationships to the key biophysical and socioeconomic determinants [16]. Between the constituents of any farming system, the human, the physical and biological parts, there is complicated interactions between so many detailed components. For example, the human element may be a set of household members including family labour, which in addition to hired labour constitute the multi-nature of each constituent. Also the soil is not only such particles where the plant grow, but a series of physical and chemical characteristics and reactions, all of which are very important for the plant life cycle.

Generally in the literature, there are so many definitions to farm or farming system, each one of them was trying to define the term from different perspective: Okigbo [17] defined a farming system as an enterprise or business in which sets of inputs or resources are uniquely orchestrated by the farmer in such a way as to satisfy needs and to achieve desired objectives in a given environmental setting. It could also be defined as a decision making unit as it transforms land, capital, and knowledge into useful products that can be consumed and sold [18]. According to McConnell and Dillon, [15], the term farming system refers to the cultivation patterns used in a plot conceptualized in relation to the farm, other agricultural entities, the socioeconomic and ecological context and the technology available that determine its character [15]. This implies that a farming system is a part of a larger ecological, social, political, economic, cultural environment that is affecting its characteristics. Hence, it is clear from the definitions that farming systems or agro-ecosystems are comprised of many components and agents. The components could be biophysical, socio-economical, and cultural and the agents could be species, ecosystems, households, social communities, scientists, policy makers. Those components and agents are operating on different scales (e.g. local, national, global) while pursuing different objectives.

Rosen [19] defined life as an open process of autopoiesis distinct from the type of external driven organization typical of machines. So building on this definition, Gomeiro et al, [1] mentioned that agriculture implying dealing with life and agricultural systems are also agro-ecosystems, and agricultural science can be referred to as agro-ecology. Furthermore, Altieri, [20] defined agro-ecosystems as communities of plants and animals interacting with their chemical and physical environments that have been modified by people to produce food, fiber, fuel, and other products for human consumption and processing [20]. In this regard, and as pointed out by Kerr, [21] farms can be considered as ecosystems managed by farmers; thus agriculture is concerned with farmer-managed ecosystems.

Norman and Malton [22] distinguished four main phases in the evolution and development of farming systems approach:

- Predetermined focus, for instance on improving cropping system. Emphasis was on normative and prescriptive issues through application of techniques such as budgeting, linear programming and other tools for decision making analysis.
- Whole farm focus, with the contribution of farm management studies.
- Natural resource focus due to conflicting interests between strategies designed to improve short-run productivity and long-run ecological sustainability.
- Sustainable livelihood focus, which includes a wider set of issues, not just production. The concept emerged nearly simultaneously in the farming system literature and in a series of international conferences.

3. Characteristics of farming systems

Agricultural systems, even the most traditional ones, are not static systems; in fact they are dynamic [7].

Spedding [23] emphasized that the classification of agricultural systems has a long history, but there is no generic system that is truly comprehensive and can serve all purposes [23]. They exhibit great diversity and have been classified in various ways including an ecologically based classification [24], [25]. According to Fresco and Westphal [25] there are basically two ways to classify farm systems. First the farm systems of the world can be grouped together in broad classes that reflect fundamental structural differences, for example, plantation systems, tillage system (with and without livestock), alternating systems and grassland systems [26]. The second approach is that used by Grigg [27] who makes explicit reference to geographical units. These classifications and others have in common that they combine economic and biological factors. The main usefulness of this type of broad classification lies in its indication of the relative importance of different classes of farm system and their relevance to the setting of priorities in international agricultural research. The weakness of these past attempts is that they provide little systematic insight into the way the classification relates to the development of agricultural technology. Furthermore, all these approaches classify elements of farm systems (livestock, crop, capital use) but do not do justice to the interaction of the elements which make up the system [25].

Existing classification are based on a wide variety of factors and differ markedly in their utility, comprehensiveness, and ability to be mapped [28]. A summary of comparison between the existing global classification systems is illustrated in the table 1.

Classification	Crops status	Livestock status	Categories no.	Pros and cons
Ruthenberg 1980	- Degree of cultivation - Forest, bush, savannah, grass - crop type - Irrigated versus rainfed	Degree of movement/ permanence	8 major	Categories too broad and incomplete
Grigg 1972	- crop type - commercialization - location/agro-ecology	Degree of movement/ permanence	9 major	System incomplete and somewhat selective
Dixon et al 2001	- crop type - commercialization - location/agro-ecology	Degree of movement/ permanence	8 major 72 globally by region	Derivation not explicit, difficult to map using existing global data set
Sere and Steinfeld 1996	- Are there crops or not? - Rainfed versus irrigated - Agro-ecology	- Landless or rangeland based - Agro-ecology	11 major	Livestock based, so no categorization of crop systems, can be mapped using appropriate proxies
Explicit AEZ method, e.g. Fischer et al. 2002	Match land suitability to crop requirements for given inputs and technology	Not dealt with though probably could be included	As required	Easily mapped, assesses what may be, rather than what actually is
Statistical classification, e.g. Wint et al. 1997	Cluster spatial units based on crop densities, intensities	Cluster spatial units based on livestock densities	As required	Easily mapped, arbitrary, data sensitive, and non- replicable

Source: adapted from Robinson et al., [28]

Table 1. Comparison between existing Global Livestock Classification Systems

A system is characterized by its elements, their inter-relationships and by definition of the boundary of the system. It could also be open, in a sense that external relationships are also included. However, systems at each level are inter-linked and even with sub-systems [29].

Around the world, agricultural ecosystems show tremendous variation in structure and functions, because they were designed by diverse cultures and diverse socioeconomic conditions in diverse climatic conditions [30]. According to John Dixon et al, [16] the following is the key biophysical and socioeconomic determinants of a farming system:

1. Natural resources and climate
2. Science and technology
3. Trade liberalization and market development
4. Policies, institutions and public goods
5. Information and human capital

These categories represent the major areas in which farming system characteristics, performance and evolution are likely to be significantly affected over the next thirty years. Some of these factors are internal to, or part of the farming system, whereas others are external. Policies, institutions, public goods, markets and information are external and they influence the development of the farming system. Technologies which determine the nature of production and processing, and natural resources, are largely endogenous (internal) factors. In general terms, the biophysical factors tend to define the set of possible farming system, whilst the socio-economic factors determine the actual farming system which can be observed at a given time [16]. In the African context, for example, Guyer and Peters [31] mentioned that there is an extensive literature on African agrarian systems that highlight how social and cultural relations shape agricultural production and investment, the type of technologies adopted, and the operation of agricultural markets.

Each individual farm or farm system has its own specific characteristics arising from variations in resource endowments and family circumstances within the context of local institutions and policies. These are translated into productive activities, and household consumption and decision making activities. In the context of sustainability, Koohafkan, *et al.* [7] had suggested, based on extensive literature review, a series of attributes that any agricultural system should exhibit in order to be considered sustainable, the following are these basic attributes:

- a. Use of local and improved crop varieties and livestock to enhance genetic diversity and adaptation to changing biotic and environmental conditions.
- b. Avoid the unnecessary use of agrochemical and other technologies that adversely impact on the environment and human health.
- c. Efficient and reduced use of resources, nonrenewable energy and farmer dependence on external inputs.
- d. Harness agro-ecological principles and processes.
- e. Making productive use of human and social capital to enhance solidarity and exchange of innovations and technologies.
- f. Reduce the ecological footprint of production, distribution and consumption practices.
- g. Promoting climate adaptive practices.
- h. Enhanced adaptive capacity to strengthen the ability to adequately respond to changes.
- i. Strengthen adaptive capacity and resilience of the farming system by maintaining agro-ecosystem diversity.
- j. Recognition and dynamic conservation of agricultural heritage systems.

The design of agro-ecosystems that exhibit many of the attributes of sustainability has become a leading objective of scientific research and policy agendas [7].

4. IGAD region: A general background

The easternmost part of the African continent is often referred to as the Horn of Africa. Some geographers considered the Horn of Africa is comprised of Ethiopia, Eritrea, Somalia and Djibouti. Others include to it Sudan, Kenya and Uganda. Then due to the complexities in defining the region, some organizations apply the term Great Horn of Africa. Major International Organizations including European Commission and the Intergovernmental Authority on Development (IGAD) use the term Horn of Africa to refer to the states of Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda [13].



Figure 1. A map showing IGAD region

IGAD region or the so called horn of Africa according to Mengisteab [32] has an estimated total population of about 226.9 million in 2012 and a total area of 5,209,975 sq km the countries of the region are all members of the Intergovernmental Authority on Development (IGAD), although Eritrea's membership in the regional body has been suspended since 2007, but now the country has applied for reinstatement. Two of the youngest countries of the region, Eritrea and South Sudan, were formed through secessions from Ethiopia in 1993 and from Sudan in 2011, respectively.

Tekle [33] has emphasized the issue of diversity and the fact that the countries of the region share certain characteristics. Among these characteristics he mentioned that their societies are divided along ethnic and religious lines, with political loyalties cut across state boundaries [33]. When recalling the pre-colonial history of the region, it had complex and diversified political structures or systems, and the societies were dynamic or there were changes or continuities [34]. One of the notable characteristics, according to Mengisteab, [32] the region is a mosaic of cultures with considerable ethnic diversity both regionally and within countries. If language can serve as a proxy for ethnic identity, the region is said to be home to some 340 languages. Lewis [35] reported that, Sudan (both north and south) is said to have 134 lan-

guages, followed by Ethiopia with 89 languages, Kenya with 62, Uganda with 43, Eritrea with 9 and Djibouti with two local languages [35]. The countries of the region are also characterized by religious diversity with various denominations of Christianity and Islam coexisting, along with various forms of traditional religion. Many of the region's ethnic groups are also split across several countries by national boundaries established by colonialism. The Somali people, for example, live in Somalia, Djibouti, Ethiopia and Kenya. The Beja, Tigre and Rashiada live in Sudan and Eritrea. The Tigrigna, the Kunama and Shaho live in Eritrea and northern Ethiopia; the Oromo live in Ethiopia and Kenya, the Afar live in Eritrea, Ethiopia and Djibouti. The Luo are spread over Kenya, Ethiopia, South Sudan, Uganda, Tanzania and Eastern Congo, while the Luhya live in Kenya, Uganda and Tanzania [32]. Michalopoulos and Elias [36] examined the impact of ethnic partitioning on civil conflict and economic development in Africa. They found that, out of a total of 834 ethnicities, for 231 ethnic groups at least 10% of their historical homeland falls into more than one contemporary states. Then with a threshold of 20%, about 164 ethnicities have been partitioned across the borders. Using regional data on civil wars in Africa (1970-2005), they found that, civil conflict is concentrated in the historical homelands of partitioned ethnicities. Also border areas populated by ethnic groups only modestly affected by the artificial border design also experience more conflict. Examining the effect of ethnic partitioning on economic development, showed that development in the historical homeland of partitioned ethnic groups is lower by almost a half, compared to non-partitioned ethnic areas. However, this ethnic partitioning was resulted from the pre-colonial artificial drawing of African political boundaries among European powers in the end of the 19th which led to the partitioning of several ethnicities across African states [36]. The partition of ethnic groups into different countries often involves the disruption of social and cultural ties [32]. In the case of pastoral communities partition also implies disruption of economic process as it hinders the movements of groups who rely on regional ecosystems for survival [37]. However, despite these ethnical partitioning and conflicts along the borders and borderlands, there is always hope that these borders and borderlands could be used as potential resources rather than triggering points of conflicts. Borders in Africa have generally been conceived as barriers [38]. But they have also been conceived as 'conduits of opportunities' [39]. Frequently, Horn of Africa is associated with natural and man-made catastrophes, which often have a cross-border dimension, and with violent border conflicts. Many local people as well as external observers perceive the arbitrary colonial borders as one of the causes for these conflicts. Four different types of resources could be extracted from state borders and borderlands. These are: first economic resources (cross border trade and smuggling), second, political resources (access to alternative centers of political power, trans-border political mobilization), third, identity resources (as security device in an inter-ethnic competition) and fourth, status and rights resources (citizenship and refugee status) [38].

Addressing this challenge, IGAD Centre for Pastoral Areas and Livestock Development (ICPALD) is now implementing an intervention that will solve this problem. This intervention will include adopting a regional protocol for transhumance mobility which will enable such groups to maintain their economic, social and cultural ties across national boundaries. Such arrangements, according to Mengisteab [32], if absent will become a source of instability and major conflicts.

Another characteristic of the Horn of Africa countries is the dichotomy of modes of production that govern their economies. The modes of production operating in the region range from a capitalist sector symbolized by emerging stock markets and relatively advanced financial systems to subsistence farming and pastoral economic systems, which are essentially non-capitalistic [32].

Many people perceive the Horn of Africa as a doomed desert area, with clashes between tribes over food, cattle and water. Less people perceive it as a region endowed with great natural resources, an extraordinary variety of flora and fauna, and powerful people with very rich cultures, who have also proved to be well capable of realizing firm economic development [13]. Table 2 presents some characteristics of the region.

Item	Djibouti	Eritrea	Ethiopia	Kenya	Somalia	South Sudan	Sudan	Uganda
Area (sq. km)	23,200	117,600	1,105,300	580,367	637,657	640,000	1,886,068	241,038
Population in 2013('000)	873	6333	94101	44354	10496	11296	37964	37579
Population growth (1970-1990)	6.2	2.7	2.6	3.7	3.0		2.9	3.1
population growth (1990-2010)	2.3	2.5	2.7	2.7	1.7		2.5	3.2
Projected population growth (2010-2030)	1.8	2.3	1.8	2.4	2.8	2.5	2.1	2.9
Population in 1960	85.0	1,424.0	23977.0	8105.0	2,819.0		11,562.0	6,788.0
Population projections for 2030	1,263	8,394	118,515	65,928	16,360	15,082	51,775	55,846.0

Source: Adapted from Mengisteab [32] and African Statistical Yearbook [40]

Table 2. Area and size of population of the countries of IGAD region

4.1. Socio-economic conditions of IGAD region

In the Horn of Africa, three out of four people reside in rural areas, and rely on subsistence production. Economic growth in the region averaged about 3% between 1965 and 1995, with a 3% population growth that led to a stagnation of per capita income at US\$ 223 at the end of

the period compared to US\$ 491 in the rest of Sub-Saharan Africa. Since the second half of 1990's, most countries in the region experienced strong growth. The region grew by 4.4% between 1996 and 2000, and at 5.3% and 7.9% in the first and second half of 2000's respectively. The overall disappointing growth performance in the Horn of Africa has led to poor socio-economic indicators [41].

The region is considered one of the most politically unstable regions in the world. This vast area is linked by a shared history of conflict and a complex web of economic ties. Economic exchange is also a feature of the region with growing trading links with the global economy. As one of the Africa's eight Regional Economic Communities, the Intergovernmental Authority on Development has institutional responsibility for advancing economic integration in the Horn. However, the economies of the IGAD region possess significant structural obstacles to the attainment of regional economic integration. Poverty and lack of diversification in the economy are root problems. The population is mostly rural with the largest percentage of the workforce engaged in agricultural labour. The livestock sector form a very important part of the economy, with the Horn of Africa supporting one of the largest concentrations of pastoralists people anywhere in the world. In common with most developing economies, the manufacturing sector remains small. The countries depend for their exports on relatively small number of primary commodities in which they compete each other. Historically, this pattern of trade has produced very low levels of formal intra-regional trade. Another disincentive is the relatively low tax base in some countries. There is also the problem of heavy dependence on imports from outside the region. There are also several important non-economic obstacles to the regional integration, including uneven capacities and different types of state, weak institutions, competing institutional frameworks (IGAD, EAC, COMESA, CEN-SAD) and regional conflicts [42]. Table 3. Presents some socio-economic characteristics of the region.

Item	Djibouti	Eritrea	Ethiopia	Kenya	Somalia	South Sudan	Sudan	Uganda
Total fertility rate (%)	3.4	4.7	4.5	4.7	6.6	8.9	5.4	6.2
rural population (%)	22.8	77.8	81.8	67.7	61.3	82.9	65.2	81.9
Life expectancy at birth (years)	61.8	62.9	59.7	57.7	55.1	59.8	61.8	50.4
Prevalence of undernourishment	19.8	65.4	40.2	30.4	-	-	39.4	34.6
GDP per capita (US\$)	1640	543	519	1011	-	1042	1856	624
Human poverty index (%)	25.6 (2007)	33.7 (2007)	50.9 (2007)	31.4 (2006)	-	-	34.0 (2007)	-
Human Development Index (HDI)	0.467 (170)	0.381 (182)	0.435 (173)	0.535 (147)	0.285 (2012)	-	0.473 (166)	0.484 (164)

Source: African Statistical Yearbook [40], and Human Development Report, 2014 [43]

Table 3. Selected indicators of socio-economic conditions of IGAD region

As mentioned before the region is riddled with conflicts of different types and causes and it is considered one of the hotspot areas in Africa and even at global dimension. However, the region is also facing other severe problems of food insecurity and poverty. The populations of the region have endured many inter-state and intra-state armed conflicts during the post-independence era. The region was by no means peaceful before the era of decolonization. During the period between 1800s and the era of decolonization, for example, it experienced many wars, which revolved mostly around state formation and empire building; slave raids, control of resources, and trade routes; resistance to colonization and the liberation struggle [32]. This implies that, the region is historically well prepared to fall in conflicts, particularly when other factors such as the undefined borders which were considered as time bombs triggering conflicts here and there.

The region's post-independence conflicts can be classified into six categories, including direct and indirect inter-state wars and armed conflicts; cross-border inter-communal conflicts; civil wars and civil conflicts; conflicts among rebel group over differences of political programmes and power struggle; intra-state inter-communal conflicts; and one-sided violence perpetrated upon civilians by the state or other armed political groups [32]. The allocation, use and management of natural resources such as water, fertile land, pasture land, trees but also oil, lead to large internal and international tensions in virtually all countries of the Horn of Africa. Through political tensions and grievances about the loss of livelihoods among farmers, pastoralists and fishermen, regional insecurity is rapidly increasing. [13].

The major economic driver of this region is crop and animal agriculture. However, a large proportion (60-70%) of the landmass in the IGAD region is covered by arid and semi-arid lands (ASALs) and experiences prolonged drought and unpredictable rainfall patterns (less than 400 mm of rainfall annually). The region is also characterized by chronic conflicts at national or cross border levels. These conflicts are often linked to scarceness of natural resources (water, rangelands) and competition over their use.

Agriculture is the core economic sector of the IGAD Member States. It contributes on average about 15% to the national GDPs and employs about 75% of the population in the region. Due to this, the performance of the agricultural sector is the key determinant of annual changes in the poverty and food security levels in the region.

The predominant livelihood system in the region is pastoral and agro-pastoral production. On average, livestock contributes 57% of the agricultural GDP in the IGAD region. This makes livestock a key contributor to the economies of the IGAD Member States. The nomadic lifestyle of the pastoralists involves a constant search for pasture and freshwater resources. Pastoralism cuts across national boundaries, frequently causing conflicts and necessitating a regional approaches to and collective action from the affected governments. Pastoralism as practiced in the IGAD region is both an economic and a social system that is highly dependent on the rearing of livestock. Livestock are core to pastoral livelihoods and pastoral identity and livestock and livestock products contribute significantly as the main sources of food and income in pastoral households. Sheep, goats, cattle, camels and donkeys are the predominant livestock holdings. Despite, the abundance of livestock in the pastoral areas, the pastoralist communities across the region remain among the most marginalized and face common

problems of low productivity of (endemic) indigenous livestock breeds, poor physical infrastructure, limited access to markets, lack of appropriate information, poor communication, lack of access to financial capital and limited access to crucial input services to enhance livestock production within their environments and the threat of dwindling pastures for their flocks. The pastoral areas are characterized by recurrent droughts and other natural disasters. The effects of climate change are reflected in the increasing frequency and severity of episodes of drought. During 2011, the most severe drought conditions to have occurred over the last 60 years were recorded in the Horn of Africa with severe consequences and impacts on the human and livestock populations.

4.2. Disasters and resilience in IGAD region

A global report on disaster hotspots [44], hundreds of disasters occur worldwide each year in locations without sufficient local capacity or resources to prevent death and destruction and to support rapid recovery. According to this report, disaster is defined as a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environment losses which exceed the ability of the affected community or society to cope using its own resources.

Globally, climate change is projected to increase the frequency and severity of extreme weather events like droughts and floods. The worst food crisis in 2011 in East Africa has been caused according to Oxfam report [45] by people and policies, as much as by weather patterns. An adequate response to the current crisis must not only meet urgent humanitarian needs, but also address the following problems:

1. To avoid catastrophic levels of global warming through: increasing efforts to limit global temperature rise and increase and mobilize financial resources by the developed countries
2. To improve food security and strengthen climate resilience with focus on: (a) disaster risk reduction, (b) climate change adaptation (c) long-term investment in livelihood protection measures and smallholder food production [45].

4.3. The Intergovernmental Authority on Development (IGAD): Background

The Intergovernmental Authority on Development (IGAD) is the Regional Economic Community (REC) of the States of Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan, South Sudan and Uganda. IGAD is recognized as one of the Regional Economic Community (REC) that is African Union's building blocks for regional and continental social and economic integration. The IGAD region is a large area occupying about 5.2 million Sq. Km and has a population of about 230 million people growing at a rate of 2.6%. This population constitutes about 20% of the African continent's population. This large economic bloc has great strategic and geopolitical significance and prospects for the people of the Eastern African region.

IGAD was established in 1986 as the Inter Governmental Authority on Drought and Development (IGADD) to coordinate the efforts of the member states in combating desertification and promoting efforts to mitigate the effects of drought. Then, in 1996 at an extra-ordinary

Summit, the Heads of State and Government resolved to re-vitalize the Authority and to expand its mandate to cover political as well as economic issues. Consequently, the Authority was re-named the Inter Governmental Authority on Development with new expanded mandate.

In terms of structure, IGAD consists of four principal bodies, with its head quarter in Djibouti. These principal bodies are Assembly of Heads of State and Government, Council of Ministers, Committee of Ambassadors, and the Secretariat. The Secretariat is the executive arm of the Authority and is headed by an Executive Secretary. The Secretariat in addition to the Office of the Executive Secretary has four divisions, namely Agriculture and Environment, Economic Cooperation and Social Development, Political and Humanitarian Affairs, and Administration and Finance Division. To more effectively implementing its expanded mandate particularly at country and community levels, IGAD has established several institutions and specialized centers of excellence, including the IGAD Climate Prediction and Application Centre (ICPAC), Conflict Early Warning and Response Mechanism (CEWARN), Sheikh Technical Veterinary School (STVS) and IGAD Centre for Pastoral Areas and Livestock Development (ICPALD). There are also IGAD programs, including IGAD Capacity Building Program Against Terrorism (ICPAT), IGAD Regional HIV and AIDS Partnership Program (IRAPP), and IGAD Political Offices.

4.4. IGAD region: Country profiles

4.4.1. Djibouti

Djibouti is a small country strategically located in the Horn of Africa to the southern tip of the Red Sea. It covers an area of 23,300 Km² and is bordered by Eritrea, Ethiopia and Somalia. This country was created in the 19th century by France after the opening of Suez Canal in 1869. The opening of a rail link with Addis Ababa in 1917 further increased Djibouti's role as a transit station for both passengers and freight. Djibouti gained independence from France in 1977. Today it still functions as a major port, transit and communication hub for the Horn of Africa [46]. The coastline which plays a major role in Djibouti's economy, is 314 Km long. The majority of the country is defined as desert and consequently the climate is torrid and dry throughout most of the country [47]. From May to September the climate is particularly hot with daily temperatures of approximately 40°C (104° F). Mid October to Mid April is considered to be cooler season with temperatures averaging about 25°C (77°F) in addition to being the time that there is occasional rain. Djibouti has three distinct geographic areas: the coastal plains which are emphasized by white sandy beaches; the volcanic plateau in the southern and central parts of the country; and in the north, the mountain ranges where the elevation can be as high as 2000 metres above the sea level. While most of the terrain is desert, there are some pockets of forest and dense vegetation in the north [48]. The country is divided into five administrative districts: Djibouti, Ali-Sabieh, Dikhil, Tadjoura, and Obock. It represents a country with relative political stability, economic freedom, and modern financial, transport and communication infrastructure in an otherwise underdeveloped region which is subject to recurrent civil unrest and economic uncertainty [46].

The population of Djibouti is estimated to be 923,000 persons, comprised of two main ethnic groups; the Afars (related to tribes in Eastern Ethiopia) and the Issas (related to tribes in northern Somalia). As well as small portion of other mixed ethnical groups. Two thirds of its population lives in the urban sites mainly in the capital town of Djibouti. Djibouti's economy is characterized by extreme duality, as it is divided between a modern outward-looking urban commercial sector and a rural, subsistence-based pastoralist economy which has little access to infrastructure, services and markets. The economy mainly depends on external sources and service sectoris. With its few natural resources and low rainfall, Djibouti has limited possibilities for agricultural production. Activities in the primary sector therefore make a negligible contribution to the national economy although are extremely important at the rural level, where livestock forms the basis of household livelihoods. The secondary sector, industry and manufacturing are poorly developed because of small domestic market, lack of locally available raw materials and a largely untrained labour force. As compared to other Sub-Saharan countries, where economic planning is central with non-liberal economies, Djibouti has no system of central economic planning and the economic structure is highly liberalized. Major industries include water bottling company, animal feed factory, slaughterhouse and dairy products plant. This is in addition to urban development, transport and communications. The private sector has given some official incentives to encourage investment [46]. The nature of dualism in the economy is explained by having a modern economic rent generating economy coexist alongside an informal economy. The informal economy constitutes a major proportion of the economic activities and provides livelihoods for much of the Djibouti population.

Djibouti adopted its first poverty reduction strategic paper in May 2004, with an incidence of extreme monetary poverty rising from 34.5% in 1996 to 42.2% in 2002. Then many efforts were adopted after the implementation of the strategy and there is significant progress reported. Some improvements in the growth rates of the GDP and social indicators were reported over the period 2004 – 2006. Despite this encouraging progress, the evaluation report mentioned that the priority actions included in the poverty reduction strategic paper have not been satisfactorily implemented [50].

According to table 4, Djibouti's Human Development Index (HDI) value for 2013 is 0.467, with a rank of 170 out of 187 countries and territories. The table shows also HDI trends since 1980.

Year	Life expectancy at birth	Expected years of schooling	HDI value
1980	53.6	2.3	NA
1990	56.7	2.7	NA
2000	57.0	2.9	0.412 (2005)
2010	60.3	6.0	0.452
2013	61.8 (+8.2)	6.4 (+4.1)	0.467 (+13.3%)

Source: Human development Report, UNDP, 2014 [43]

Table 4. Djibouti's HDI trends 1980-2013

Djibouti's HDI is below the average of 0.493 of the countries in the low human development group and of 0.682 for countries in the Arab States [43].

As well, Djibouti earns rents from several foreign military bases especially French and American ones, alongside considerable bilateral assistance aimed at fighting endemic poverty [50]. The country is faced by several environmental and biodiversity threats such as poverty, decreasing vegetation, overgrazing, deforestation, increased development around the coastal zones, depletion of mangrove forests, and continuous loss of wildlife habitat [46].

4.4.2. Eritrea

Eritrea is situated along the western coast of the Red Sea and has a total land area of about 124,000 km². The climate ranges from hot arid in the lowlands to temperate sub-humid in the highlands [51]. Eritrea is the Italian form of the Greek name *Erythraia*, meaning "red land". With its capital at Asmara, it is bordered by Sudan to the West, Ethiopia in the south and Djibouti in the east. It is a multi-ethnic country, with nine recognized ethnic groups [52].

According to IFAD [51], Eritrea is a country emerging from a dual crisis of war (1998 -2000) and an unprecedented series of drought (2000-2003). It has unable to build its institutions, suffer from financial constraints and has large number of internally displaced persons, returnees and demobilized soldiers due to those crises [51]. Eritrea population is estimated as 6,130,922 persons, and according to the World Bank ranking, it is classified as low income country. Eritrea has faced considerable challenges over the years, including variable climate conditions. This has been compounded by restrictive economic policies, political isolation, a significant decline in remittances and scarcity of foreign exchange.

The real GDP growth for 2013 fell sharply to 1.1% from 7%, the previous year and is projected to increase marginally to 1.9% in 2014. This growth will largely be driven by copper production at the Bisha mine; the start of gold production at the Zara mine project in 2014; and continued exploration activity and investment in the mining sector. In the medium term, Eritrea sees further prospects in oil production, fisheries and tourism [53]. The economy remains largely managed with the government active in most sectors. Despite on-going efforts to promote more private sector participation in the economy, performance remains sub-optimal. The economy continues to suffer from the effects of the border conflicts, the country's vulnerability to external shocks and the persistent foreign exchange shortages, which are fueling macro-economic imbalances and hampering growth [54].

As far as regional integration is important for Eritrea as for other countries as well, it is currently a member of the Common Market for Eastern and Southern Africa (COMESA), the Community for Sahel - Saharan States, New Partnership for Africa's Development (NEPAD), and the IGAD. This is in addition to some bilateral investment agreements. It is also gradually renewing its engagement with the wider international community [53].

According to table 5, Eritrea's Human Development Index (HDI) value for 2013 is 0.381, with a rank of 182 out of 187 countries and territories. The table shows also HDI trends since 1980.

Year	Life expectancy at birth	Expected years of schooling	HDI value
1980	43.3	NA	NA
1990	48.2	NA	NA
2000	56.1	4.1	NA
2010	61.3	4.1	0.373
2013	62.9 (+19.6)	4.1	0.381 (+2.1%)

Source: Human development Report, UNDP, 2014 [43]

Table 5. Eritrea’s HDI trends 1980-2013

Eritrea’s HDI is below the average of 0.493 of the countries in the low human development group and of 0.502 for countries in Sub-Saharan Africa [43].

4.4.3. Ethiopia

In an area of 104300 km², Ethiopia is bordered by five countries, namely Sudan, Somalia, Djibouti, Kenya and Eritrea. Its population which represent second largest one in Sub-Saharan Africa after Nigeria, is estimated at 85900 million persons in 2013, of which about 81.8% live in rural areas. Of the total population, about 73.5% are 14 years old or younger, 79.1% portion represent the economically active population in agriculture, and about 81.8% live in rural areas [40].

Ethiopia is culturally and biologically diverse, with a diverse mix of ethnic and linguistic background; and more than 80 ethnic groups, each with its own language, and about 200 dialects, culture and tradition. It has extremely varied topography, characterized by highland complex of mountains and bisected plateau. Then surrounding the highlands is the lowland grazing areas that form a wide apron surrounding the highland massif and part of the Great Rift Valley [55].

Poverty in Ethiopia is wide spread and multifaceted. The proportion of the population below the poverty line is 77.6% in 2005 and the Gini’s index is 29.8%. However, now the government has formulated a five year growth and transformation plan (201 -2105) to eradicate poverty. This plan envisages that besides maintaining a fast growing economy, better results will be realized in all sectors. During this plan period special emphasis will be given to agricultural and rural development, industry, rural infrastructure, social and human development, good governance and democratization [56].

According to table 6, Ethiopia’s Human Development Index (HDI) value for 2013 is 0.435, with a rank of 173 out of 187 countries and territories. The table shows also HDI trends since 1980.

Year	Life expectancy at birth	Expected years of schooling	HDI value
1980	43.8	3.2	NA
1990	46.9	3.1	NA
2000	52.2	4.3	0.284
2010	61.5	8.2	0.409
2013	63.6 (+19.8)	8.5 (+5.3)	0.435 (+53.2%)

Source: Human development Report, UNDP, 2014 [43]

Table 6. Ethiopia's HDI trends 1980-2013

Ethiopia's HDI is below the average of 0.493 of the countries in the low human development group and of 0.502 for countries in Sub-Saharan Africa [43].

4.4.4. Kenya

The republic of Kenya is a country in the African Great Lakes region of East Africa. It lies on the equator with the Indian Ocean to the south-east, Tanzania to the south, Uganda to the west, South Sudan to the north-west, Ethiopia to the north, and Somalia to the north-east. It covers about 581,509 km² and has a population of 44,354,000 persons in 2013 according to the African statistical Yearbook [40]. Kenya has a warm, humid, climate along its Indian Ocean coastline, with wildlife rich savannah grasslands inland towards the capital. Nairobi, the capital has a cool climate which becomes colder towards Mount Kenya. Further inland there is a warm and humid climate around Lake Victoria, and temperate forested and hilly areas in the western region. The long northeastern regions along the border with Somalia and Ethiopia are arid and semi-arid areas. Lake Victoria, the world's second largest fresh water lake, is situated to the southwest and is shared with Uganda and Tanzania. Kenya, along with Uganda and Tanzania is famous for its safaris and diverse wildlife reserves and national parks [57].

Topographically, Kenya rises from a low coastal plain on the Indian Ocean in a series of plateaus to more than 3000 metres in the centre of the country. All inland regions of semi-arid, bush covered plains constitute most of the country's land area (nearly 70%-80%). In the northwest there is Lake Turkana and Kulal Mountains. In the southwest lie the fertile grasslands and forest of the Kenya Highlands, one of the most successful agricultural production regions on Africa. North of Nairobi, the Kenya Highlands is bisected by the Great Rift Valley, an irregular depression that cuts through western Kenya from north to south in two branches [58].

Population in Kenya, is 41800, about 39.6% aged 14 years and less, 49.5% aged in a range of 15-64 years, while the rest represents 65+ years group. Of the total population, about 67.7% live in rural areas [40]. People of African descent make up about 97% of the population in Kenya and they are divided into 40 ethnic groups. The Kikuyu who make up to 22% of the population constitute Kenya's largest ethnic group. The next largest groups are Luhya (14%), Luo (13%), Kalengin (12%) and Kamba (11%). Small numbers of people of Indian, Pakistani, and European descent live in the interior and there are some Arabs along the coast [58].

Kenya's Growth Domestic Product (GDP) growth rate is estimated at 4.9% in 2013 and it is estimated at current market prices at US\$ 44850 million and with a rate of US\$1011 per capita [40]. The economy of Kenya is market-based, with some state-owned infrastructure enterprises, and maintains a liberalized external trade system. The economy's heavy dependence on rain-fed agriculture and the tourism sector leaves it vulnerable to cycles of boom and bust [58]. The proportion of the population below the poverty line is 19.7% in 2005 and the Gini's index is 0.4% in 2009 [43]. However, according to IFAD [59], while Kenya is on the path to economic growth, poverty reduction remains a challenge. More than three quarters of the population lives in rural areas, and rural households rely on agriculture for most of their income. About 70% of the poor are in the central and western regions, living in areas that have medium to high potential to agriculture. Poverty and food insecurity are acute in arid and semi-arid lands which have been severely affected by recurrent droughts. Rural poverty in Kenya is also strongly linked to environmental concerns, especially poor water management, soil erosion, declining soil fertility, and land degradation [59].

According to table 7, Kenya's Human Development Index (HDI) value for 2013 is 0.535, with a rank of 147 out of 187 countries and territories. The table shows also HDI trends since 1980.

Year	Life expectancy at birth	Expected years of schooling	HDI value
1980	57.7	9.3	0.424
1990	59.3	9.3	0.463
2000	52.3	8.3	0.447
2010	56.6	11.1	0.511
2013	61.7 (+4.0)	11.0 (+1.7)	0.535 (+20.0%)

Source: Human development Report, UNDP, 2014 [43]

Table 7. Kenya's HDI trends 1980-2013

Kenya's HDI is above the average of 0.493 of the countries in the low human development group and of 0.502 for countries in Sub-Saharan Africa [43].

4.4.5. Somalia

Somalia is a country located in the Horn of Africa, bordered by Ethiopia to the west, Djibouti to the northwest, the Gulf of Aden to the north, the Indian Ocean to the east, and Kenya to the southwest. It has the longest coastline on the continent's main lands, and its terrain consists mainly of plateaus, plains and highlands. Climatically hot conditions prevail year-round, with periodic monsoon winds and irregular rainfall [60].

The population of Somalia is estimated at 10496 persons, out of which about 47.2% aged 14 years and below, 49.9% aged 15-64 years, while the rest comprise the elderly group (65+) [43]. The majority of the population is ethnic Somalis who have historically inhabited the northern

part of the country. Other minorities inhabited the southern part of it [60]. The Somalis are a culturally, linguistically and religiously homogenous people who are divided along clan lines and sparsely scattered over a harsh dry land. The majority of Somalis trace their genealogical origin to the mythical founding father, Samaale or Samaal. However, genealogy constitutes the heart of the Somali social system [61].

A report by UNDP [62] illustrated that Somalia is at a crossroads due to this complex and protracted conflict. The south central region has experienced years of fighting and lawlessness, while the north-east and north-west have achieved a fragile semblance of peace and stability [62]. According to the African Development Bank country brief on Somalia (2013), the country, after more than two decades of civil conflict, is at a turning point in terms of positive political and security developments as well as the commitment of the international community for a sustainable resolution of the protracted crisis in the country. The outlook is more positive than it has been in a generation. However, the situation remains extremely fragile, joint and concerted domestic and international efforts need to be sustained and enhanced to ensure national reconciliation, durable peace, stability and state building [63]. A powerful new vision for Somalia is required, one oriented around building an inclusive peace society, where all people feel empowered, and have the capabilities and opportunities to improve their lives [62].

Somalia is still characterized by a severe lack of basic economic and social statistics. The situation has been worsened by two decades of conflict and the resulting collapse of the country's institutions. The common feature in the structure of the economy of the three sub-entities of Somalia is the predominance of agriculture and livestock as means of livelihood. As well the economy is dominated by the informal sector, in that the economy is based on international trade networks controlled by small groups of wealthy businessmen [63]. Somalia has suffered severe consequences from conflict, as reflected in the indices developed by the Global Human Development Report [62]. In 2011, two consecutive years of failed rainy seasons in the Horn of Africa and the absence of drought mitigation mechanisms resulted in the worst famine and vast humanitarian crisis in the last sixty years in Somalia and the Horn of Africa [63]. This famine signifies an increasingly dismal future, if approaches to both conflict and development do not significantly change. Somalia's Human Development Index (HDI) value is strikingly low at 0.285, which will be further worse, if one accounts for the level of inequality in the distribution of income, education and health. Gender inequality is alarmingly high at 0.776 out of a value of one (complete inequality). In terms of measuring deprivation related to poverty, Somalia's Multidimensional Poverty Index (MPI) of 0.47 out of one would place it at 94 out of 104 countries in 2010. An estimated 82% of Somalis are considered poor across multiple dimensions. The divide between rural and urban population is significant – 61% and 94% respectively. In south central Somalia, 89% of people are poor, across several dimensions, compared to 75% in Puntland, and 72% in Somaliland [62].

4.4.6. South Sudan

South Sudan is a country in northeastern Africa that gained its independence from Sudan in 2011. It is bordered by Sudan to the north, Ethiopia to the east, Kenya to the southeast, Uganda to the south, the Democratic Republic of Congo to the southwest, and the Central African

Republic to the west. South Sudan lies between latitudes 3 and 13 degrees north and longitudes 24 and 36 degrees east. It is covered in tropical forests, swamps, and grasslands [64].

Population in South Sudan, is 11,300,000 persons, and has area of 640,000 km² [40]. Of the total population, 15.9% represent those aged 14 and below, 3.5% those who aged 65 and above and the rest comprise the age group of 15 – 64 years. Also about 82.6% of the total population lives in rural areas [43]. South Sudan is historically divided into three provinces: Great Upper Nile, Bahr el Ghazal and Equatoria. For administrative purposes the country is separated into ten states which are then further broken down into 86 counties. The majority of the population continues to live in rural areas, although the urban population of the state capital is steadily increasing. The country's history is the history of competition for natural resources and for influence among different tribes, religions, political factions and colonial powers [65]. South Sudan is potentially rich in natural resources; however, its development was neglected during the colonial period. On the eve of the independence of the whole former Sudan in 1956, the first war broke out. It ended with Addis Ababa Agreement in 1972. Failure of socio-economic development in the post-first war period contributed to the outbreak of the second war in 1983 [66].

4.4.7. Sudan

Sudan, the third largest country in Africa, has an area of 1,886,068 km² (181 million hectare). It is bordered by Egypt to north, the Red Sea, Eritrea and Ethiopia to the east, South Sudan to the south, the Central African Republic to the southwest, Chad to the west and Libya to the northwest. The Nile River divides the country into eastern and western halves. Along this Nile numerous ancient civilizations were evolved [67].

Sudan geography, like its history, appears to be dominated by the Nile. Most of the population lives along the river, the major cities, industry, wealth and power are all concentrated there. Greater Khartoum, at the junction of Blue and White Niles – comprising the three cities of Khartoum, Khartoum North and Omdurman is overwhelming the larger urban centre in the country. Sudan geography is the product of political and historical factors, as well as, conditions imposed by nature [68]. Population in Sudan, is 36164, about 54.6% aged 14 years and less, 42.0% aged in a range of 15-64 years, while the rest represents 65+ years group. Of the total population, about 65.2% live in rural areas [40].

According to the World Bank report on Sudan [69] Sudan holds the potential to be a regional economic powerhouse. The largest economy in the greater eastern Africa region, it has abundant fertile land and livestock, a reasonable manufacturing base, and strategic market location at the crossroads of sub-Saharan Africa and the Middle East. Oil discovery and export in the last decade fueled unprecedented growth (GDP grew more than six-fold from 1999 to 2010). However, much of this potential has not been realized due to long-running conflict and governance challenges; and the gains of the last growth decade have not advanced productive public investment that contributes to poverty reduction, or been widely shared [70]. During 1970-90 the real GDP growth rate fell below -5% in six years (1972, 1978, 1979, 1984, 1985, and 1990) and exceeded 10% in four years (1974, 1975, 1976, and 1987). In contrast, the growth rate has hovered within 5-11% range during 1999-2008 periods [74]. Currently, Sudan's Growth

Domestic Product (GDP) growth rate is estimated at 3.6% in 2013 and it is estimated at current market prices at US\$ 70,463,000 and with a rate of US\$1,856 per capita [40].

According to table 8, Sudan's Human Development Index (HDI) value for 2013 is 0.473, with a rank of 166 out of 187 countries and territories. The table shows also HDI trends since 1980.

Year	Life expectancy at birth	Expected years of schooling	HDI value
1980	54.2	3.7	0.331
1990	55.5	3.9	0.342
2000	58.0	4.5	0.385
2010	61.5	7.3	0.463
2013	62.1 (+7.9)	7.3 (+3.6)	0.473 (+42.8%)

Source: Human development Report, UNDP, 2014 [43]

Table 8. Sudan's HDI trends 1980-2013

Sudan's HDI is below the average of 0.493 of the countries in the low human development group and of 0.502 for countries in Sub-Saharan Africa [43].

According to the World Bank report (2013) gender disparities remain persistent in Sudan. Women comprise only 23% of the formal economy, but 70% of the informal economy, with a majority of them engaged in agricultural production. On the other hand, despite those ten years of oil boom, Sudan continues to suffer wide and deep swaths of poverty and stark inequality between regions [69].

4.4.8. Uganda

Uganda is a landlocked country in east Africa. It is bordered to the east by Kenya, to the north by South Sudan, to the west by the Republic Democratic of the Congo, to the southwest by Rwanda, and to the south by Tanzania. The southern part of the country includes a substantial portion of Lake Victoria, shared with Kenya and Tanzania, situating the country in the African Great Lakes region. Uganda also lies within the Nile basin, and has a varied but generally equatorial climate. Uganda takes its name from Buganda Kingdom, and beginning in the late 1800s, the area was ruled by the British, who established administrative law across the territory. Uganda gained independence in 1962. The period since then, has been marked by intermittent conflicts, most recently a lengthy civil war against the Lord's Resistance Army, which has caused tens of thousands of casualties and displaced more than million people [71].

Population in Uganda, is 35357, about 50.9% aged 14 years and less, 47.7% aged in a range of 15-64 years, while the rest (1.4%), represents 65+ years group. Of the total population, about 81.9% live in rural areas. Uganda, in 2013 had a GDP of US\$ 23,459,000 and a per capita income of US\$ 624,000 and the GDP growth was at 5.2% rate [40].

According to table 9, Uganda's Human Development Index (HDI) value for 2013 is 0.484, with a rank of 164 out of 187 countries and territories. The table shows also HDI trends since 1980.

Year	Life expectancy at birth	Expected years of schooling	HDI value
1980	49.5	4.0	0.293
1990	47.5	5.7	0.310
2000	48.1	10.7	0.392
2010	57.3	10.8	0.472
2013	59.2 (+9.7)	10.8 (+6.8)	0.484 (+65.0%)

Source: Human development Report, UNDP, 2014 [43]

Table 9. Uganda’s HDI trends 1980-2013

Uganda’s HDI is below the average of 0.493 of the countries in the low human development group and of 0.502 for countries in Sub-Saharan Africa [43].

Uganda’s sustained growth over the past two decades has continued to be rewarded with strong poverty reduction. However, poverty remains mainly a rural phenomenon, with 34% of the rural population living the national poverty line. The poorest areas of the country are in the north, where poverty incidence is consistently above 40% and in many districts exceeds 60% [72].

5. Farming systems in IGAD region

5.1. Introduction

According to Giessen [13] the hydrological assets in the Horn of Africa includes precipitation, the Nile River and its tributaries, the Ethiopian Highlands which make the water tower of the region, and a number of some important lakes such as Lake Tana, Lake Turkana and Lake Victoria. The Horn of Africa is not a total desert or dry wetland, as it is often considered. Vegetation is quite varied and spatially correlated with precipitation levels and the systems of rivers and lakes. Very generally, the drier eastern parts of the Horn of Africa consist of desert, semi-desert and steppe vegetation, while in areas close to the major hydrological assets savannah grasslands and deciduous forest vegetation occur. In terms of biodiversity, Ethiopian highlands can be regarded as historical gene centre or a centre for origin for many crops. As well high value protected areas are also found in Kenya, South Sudan and Uganda [13].

In IGAD countries, agriculture dominates their economies in terms of contribution to GDP, employment and income. This indicates clearly that, for sound socio-economic development, the real growth and developing of this sector will be the leading engine. Any developments in this sector are vital for poverty reduction, wealth creation and improved food security status.

Most of the landscapes in the IGAD region consist mainly of lowlands with arid, semi-arid or dry sub-humid zones. Based on agro-ecological zoning considerations, the region can be classified as arid (55%), semi-arid (15%), sub-humid (16%) and humid (2%) and high lands

zones (12%). About 3.4 million km², or 80% of the IGAD region's total area, consists of lowland, with arid, semi-arid or dry sub-humid climates, where precipitation is low and uncertain (100 – 600 mm per annum) [73]. These arid and semi-arid lands, according to Mortimore, (2009) provide numerous goods and services that have great economic, social, cultural and biological value in all geographical aspects: locally, nationally and globally [74]. More than 40% of the total area is unproductive because of severe environmental degradation, resulting from both natural conditions and human actions. The agricultural sector is one of the three priority development areas of IGAD and sector oriented activities are focused on food security, natural resources management and environmental protection. The majority of the people in the region depend on natural resources for their livelihood. The different key components of drylands (land, water, nutrients, and energy) are deeply interconnected: changes in one component will affect the other [75].

According to Knips, [76] IGAD region could be divided into seven ecological Zones, namely: desert, arid, semi-arid, sub-humid, humid, highland and urban/peri-urban ecological zones (Figure 2).

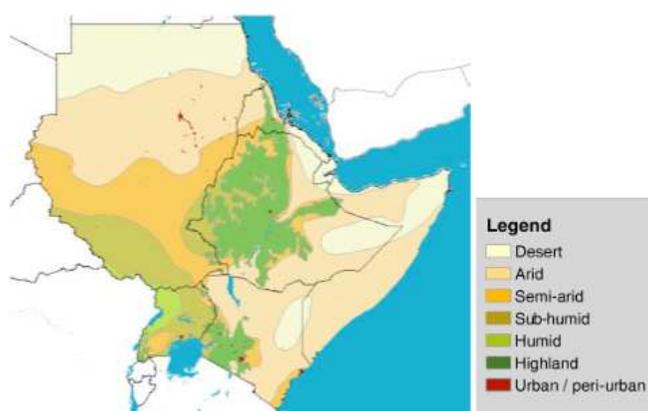


Figure 2. A map showing the agro-ecological zones in IGAD region

5.2. Major farming systems in the region

As well documented in the literature, and based on Schiere, [14] farming system typologies are dictated by climate, production goals and culture with a farming system being described as a unit consisting of a human group (usually a household) and the resources it manages in its environment, involving the direct production of plant and/or animal products [14].

Generally, it has been reported by Robinson *et al.* (2011) that, the existing global system classifications were facing the following limitations: (i) they tend to focus either on crops or on livestock farming; (ii) some classification systems tend to group the majority of production systems into a single mixed farming category, which may include many different combinations of crop and livestock species; (iii) many existing classification systems can be useful at very broad scales but they are often of little practical use for priority setting and planning at national level [28].

The countries of the Horn are characterized by four broad-based systems of land utilization. These systems are pastoralism, agro-pastoralism, rain-fed and irrigated agriculture. However, it has to be emphasized that these four systems are closely inter-linked through symbiotic relationships. High potential areas which are put under agriculture have a better chance of supporting the system that utilizes them. Yet the increasing demand for food production has put marginal lands in the region under severe strain and has led to long lasting land degradation [77]. Pastoralists and agro-pastoralists represent a high proportion of the population in the region and are utilizing the arid and semi-arid areas. This is largely due to the fact that much of the land in the Horn is dry land which offers little or no opportunity for means of subsistence other than livestock raising [78]. According to Sandford, [79] in the late 1970s the most important single countries of the world in terms of the numbers of pastoralists were Sudan, the USA, Somalia, Chad, Ethiopia, Kenya, Mali, Mauritania, India and China [79]. The order may be different at present, but one important thing to note is that four out of the ten countries above are found in the Horn of Africa, which indicates the importance of pastoralism as a livelihood system and as a method of land utilization in the region [78].

In African context, Dixon *et al.* [16] defined a farming system as a population of farm households, often a mix of small and large farms, that as a group have broadly similar patterns of livelihood and consumption patterns and constraints and opportunities, and for which similar development strategies and interventions would be appropriate. Often such systems share similar agro-ecological and market access conditions. Based on this definition and on two factors, namely the available natural resource base and the dominant patterns of consumption and household livelihoods, they mentioned about 13 farming systems in Africa in general; these systems are:

1. Maize mixed farming systems: sub-humid and humid, in east, central and southern Africa.
2. Agro-pastoral farming systems: semi-arid areas, west, east and southern Africa.
3. Cereal root crop mixed farming system: sub-humid areas, west and central Africa.
4. Root and tuber crop farming systems: lowland areas, west and central Africa.
5. Highland perennial farming systems: moist highland areas, east Africa.
6. Highland mixed farming systems: cool highland areas, east and southern Africa.
7. Humid lowland tree crop farming systems: humid lowland areas, west and central Africa.
8. Pastoral farming systems: in arid areas, west, east and southern Africa.
9. Fish-based farming systems: along coastal areas and major lakes.
10. Forest-based farming systems: humid lowlands, central Africa.
11. Irrigated farming systems: low rainfall areas.
12. Sparse arid pastoralism and oases farming systems: arid areas, west, north east and southern Africa.
13. Urban and peri-urban farming systems: all parts of Africa

Based on this classification, the following farming systems are currently practiced in IGAD region:

1. Maize mixed farming systems: this is found in Kenya
2. Agro-pastoral farming systems: such as in Somalia, Djibouti and Ethiopia
3. Highland perennial farming systems: this one found in Ethiopia and Uganda
4. Highland mixed farming systems
5. Pastoral farming systems: in the arid and semi-arid zones of Sudan, Eritrea, Ethiopia, Somalia and Kenya and Uganda.
6. Fish-based farming systems: such as in Kenya.
7. Irrigated farming systems: this comprises large scale irrigation schemes such as the Gezira scheme in Sudan and Wabi Shebelle in Somalia
8. Sparse arid pastoralism and oases farming systems: this is found in Sudan
9. Urban and peri-urban farming systems: around the major cities in all IGAD countries.

According to a regional study on the livestock sector in the horn of Africa [80] commissioned by the African Development Bank, there are two main production systems practiced in the Horn of Africa accounting for over 80% of the total livestock numbers. These are the pastoral and agro-pastoral production systems; however, there is also the mixed crop-livestock production system [80]. On the other hand, following an approach tackled by FAO, the Africa Development Bank study categorized the production systems in the Horn of Africa region into seven different production systems. These systems, according to AfDB study [80] could be summarized as follow:

1. Grassland based systems: these systems in the Horn of Africa could be sub-divided into three sub-types:
 - a. Livestock only, arid/semi-arid tropics and sub-tropics production system: it has a growing period of less than 180 days per year; the main livestock type is grazing ruminants. It is mainly pastoral due to scarcity of rainfall, water and pasture. One of the most severe problems of this system is the feed variability, in addition to some environmental concerns and problems of land degradation.
 - b. Humid and sub-humid tropics and sub-tropics production system: this enjoys more than 180 days of pasture growing period. It is found in South Sudan, Ethiopia and Uganda. Among the main constraints are the prevalence of trypanosomiasis, poor feed quality, poor road infrastructure and some environmental concerns.
 - c. Temperate zones and tropical highlands production system: it is practiced in Ethiopia, South Sudan, Uganda and Kenya. It has seen the introduction of temperate livestock breeds with some efforts of local breeds improvement through artificial insemination. Range is the primary feed source making the livestock vulnerable to changing weather patterns. There is potential for greater forage production similar

to the intensive systems in other regions, however, the balance between intensive production and ecosystem protection remains the bigger challenge for increased productivity.

2. **Mixed irrigated husbandry production system:** this system is only reported in Somalia under the type mixed irrigated arid and semi-arid in which irrigation makes year round intensive crop production feasible. In other countries it is thinly spread with efforts going on in Ethiopia and Sudan, while Kenya has put in place policies that are geared at promoting this system in the drylands. Private investments in parts of northern Somalia has made some production possible under this system.
3. **Mixed rain-fed systems:** these are found in all the countries of the Horn except in Djibouti and Eritrea. There are three main categories of this system in the Horn of Africa:
 - a. **Temperate zones and tropical highlands production system:** it is practiced in the tropical highlands of Ethiopia where the large numbers of livestock provide a variety of services in support of crop production, Kenya where dairy development and dairy cattle improvement has taken root and a little bit in Sudan and Uganda. It has been the most versatile in response to technological innovation, adaptation to climate change and changing land use practices. The future challenge of this system is the adoption of cleaner production practices that conserve the environment while at the same time coping with the increasing demand for livestock products.
 - b. **Humid and sub-humid tropics and sub-tropics:** it is based on a mixed farming method under varying socio-economic and climatic conditions. It is found in Uganda, Ethiopia and Kenya. The challenge for this system is to device ways of increasing productivity under reduced land resource availability.
 - c. **Arid and semi-arid tropics and sub-tropics production system:** is a mixed production system with a vegetation growth period of less than 180 days. The soils are normally less productive and rainfall is usually too low to sustain cropping. Livestock is normally the primary income generating activity. Crop production is very low and normally for subsistence only. Rangeland degradation and high methane production per animal are among the challenges of this system.

Within the agricultural sector in IGAD region, the major contribution to the GDP comes from livestock. The importance of the livestock sector in the region can partly be explained by the fact that the major proportion of the land area in the region is classified as arid, with highly variable rainfall making it unsuitable for crop production. This leaves livestock production as the only viable form of land use. In agro-ecological zones where crop production is possible it is mostly practiced in mixed systems with livestock providing important inputs into the farming system. Livestock production systems in the region are pastoral, agro-pastoral, settled mixed crop-livestock production systems and small-scale dairy production [73]. The pastoral production systems according to Otte and Chilonda, [81], are characterized by a contribution of livestock and livestock-related activities to household gross revenue of over 50% and it involves seasonal or annual mobility of livestock in search of pasture over a large area of rangeland [81]. Both pastoral and agro-pastoral livestock systems are practiced in all IGAD

countries. The dominant species of livestock kept under both systems are cattle, sheep, goats and camels. The degree of mobility of herds and households varies depending on environmental factors and normally increases with the increase of aridity [73]. In the agro-pastoral systems, the livestock are kept for subsistence (milk and milk products), transportation (camels, donkeys), land preparation (oxen, camels), sale or exchange, saving, bride wealth and insurance against crop failure. The population generally lives in permanent villages, although part of the herds may continue to migrate seasonally in the care of herd boys. The main crops planted in this system are millet, sorghum, maize, and cowpea. Irrigation is rarely practiced, except for few locations in Somalia and Sudan, where cotton, sugarcane and rice are grown [16].

Settled mixed systems are found in the highlands, sub-humid and humid zones within the IGAD countries. They are predominantly subsistence oriented and crop dominated with the type of crops planted depend on agro-climatic conditions, while the numbers and species of livestock kept depend on human population pressure and prevalence of trypanosomosis. It is found in all IGAD countries except in Djibouti and Somalia [73]. The major characteristic of the small-scale dairy production systems is the production of milk for sale. Milk production is integrated with the growing of subsistence crops such as maize, beans and potatoes and of cash crops such as coffee, tea and pyrethrum. This system is found in Kenya, Ethiopia and Uganda [81].

Globally and at regional levels, in the drylands context, the agro-ecosystems comprise a diverse and complex mix of pastoral, agro-pastoral, rain-fed and irrigated farming practices. Farmers and pastoralists employ a diverse mix of food, fodder and fiber crops, vegetables, rangeland and pasture species, fruit and fuel wood trees, medicinal plants, livestock and fish to meet their food and livelihood needs. They have developed these practices over centuries, adapting them to the limited resources and variable climate that characterize dry areas. Agricultural production systems in the drylands face not only persistence water scarcity and frequent drought, but also high climatic variability, land degradation, desertification and widespread poverty. These constraints are expected to intensify as a result of climate change [82]. These areas are usually perceived as having low production potential, but according to Fowler and Hodgkin, [83] they are home to several important centers of origin and diversity of crops, vegetables, livestock, trees and fish, and most traditional farming systems maintain this agro-biodiversity. These genetic resources can provide breeders with the traits needed to adapt plants and animals to heterogeneous and changing environments [83]. These genetic resources, as reported by Maestre *et al.* [84] are an important buffer against the effects of climate change and desertification [84]. However, as mentioned earlier, and according to Harvey et al., (2011) land degradation and pressure on natural habitats threaten biodiversity in dry areas and farmer behavior, if not directed otherwise, will generally result in decline in species diversity to meet immediate production objectives[85]. Therefore, the multifaceted constraints facing dryland agricultural systems call for broad-based, integrated approaches addressing the full range of socio-economic and biophysical constraints that farmers and pastoralists in drylands typically face. This requires innovative approaches that bring together all participants in the impact pathway, from primary producers to policy makers, to develop technologies, resource management strategies, and institutional arrangements that: reduce demand for water per unit

crop area, and livestock unit; improve water capture and storage; increase productivity per unit of water and land at farm and landscape scales; enhance the capacity of communities and the most marginalized actors within them; and strengthen institutional arrangements to build resilience of livelihoods and increase system productivity through diversification and sustainable intensification [82]. These approaches aim to identify, quantify and address the driving forces and interactions that shape and constrain farming systems and the management of natural resources [86].

To give full overview about the major farming systems currently practiced at country level in the region, a detailed description and analysis will be presented on the following part of this chapter.

5.3. Farming systems in Djibouti

Geographically, Djibouti has one of the most inhospitable, barren environments on the planet. It has virtually no arable land, no permanent fresh water source, no significant mineral resources, very little vegetation, high daily temperature and severe persistent drought for the past six years [50].

According to the Convention of Biological Diversity [87], Djibouti is made up of rich and varied terrestrial and aquatic eco-systems. The majority of the country is defined as desert with a climate that is torrid and dry throughout the country. It has three distinct geographic areas: the coastal plains, the volcanic plateaus in the southern and central parts and in the north, the mountain ranges where the elevation can be as high as 2000 metres above sea level. Djibouti contains several different types of eco-systems however over 90% of the land is desert. The terrestrial eco-system is separated into the mountains region and the semi-arid lowlands which are dominated by shrubs and trees [87]. Almost 78% of the people in Djibouti base their livelihoods on agriculture. Therefore, most parts of Djibouti are allocated for agricultural activities, all the land is used for pasture, with smaller areas for the production of crops, mainly vegetables and fruits [13]. The National Strategy for Food and Nutrition Security (2008) estimated that less than 10% of the calories consumed nationally come from domestic production, the remaining 90% being imported from neighboring countries or from the international market. This heavy reliance on food import makes the country highly vulnerable to external market risks that are often beyond its control [88].

According to FAO [89] livestock rearing is the main livelihoods activity for 80% of rural households. In recent years, herds have been decimated due to impact of recurrent drought particularly that of 2010/2011 [89]. In rural areas, two traditional production systems are present: pastoralism and small scale farming. Pastoralism is an age-old and deeply entrenched tradition that dominates Djibouti's rural economy. Pastoral activities consist primarily of extensive nomadic herding which often represents the sole source of subsistence for pastoral communities. Some 90.5% of the country's territory can be classified as pastoral lands that are used for herding. Transhumance is still practiced extensively along grazing routes determined by the presence of water and pasture. Mobility is a highly efficient way of managing the sparse vegetation and relatively low fertility of fragile soils of Djibouti [88].

From the previous discussion and evidences from the literature pertaining to the currently practiced farming systems in Djibouti are crop farming, pastoral and agro-pastoral farming systems. According to Brass, [89] crop farming has been introduced to Djibouti in the past 30 years, and comprises only a tiny percentage of Djibouti's economy, population and land. The remainder of Djibouti's non-urban lands is used solely for livestock production, the vast majority of which is subsistence nomadic or semi-nomadic pastoralism of small ruminants (primarily goats) and camels. The Djiboutian livestock production system unifies with its neighbours; pastoralists move between Djibouti, Ethiopia and Somalia following the rains. These pastoralists maintain a traditional approach to animals, seeing them as store of value and a source of protein via milk – animals are only slaughtered or sold in case of liquidity crisis or for important celebrations. Thus, while it is the prominent rural activity, livestock production is not well integrated into the national monetary economy, nor is it a government priority [90].

5.4. Farming systems in Eritrea

Eritrea's topography can be divided into three broad categories: the arid, narrow, lowland along the Red Sea; the north central region, which is an extension of the Ethiopian plateau and is dissected by river valleys; and the western plain along the Sudanese border. The highest point is Emba Soira, southeast of Asmara at 3,010 metres; the lowest is in the Dinakil Depression along the Red Sea, which at places is at 130 metres below sea level. It is one of the hottest places on earth. The Setit River is Eritrea's only perennial waterway. It flows from Ethiopia, where it is called Tekeze, along the western border and into Sudan, where it is called the Atbara. There are other seasonal rivers during the rainy season, namely the Anseba, the Baraka, and the Mareb (the Gash) [91]. Eritrea is geographically situated on the south-eastern border of the Sahel-Zone. Rainfall ranges from 1200 to less than 200 mm per year. The interregional differences and the variability in amount are high, and the risk to have an insufficient rainy season with erratic rainfalls is high. Some parts have hot tropical semiarid climate, with rainfall regimes that range from 400 to less than 700 mm per year [92]. As one of the arid or semi-arid Sahelian countries of Africa, Eritrea faced serious droughts in 1975, 1984, 1989, and 1991. Less than 5% of the land in Eritrea is arable, and permanent crops occupy a mere 0.03% of total land area. Most land is suitable for pasturage, but some areas, such as the Red Sea coast and the far north, are too arid even for this purpose [91]. However, land in Eritrea falls into four categories, namely cultivated, grazing, forests and barren land [93]. More than 70% of the population depends on traditional subsistence agriculture for their livelihood. The main sources of income for rural households are the sale of crops, livestock, and livestock products; wages for daily labour and remittances. In urban areas, people generate income from wage labour, small businesses, petty trade, and poultry farming. Eritrea has a number of agricultural systems: rain-fed cereal and pulses, semi-commercial and peri-urban agriculture, small-scale irrigated horticulture, commercial farming, agro-pastoral rain-fed farming, and agro-pastoral spate irrigation systems [93]. The agricultural sector is hampered by the absence of modern farming equipments and techniques, erratic rainfall, exhausted soils and lack of financial services and investment. Major agricultural products are barley, beans, lentils, dairy products, meat, milk, skins, sorghum, teff and wheat [91]. Eritrea's location in arid and semi-arid zones makes it vulnerable to the adverse effects of climate change, such as drought, pest infestation and

degradation of natural resources which can affect food security, and if it does, can eventually lead to malnutrition or under-nutrition in adult and children [93]. Despite the fact the economy is agriculture based; its contribution to the GDP has been moderate, due to recurrent drought, rudimentary farming methods, and effects of war. Now, this sector could be transformed into a promising sector through increased reliance on irrigation and improved farming methods and promotion of the livestock sector exports activities especially to the Middle East Markets. There are also opportunities in the production of high valued crops and vegetables for exports to Europe and Middle East [94].

5.5. Farming systems in Ethiopia

With its dramatic geological history and broad latitudinal and altitudinal ranges, Ethiopia encompasses an extraordinary number of the world's broad ecological zones. With a high plateau and a central mountain range divided by the Great Rift Valley, Ethiopia contains a huge altitudinal range from the depressions in the Afar (115 metres below sea level) to the mountain tops of Ras Dashen in the north (4,533 metres above sea level) and the Bale Mountains in the southeast. The headwaters of the Blue Nile are located in northwest Ethiopia at Tana Lake. This range of habitats also supports a rich variety of species, which contributes to the overall biological diversity of the country [95].

The agricultural sector greatly influences the rate of economic growth in Ethiopia: about 11.7 million smallholder farmers account for approximately 95% of agricultural GDP and 85% of the population. With a total area of about 1.13 million km² and about 51.3 million hectares of arable land, Ethiopia has tremendous potential for agricultural development. However, only about 10.6 million hectares of land are currently being cultivated, just over 20% of the total arable area. Ethiopian agriculture is dominated by a subsistence, low input, low output, and rain-fed farming system. Low productivity levels could be attributed to limited access by smallholder farmers to financial services, improved production technologies, irrigation and agricultural markets; and more importantly to poor land management practices that have led to severe land degradation [96].

According to Rahmato, [97] Ethiopia has varied agro-climatic zones. The Government extension programmes list these as: areas of adequate rainfall; areas of moisture stress; and pastoral areas. Farmers traditionally classify them as dega (cool), woina dega (temperate) and qolla (low land, warm climate). This diversity makes it a region for growing a variety of crops [97]. The country is endowed with one of the most bio-diverse systems in the world. It has earned the name 'the Water Tower of Eastern Africa' for having more than ten rivers, each of which has irrigation potential [98].

Based on John Dixon et al, [16] and FAO report [99], the following farming systems are found in Ethiopia:

1. Irrigated, small scale, traditional farming system: these have been established under self-help programs and initiatives by farmers' groups with sizes varying from a few to 100 ha. Modern small scale irrigation is also practiced. Traditional irrigation is practiced in the different agro-ecological zones making use of rivers, creeks, or gully waters that can last

up to three months in the dry season. These systems are less capital-intensive than large scale ones and are managed by traditional community rules and water rights, which make them an integral part of indigenous farming systems. Irrigated agriculture in Ethiopia is not well developed, but includes both traditional and modern small scale systems. The typical cropping pattern is organized into dry and wet seasons. In the dry one (September-April) vegetables like potato, onion and peppers. In the wet season (May-November) all cereals including teff, barley and rice are grown. Commercial agriculture is a relatively recent introduction and its contribution to total agricultural production is therefore still small.

2. Pastoral farming systems: this lies where climatic conditions lead to sparse vegetation cover over often fragile soils, with a scarcity of surface water. It can support only sparse human population and is not suitable for rain-fed crop production, only well adapted livestock. It is governed by social and community laws concerning the management and utilization of natural resources. Although there are profound similarities, the different ethnic groups practicing the system exhibit considerable differences in their overall enterprise patterns, seasonal movements, and the other natural resource-based activities. There are also wide variations in the level of integration of pastoralists into the market economy. Typical pastoral family size is relatively large and has a high dependency ratio, mainly due to cultural factors. It is common for men to have more than one wife, which is believed to make mobility of livestock from place to place easier. The nature of animal husbandry and the mobility of herds demand extended families in order to distribute the workload and defend economic and/or social/cultural interests. Better off pastoral families create employment for poor and marginalized families. Livestock production is dependent upon climate, vegetation, and animal type. The main sources of feed in pastoral areas are grasses, shrubs and browse. Their distinctive management systems, includes undertaking seasonal migrations in response to availability of grazing; and keeping different species of livestock, including small and large ruminants. Cattle and sheep are kept in areas with reasonably abundant water and where grazing species are predominant; goats and camels are reared in drier areas, where browse species predominates. This farming system links up with the rest of the agricultural economy in that male cattle are sold to highland farmers for draft power. There is also linkage in the opposite direction as pastoralists import breeding bulls from the highlands to bring new blood into their herds.
3. Agro-pastoral farming system: this is found under conditions fairly similar to those of the pastoral system, the key difference being the slightly greater availability of water. It is a semi-nomadic livelihood in which livestock production is dominant. Crops are grown but play a less significant role than in most other farming systems as moisture stress is a critical limiting factor on crop production. It extends from the north-western to south-western parts of the Nile Basin. It is practiced along river banks in particular and in areas neighboring the pasture zones which receive slightly higher rainfall. The average family owns between 1.0 to 1.5 ha of cultivated land, a minimum of 6 cattle and more than 6 goats. Main crops are sesame, cotton, sorghum and vegetables. Additional cash is obtained from sale of fruit, vegetables, honey, gum, firewood and grasses. Agro-pastoralists benefit from

being able to graze their animals along the perennial Nile tributaries, which help them cope in drought periods. The major challenges to this system include ecological disturbance and land degradation associated with slash and burn shifting cultivation, moisture stress and lack of adequate water supply, human and livestock diseases, livestock feed shortages during the dry season and poor infrastructure. Major constraints include sociological factors, transport and communication, marketing, livestock diseases, land tenure, livestock diseases, marketing, inter-clan disputes, low rainfall, lack of security in border areas and disputes between agro-pastoralists and settled farmers.

4. Dryland farming system: It is undertaken in rangelands ecosystems where there is sufficient soil moisture or ground water to allow settled farming. It has many similarities with the agro-pastoral system. The main difference being in the relative importance of the arable and livestock components, where in this system, crops are more important. It is a rainfed system, where mixed crops are grown such as sorghum, teff, wheat, maize, millet, sesame, groundnut and some vegetables. Livestock in this system is indigenous and their management is traditional. The constraints of this farming system include: short and long term droughts, low productivity, use of local crop varieties and landraces, lack of inputs, and pests and disease; deforestation, insufficient fodder and forage, animal diseases, lack of saving and credit institutions, and marketing bottlenecks.
5. Highland temperate farming system: this is found extensively in the high land complexes comprising mountain chains and plateaus at altitudes of 2000 to 3000 m above sea level. Traditional rainfed subsistence farming is practiced on the highland plateaus. Teff, wheat, barley, sorghum, broad beans, field peas, chickpeas, vetch and oil crops are grown. The livestock in this system include cattle, sheep, goats, horses, donkeys, mules, poultry and bees. The major sources for feed of livestock are natural pastures with contribution from crop residues, industrial by-products and locally grown fodders. There is growing pressure on land due to high rates of human and livestock population growth in the high land areas that had led to severe shortage of land and deterioration of natural resources base. The constraints include weed infestation, crop pests and diseases, use of traditional tools, post-harvest crop losses, various types of widespread livestock diseases, and climate change.
6. Highland cold farming system: is practiced at more than 3000m above the sea level. The climate is cold with frequent night frosts during the dry season. This system features two components, barley cropping and grazing in the lower part (up to 3300 m) and pure grazing above that altitude; most farmers use both components. Livestock are a particularly important component as the crop yields are low and unreliable. The constraints include: land not inherently suitable for cropping, little knowledge of pasture improvement, livestock health problems, poor access to infrastructure, human population pressure and low incomes.
7. Forest based farming system: this is found in southern Ethiopia, with rain falls all the year, with very short dry period from December to February. Traditionally communities depended on extraction of forest products, hunting, gathering and some pastoral livestock herding. Shifting cultivation is practiced to grow maize, sorghum and millet. Vegetables,

fruit trees, spices and coffee trees are also cultivated. The constraints include: destruction and over-exploitation of natural resources, ecological disturbances and emergence of pests and weeds, accelerated loss of soil nutrients, land degradation, animal diseases and poor services to livestock sector.

8. Riverside and lakeside farming system: livelihoods in this system are based on crop cultivation supplemented by fishing and livestock rearing. The system is practiced along the riverbanks and in the swamps around Lake Tana. Crops cultivated include maize, sorghum, sesame, groundnut, cowpea, rice, onions, other vegetables, tobacco and beans.
9. Market oriented agriculture (including urban, peri-urban and commercial farming): it encompasses a wide range of specialized forms of agriculture which developed to cater for urban and export sector. Most of the large scale production farms are concentrated in the western lowlands and the north Gondar and west Gojam areas. Most farming operations are carried out with machinery and make wide use of fertilizers and other yield enhancing inputs. This farming system is very heterogeneous, ranging from small scale, capital intensive, market-oriented, vegetable-growing, dairy farming, and livestock fattening, to part-time farming by the urban poor to cover part of their subsistence requirements. The level of crop-livestock integration is often low. The main shortcomings include: low yields, high cost of production, shortage of credit, poor infrastructure, poor access to marketing, land degradation and uncertain land tenure.

5.6. Farming systems in Kenya

Kenya is ecologically diverse, and most of its land is classified as arid or semi-arid, yet also higher elevations lush montane forests are found. It is the home to the second-highest peak in Africa, glacier-capped Mount Kenya [100]. It has a great variety of agro-ecological conditions broadly correlated with altitude and aspect, ranging from arid pastoral rangelands to tropical alpine conditions [101]. By area, about 28% of Kenya's ecosystems are marine and 72% are terrestrial. Kenya's average annual rainfall is approximately 630 mm per year, but it varies across the country. It ranges from 200-400 mm per year in northern and eastern Kenya to up to 2000 mm per year in the highlands and mountains of the southwest. More than 80% of Kenya is arid and semi-arid. Croplands and the associated agro-ecosystems cover about 19% of Kenya [102]. According to Sambroek et al. [103] Kenya's land is divided into seven agro-ecological zones based on moisture index. These are humid, sub-humid, semi-humid, semi-humid to semi-arid, semi-arid, arid and very arid [103].

The major ecosystems in Kenya are the terrestrial, aquatic, marine and endangered ecosystems. Regarding the terrestrial ecosystems, according to WRI, et al. [104] a mosaic of grassland savanna, wood-land savanna, and bush land plant communities are found in Kenya's ASALs, depending upon soil type, rain-shadow effects, and other factors. In areas with rainfall above 800 mm per year, the potential natural vegetation is forests which cover about 20% of Kenya and along the Indian Ocean; there is a belt of forest comprising about 1.7% of the country [104]. These ASALs lie in agro-climatic zones IV, V and VI and they represent 80% of the country's area and support 25% of the human population and 50% of the total livestock population. According to Barret *et al.* [105] these ASALs are ill-suited for intensive crop production but

fairly suited for extensive livestock production [105]. The aquatic ecosystems according to NEMA and UNDP, [106] cover about 8% of Kenya's surface area and include freshwater and saline lakes, rivers and wetlands [106]. Kenya's territorial sea area is approximately 13800 km² covered by mangroves at about 600 km². This in addition to coral reefs, sea grasses and sandy beaches [102]. In general, the largest proportion of the country falls into two categories of land cover: (i) herbaceous cover, closed open, and (ii) sparse herbaceous or shrub cover. The two types of land cover are ideal for pastoralism (sheep, goats and camels) which characterizes the livelihoods of the arid and semi-arid lands (ASALs) that cover 83% of the country's land area. Cultivated and managed areas are to be found in agriculturally high- to medium-potential areas of the country. Areas with tree cover are found in the major water catchments and along the coastal strip. The country's grain basket, the Rift Valley and Western Provinces, is characterized by mosaic cover: cropland, trees or other natural vegetation. Natural resources from wildlife and forestry in the protected areas play two basic roles in development: support to subsistence livelihoods, and source of earnings from tourism [100].

Based on John Dixon et al, [16] and FAO report [99], the following farming systems are found in Kenya:

- 1. Maize mixed farming system:** it is one of the most important food production systems that mostly found at altitudes of 800-1500 metres. It is characterized by farm sizes less than 2 ha, with scattered irrigation schemes. Maize is the staple crop with other cash crops, cattle and small ruminants. Among the challenges faced by this system: input shortages, declining soil fertility, drought, market volatility and incidence of chronic poverty.
- 2. Irrigated farming system:** in Kenya, irrigation may be seen as both a major cause of and an important solution to the country's increasing water scarcity and water insecurity. In addition to the traditional small scale irrigation practices, large scale irrigation schemes have also been in existence from the time of the colonial era. Irrigation schemes in Kenya can be categorized into three organizational types: (a) smallholder schemes, these are schemes of variable farm sizes and are operated by water user groups or by farmers' organizations within the scheme. Approximately, at present there are 2,500 such irrigation schemes covering an area of about 47,000 ha which accounts for about 46% of the total irrigated area, with overall management from the Ministry of Water and Irrigation. Their produce is mostly for domestic food consumption and local market. The challenge faced by this type include marketing problems and poor access to credits; (b) large scale schemes managed by National Irrigation Board, these range from several hundred to several thousand hectares in size that produce for domestic and export markets. Today, there are a total of seven such schemes covering an area of 13,000 ha, accounting for about 12% of Kenya's irrigated land and about 12% of the farmers active in irrigated agriculture. About 90% of the Kenya's rice is produced in these schemes. One bottleneck is the financial sustainability of these schemes; (c) Commercial flower and vegetable farms, also known as agro-industrial irrigation of high value crops, these are schemes with modernized irrigation facilities. They produce almost for export markets in an area of 42,800 ha representing about 42% of the land under irrigation in Kenya. They financed and developed by private corporations or individuals and relying heavily on pump-based technol-

ologies in combination with drip or sprinkler irrigation. Their main concern is the maintenance of their international competitiveness. The overall major challenge for the three types is the secure access to water [107]. However, Blank, et al., [108] highlighted that the boundaries between these three types have become blurred due to some rapid changes. Among these changes: the collapse of the government capacity to manage the large scale systems, the commercialization of smallholder irrigation has enabled some individuals to move away from irrigation of traditional crops and enter the high value vegetable and fruit market, and the third change is that new technologies are rapidly being introduced and adopted widely by irrigators [108].

3. **Pastoral farming system:** according to Cecchi et al, [109] this system in Kenya cover around 336,367 km², with estimation of rural population of about 2,048,000. The main livestock species raised in this system are camels, cattle, sheep and goats [109]. Among the main constraints of this system are the recurrent drought, insecurity, water accessibility, rising poverty, declining asset level, environmental degradation and desertification [110].
4. **Agro-pastoral farming system:** is a form of livelihood that combines crop production with pastoralism. In Kenya, the area covered by this system estimated at about 112,081,000 km², with rural population of around 6,392,000. The main livestock species raised in this system, cattle, goats, sheep, camels, donkeys, poultry and pigs [109].
5. **Urban/pre-urban farming system:** as in other countries of Sub-Saharan Countries, farming in Kenya is very common among urban households, particularly poor female-headed ones. In Nairobi for example, four sub-types of this farming system are found, namely; small scale subsistence crop production, small-scale market oriented crop production, small-scale livestock production and large-scale commercial farming.

5.7. Farming systems in Somalia

Somalia is an arid region in the north and semi-arid in the south. The climate of seasonal rains, almost continuous winds and even worse, irregularity of rainfall over the years, made it very difficult for the population to work effectively. In areas where rainfall is sufficient for cultivation, there was the problem of shortage of agricultural workers. Animal husbandry was always limited by the scarcity of water. About four-fifths of the population of Somalia was engaged in agriculture and subsistence pastoral farming. The country was divided into four regions: northern Somalia or Migiurtinia with an arid climate and little vegetation, central Somalia or Mudug, equally arid and with a nomadic population, central-southern Somalia, which had the most, developed agricultural and animal husbandry sectors and southern Somalia or lower Juba with thick vegetation and very rich fauna. One of the greatest problems was the shortage of water. Water reserves were limited to the area between the Jubba and Shabelle Rivers and outside of this area there were only wells [111]. Agriculture is by far the dominant sector in the economy: it contributes to more than 65% of GDP. The nomadic livestock sub-sector accounts for more than 44% of agricultural GDP and 50% of total agricultural employment. Nomadic livestock is the main source of Somali livelihoods. In addition to subsistence of nomad and agro-pastoralists, it also contributes about 80% of the exports and is thus the main

source of the country's foreign currency earnings [112]. The Somali economy is the only one in the world where over half of the population is dependent on nomadic pastoralism [113]. The livestock sector is central to the economic and cultural life of the Somali people. Burao and Galkayo are the largest livestock markets in the Horn of Africa especially for export sheep and goats from the Somali region of Ethiopia and parts of southern Somalia [114]. The inter-riverine region which is the fertile valley that lies between the Shebelle river in the north, the Ethiopian border in the west, and the Indian ocean in the east has over fourteen ecological regions providing four modes of livelihood: agriculture, pastoralism, agro-pastoralism and trade [115]. The pastoral system is characterized by herds or flocks that are constantly moved in search of water and pasture, as the season progress. Moreover, in contrast to most pastoral systems, which are normally devoted to household subsistence, the Somali system is traditionally oriented towards trade and export [116]. After the collapse of the government in 1991, the Somali economy became entirely unofficial; however it has proven to function effectively and the livestock trade shows considerable resilience, in spite of total absence of formal institutions [117]. Livestock export in Somalia revolves around three supply chains, two of which supply the Arabian Peninsula with mostly small ruminants and cattle by sea, and the third which supplies the Kenyan market with cattle overland. [118]. [Strangio, [111] has mentioned two justifications why most of Somali population is nomadic pastoralists: first, their origins with strong cultural nomadic-pastoralist bases. Second, the climatic and environmental conditions that favour a nomadic-pastoralist economy rather than a settled agricultural economy.

5.8. Farming systems in South Sudan

Most of South Sudan country has a semi-humid climate, with annual rainfall ranging from 200-2200 mm. Rainfall is seasonal, from April to December and causes seasonal flooding of floodplains. The seasonal climate patterns cause cyclic relations in the ecosystem and hence determine land use patterns of cultivation, livestock grazing and fisheries [119].

Altitudes in Southern Sudan range from 600 to 3000 meters above sea level. Temperatures are typically above 25° C and can rise above 35° C, particularly during the dry season, which lasts during January to April [120].

South Sudan's diverse ecology provides a growing season ranging from 280-300 days in the south-western parts to 130-150 days per annum in the northern states due to bimodal and unimodal rainfall regimes. The bimodal areas cover much of Greater Equatoria, while the rest of the country has a unimodal regime [121]. There are five ecological zones in South Sudan, namely; the savannah region, the flood region, the Montane forest zone, the semi-desert zone and the lowland forest zone. The savannah region is divided into low rainfall woodland savannah zone and high rainfall woodland savannah zone. The woodland savannah region is the largest ecological region in South Sudan. The flood region includes the Suds and toic. The Suds covers about 57,000 km² and it is one of the largest floodplains in Africa. It is an important breeding area for Nile ecosystem fish species. Toic are areas subject to seasonal flooding by spill-water from rivers and watercourses where the soil retains sufficient moisture throughout the dry season to support grasses. It is of special importance for dry season grazing by both livestock and wildlife and is critical for the country's pastoralists. The semi-desert is the

extreme southeast in and around the Ilemi Triangle; it is an extension of the northeastern Kenya semi-arid zone and shares much of the fauna and flora from that region. The lowland forest is the northernmost extension of the Congo Basin forests [122], [120]. However, the Livelihood Profile Project divided the country into seven livelihood zones that are defined based on climate conditions and farming systems: Eastern Flood Plains, Greenbelt, Hills and Mountains, Ironstone Plateau, Nile-Sobat Rivers, Pastoral and Western Flood Plains [121]. The country is naturally endowed with agricultural potential given its favourable soil, water and climatic conditions. It is estimated that about 70% of total land area is suitable for producing a wide range of agricultural products, including annual crops such as grains, vegetables, tree crops such as coffee, tea and fruits, livestock, fishery and various forest products [122].

The dominant land use in terms of land occupation is livestock keeping, which is practiced throughout almost all the country, but practically in dryer areas with better grass quality and lower livestock parasite occurrence. The vast forested areas provide, apart from food for livestock, timber, fuel wood, charcoal and non-timber forest products including food plants, medicines and bush meat. Most of the rural population practice cultivation. In the northern part of the country, sorghum, sesame and groundnut are the principal crops. Many farmers have little access to inputs and credits [119]. Crop production is mostly conducted on small, hand cultivated plots farmed by women-headed households. Sorghum is the main cultivated crop, in addition to maize, millet and rice. Other crops such as groundnut, cassava, sweet potato, vegetables and sesame are also grown. Rainfed mechanized cereal production is practiced on large scale in the Upper Nile state [123]. Crop production systems remain primarily subsistence in nature and crop yield is low. Less than 4% of the total land (about 2.7 million ha) is currently cultivated while more than 80% is still under natural vegetation [122]. According to UNEP [124] livestock rearing may be categorized into three systems: (a) nomadic, based on herding of cattle, camels, sheep, and goats (b) semi-nomadic agro-pastoralist, combining the herding of cattle and some sheep with cultivation (c) sedentary system, where cattle and small livestock are reared in close proximity to villages [124]. Livestock is mainly perceived as a store of value by many livestock keepers, and production of livestock products (butter, milk, meat and hide) is low [119]. Livestock are very important assets throughout the country, the main species being cattle, goats and sheep. The sale of livestock especially small ruminants, offer significant income generation opportunities for both transhumant pastoralists and sedentary livestock rearers [123].

5.9. Farming systems in Sudan

Geographically, four major regions are characterizing Sudan: the Northern, Western, Eastern regions and the Central Clay Plains. The northern region lies between the Egyptian borders and Khartoum. It consists of two distinct areas: the desert and the Nile Valley. The Nile River provides an alluvial strip of habitable land some 2 km wide, whose productivity depends on the annual floods. Western Sudan is a generic term describing Darfur and Kordofan, amounting to about 850,000 km². Its dominant feature is the absence of perennial streams, and people and animals must remain within reach of permanent wells. Consequently, the population is sparse and unevenly distributed. Eastern Sudan is located northeast of the Central Clay Plains.

It is divided between desert and semi-desert and includes Al Butanah grazing area (stretches between Khartoum and Kassala), the Qash Delta, the Red Sea Hills and the coastal plains. The Central Clay Plains stretch eastward from Nuba Mountain to the Ethiopian frontier, broken only by Ingessana Hills in Blue Nile state. These plains are productive and provide the main support of the national economy [125].

Sudan is a country of fragile eco-systems, frequent droughts, and as a result, pressing challenges to address the national priorities of food security, water supply and public health. An examination of Sudan's ecological zones indicates that the majority of its land is quite vulnerable to changes in temperature and precipitation [126]. With the secession of South Sudan, the ecology of Sudan has shifted towards a predominantly dry lands environment. The rainy season lasts less than two months in the north and extends up to four months further south. This extreme rainfall variability over time and space has a remarkable impact on vegetation, especially in more arid areas.

The country's land and water resources can be classified into four major ecological regions: (a) arid and semi-arid ecosystems, which occur in the northern and central parts of the country. Summer temperatures can often exceed 43°C, and sandstorms blow across the Sahara from April to September, with an average rainfall of 0 – 300 mm. the soil is generally poorly developed due to little rainfall and lack of vegetation. However, in some parts of this zone (Northern Darfur state), during winter times, the air may cool down at night sufficiently to form dew, allowing certain grasses, called 'gizu' to grow after rain. Irrigated agriculture is practiced along the Nile banks, apart from that pastoralism and agro-pastoralism are also practiced. Among the challenges are desertification and severe soil degradation; (b) low rainfall savannah (sand) are typified by low rainfall (300-400 mm) and the prevalence of sandy soils. The zone is devoted to traditional rainfed farming and pastoral systems, (c) low rainfall savannah (clay) which are typified by low rainfall (400-900 mm) and clay soils, rainfed farming and pastoral livelihoods are the major farming systems in this zone. Both savannah types are characterized by a mixture of grasses and trees; (d) high rainfall savannah which is characterized by moderately high rainfall (800-1300 mm) and it represents area bordering the country of South Sudan including some parts from South Darfur and Nuba Mountains [127], [128], [125].

Based on FAO, report [125], [16], and FAO report on Nile Basin [99], the following farming systems are practiced in Sudan:

1. Irrigated farming systems: it occupies about 1, 86 million ha, dominated by gravity-supply type of irrigation. These are originally owned and managed by the public sector. The schemes are cultivated by thousands of tenant farmers and the main crops are cotton, wheat, groundnut and sorghum. Apart from these public large schemes, pump irrigation is also practiced. Performance problems in irrigation schemes include: inefficient water management; non-collection of water charges and land use fees; low productivity; large debt burdens; unsettled land rights; and inadequate financial and marketing services. On commercial basis, sugarcane for sugar industry is also widely practiced in the fertile delta lands between the Blue and White Niles. On small scale basis, there are considerable numbers of farmers practicing traditional irrigated farming along the Nile banks all over the Sudan.

2. **Traditional farming systems:** this is practiced in an area account for about 8.4 million ha where there is moderately sufficient rainfall. Over 70% of the population depends on this system for their livelihoods on crop production or livestock husbandry or both. It is dominated by small scale famers who typically live in conditions of persistence poverty and are reliant on rain-fed and traditional agricultural practices. They face challenges of climate change, droughts, rainfall variability, land degradation, desertification, low productivity and persistent food insecurity. This system includes millions of small scale subsistence farmers, who grow sorghum, millet, maize, sesame, and groundnut. They mainly depend on family labour and use of traditional tools.
3. **Rain-fed commercial semi-mechanized farming systems:** this has been developed on generally alkaline clay soils and loams. It is found in states of Gadaref, Blue Nile, White Nile, Sennar, and Southern Kordofan. These are mostly owned and managed by the private sector. Unfortunately, this system had been perceived as one of the wrong policies in the history of agriculture in Sudan. For example, Sulieman and Buchroithner [129] claimed that it has been the main contributing factor to deforestation and land degradation [129]. On the other hand, Sulieman and Elagib, [130] reported that, in recent decades, pastoralism has been in decline because of threats posed by rapid encroachment of mechanized rain-fed agriculture, human population growth and other human activities that force extensive livestock production to shift to areas of increasing marginal productivity [130]. However, the changes in land use practices have brought nomads/pastoralists into conflict with farmers both on mechanized schemes and on traditional farms [131].
4. **Pastoral farming systems:** these are entirely raised on natural rangelands and are mainly semi-nomadic; however, nomadic and transhumance are also there to strategically utilize the available rangeland resources. Households move with their animals and spend the rainy season in the northern semiarid zone at places of availability of both pasture and water and where they can avoid biting insects and the muddy conditions. In the dry season, they move to the south, the savannah areas. In the Eastern and the Central areas of Sudan the migration is towards the Nile during the rainy season and back during the dry season. Movement is usually practiced along the livestock routes or corridors, traditionally known as 'Masarat' or Maraheel'. The major challenges include: shortage of water, animal feed, diseases, and horizontal expansion of mechanized, rain-fed cultivation, land degradation, conflicts, and lack of capital and poor marketing services of the livestock products. It has been emphasized by Behnke [132] that unlike other countries in the region, pastoralism is not merely an occupation of the peripheral areas of Sudan; pastoral rangelands are distributed throughout Sudan, even in Khartoum State itself, and are the backbone of livestock production in Sudan [132].
5. **Agro-pastoral farming systems:** it is practiced under conditions fairly similar to those of pastoral systems, but differs in the slightly available water sources and growing of some crops. Crops are grown, but play a less significant role than in most other farming systems as moisture stress is a limiting critical factor on crop production. Livestock production is the main source of income and food. Among the constraints are some socio-cultural practices, land degradation, land tenure problems, diseases, lack of security and low rainfall.

5.10. Farming systems in Uganda

Uganda lies between latitudes 4° N to 1° S and longitude 29° E and 36° E. Although temperature variations may be significant, especially over high ground areas in western, eastern, south western and parts of northern Uganda, rainfall, like in many tropical areas largely determines the climatic sub-regions (agro-climatic zones) of the country. It also determines the spatial patterns of natural resources and land use activities [133]. A large part of Uganda consists of a plateau, lying between 1000 and 2500 above sea level. Temperatures are moderate, between 15° and 30°C. Precipitation varies from 750 mm to 1500 mm. Due to climate change; the onset of the rainy season is increasingly unreliable, and rainfall distribution is more uneven with erratic, heavy rainfall events [134]. It is endowed with large fresh water resources and a high agricultural potential. The population, young and predominantly rural, is mostly engaged in subsistence rainfed farming. [135]. The main water bodies are Lake Victoria, Lake Albert, Lake Kyoga, Lakes Edward and George. The main rivers include the Victoria Nile, and the Albert Nile [136]. The Nile Victoria divides the country in two parts, flowing from Lake Victoria at Jinja through Lake Kyoga to the northern tip of Lake Albert, and then north to South Sudan. The climate is tropical but mild because of the generally high altitude. The temperature ranges from about 16° to 29° C, with 1000 mm or more rainfall over most of the country. In the extreme north-east, in Karamoja, there is small zone with less than 500 mm of rainfall. Rainfall is bi-modal in the central and western regions, and mono-modal in the northern and eastern regions. In the central and western regions, the months of December to mid-February and June to mid-August are usually dry periods [135]. Soil fertility varies according to the level of rainfall. The land is generally fertile in the central and western regions and becomes less fertile as one move to the east and the north [137].

CIAT [138] had defined, delineated and characterized about 33 agro-ecological zones for Uganda, and then they have been aggregated into 14 zones. A number of classifications of agricultural production systems have been developed for Uganda [138]. For example, five systems have been distinguished by NEMA [134]. These systems are: northern and eastern cereal-cotton-cattle, intensive banana-coffee, western banana-coffee-cattle, west Nile cereal-cassava-tobacco, and Kigezi afro-montane.

Based on these zones, Mwebaze [139]; Kabeere and Wulff [140]; Ronner and Giller [141]; classified the farming systems into seven as follows:

1. **The banana-coffee system:** in this system, rainfall is evenly distributed (1000-1500) on soils of medium to high productivity. The areas cultivated per capita are small, under one hectare. The main crops are banana, coffee, maize, and sweet potatoes.
2. **The banana-millet-cotton system:** rainfall for this system is less stable than for the banana-coffee system, so there is greater reliance on annual food crops (millet, sorghum and maize). In the drier areas, livestock is a main activity.
3. **The montane system:** it is found at higher elevations between 1500-1750 metres above sea level. The area receives high and effective rainfall and cloud cover. Crops grown are banana, sweet potatoes, cassava and Irish potatoes. Arabica coffee is prevalent at above 1600 metres. Some temperate crops like wheat and barley are grown.

4. **The teso system:** the area receives bimodal rainfall on sandy loams of medium to low fertility. The dry season is longer from December to March. The vegetation is moist and grass savannas, short grassland which is ideal for grazing. Main crops are millet, maize, sorghum, cotton and oil seed crops. Mixed agriculture (crops and livestock) is practiced. Livestock are kept extensively in those areas which are tsetse-fly free.
5. **The northern system:** the rainfall in this system is less pronouncedly bimodal with about 800 mm annually. The dry season is so severe that drought tolerant annuals are cultivated; these include finger millet, sesame, cassava, and sorghum. Tobacco and cotton are the major cash crops. The grassland is short and communal grazing abounds. This area is well known for its pastoral system with semi-nomadic cattle herding.
6. **The West Nile system:** the rainfall pattern resembles that of the northern system, with more rain at higher altitudes. Mixed cropping is common with a wide variety of crops. Livestock activities are limited by the presence of tsetse fly. Tobacco and cotton are also the major cash crops.
7. **The pastoral system:** this system covers some districts in the north-east, parts of Western and Central districts. Annual rainfall is low (less than 100 mm). The system is characterized by short grassland where pastoralism prevails with nomadic extensive grazing. The livestock production systems are generally two main groups according to Mbuza [142], they are: the traditional systems and the improved systems. However, according to Mwebaze [139] and based on the grazing methods, there are about seven livestock production systems, namely:
 - a. **Communal pastoral systems:** this is prevalent in the south west of the country, in the central areas, and in the north and north east. Indigenous breeds of cattle, goats and sheep are raised depending on natural grazing. Among the factors limiting production: water scarcity, sparse population, low vegetation with low grass quality, low literacy rate, lack of effective extension systems, breeds are genetically poor and wide spread diseases.
 - b. **Agro-pastoral system:** are sedentary farmers who grow food crops both for subsistence and sale, while keeping some livestock which graze on communal land, fallows and on crop residues. Nowadays, with the increase in population and land pressure, this system evolves into mixed farming. Among the limiting factors: little control over land, crop residues and other feed sources, high mortality rates, diseases, uncontrolled mating, and reduced grazing time.
 - c. **Tethering system:** this semi-intensive system, where livestock are restrained by a rope, is common in urban, peri-urban and intensively cultivated areas where herd size is small. Crop production is the farmers' main activity. Among the limiting factors are: losses due to diseases and predators, scarcity of water and veterinary and extension services, negative genetic selection, no fodder banks and environmental degradation.
 - d. **Fenced dairy farming system:** this is an intensive or semi-intensive system of dairy farmers where farmers use part or all of their land to plant or improve pastures and grow fodder. They may also buy concentrates. This system is found in south Western Uganda Central and south eastern parts of Uganda.

- e. **Zero grazing system:** this is on an increase in and around urban areas where land is scarce but there is good market for milk and other livestock products. It is not traditional and is intensive, livestock is continuously housed and owners have to establish fodder gardens to provide green forage. The main sources of feed are fodder, crop residues, domestic wastes, and agro-industrial by-products. Among the limitations are: labour intensive, forage crops occupy the land at the expense of food crops, high capital outlay, high cost of feeds, weed problems and difficulty of providing water.
- f. **Mixed farming system:** in Uganda, it is common to combine livestock and crop production, the two enterprises are complementary. Crops are the main agricultural activity. Livestock are kept for draught, milk and/or meat for sale. It is common smallholder dairy system in the south-east, central and south eastern parts.

6. Conclusions, recommendations and policy implications

6.1. Conclusions

It is apparent from the different parts covered by this chapter that any single agricultural system is open to both nature and the society existing around it or more specifically to both the bio-physical and socio-economic entities.

The analysis of farming systems is perhaps one of the instruments adopted to study, among others, agricultural policies at national, regional and even at global level. It will also provide a framework of analysis to consider the different agro-ecological zones available in one setting i.e. a country or a region as well the socio-economic characterization of the population and their livelihoods. Within that framework changes in policies and other factors that negatively or positively impact levels of agricultural production in each system, could be foreseen. However, both homogeneity and heterogeneity of bio-physical and socio-economic constituents of each agricultural system could be identified and used as variables within that analysis. In this regard, it may worth mentioning that, each farming system has its own characteristics in terms of its physical environments, market linkages, household traits and other social and economic characteristics. These characteristics of the analyzed farming system will act as pillars upon which any changes in production within the boundaries of that system are possible.

From socio-economic point of view, in addition to the available set of secondary data, about each farming system, detailed set of primary data, as well, will be needed to help knowing the developments and opportunities within the farming system under investigation. However, the detailed data will make possible grouping of the producers in each system into socio-economic strata within their corresponding livelihood systems. In addition to that, the socio-economic characterization of each system will be identified and knowing this at national level allows reviewing of the possible policy change or impact. At the regional level, the aggregated policy change will be examined for further adjustments and harmonization. Knowing of these

detailed characteristics of each farming system is required urgently under the current global, regional and national concerns, such as climatic risks, poverty levels, environmental risks. As well, identifying the limiting constraints for the performance of each farming system is also valuable particularly for tailoring appropriate interventions that can bring some change in terms of practical solutions. Of course, tailoring of these interventions as practical solutions would mean considering the basic idea of being profitable, co-efficient and sustainable innovative solutions.

The Horn of Africa region is well endowed with natural resources, yet its countries still facing severe incidences of famine and poverty, compared with other developing regions. Agricultural sector in these countries represent the backbone of their economies, yet still unable to perform efficiently. The analysis of the farming systems existing in the region and its countries indicates the following remarks:

1. The Horn of Africa is diverse; its countries share specific characteristics. Their populations are divided along ethnic, border and religious lines. The region is the least developed food unsecured, poorest and conflicted region in the world.
2. Some of the studied farming systems lie within broad altitudinal and latitudinal ranges that lead to a wide agro-ecological categorization.
3. Most of them are heterogynous in nature, some are sparsely populated, others are densely, and ranging from highlands to low and dry land environments, ranging from purely irrigated to mostly rain-fed systems and some are specialized in terms of the produce, while others are run on multi-products nature.
4. They are characterized by duality in terms of presence of traditional practice alongside somewhat modernized practices. Some of them are purely subsistence while others are market oriented. There is weak engagement of the private sector in this sector in general.
5. Some of them although found in higher potential areas but they show very poor agricultural performance compared to those at lower potential areas. This implies that the agro-ecological zone though very important, but not the only factor.
6. Some of them are found at poor agro-ecological conditions while others are at good and relatively good agro-ecological conditions.
7. There are no clear linkages between these farming systems and the input and output markets. There are also weak land management practices together with weak extension service delivery.
8. For both crop and animal agriculture, there seem clear symptoms of poverty incidences particularly for smallholder producers.
9. Farming systems existing in the region are highly dynamic which necessitates the need for understanding them carefully in order to adopt sustainable interventions that may bring positive change for the people and their livelihoods.
10. Productivity levels for most of the studied farming systems are very low and they lack understanding about how to cater for sustainability and efficient use of resources.

11. Regarding the animal-based farming systems, among their challenges are: rangeland degradation, water and feed scarcity, poor infrastructures, animal diseases, agricultural expansion, conflicts, land tenure problems, genetically poor breeds, low rainfall and lack of effective extension services.
12. Regarding the crop-based farming systems, among the challenges they face are: soil-related problems, land tenure problems, shortage of inputs, chronic poverty, managerial and financial problems, problems related to marketing and lack of infra-structure, high costs of production, and low production levels.

6.2. Recommendations and policy implications

Based on the preceding analysis of farming system in the region, the following recommendations and priority interventions could be indicated to help overcoming some of the challenges faced these systems:

1. Taking into account the set of crises that put all the countries of the Horn (IGAD countries), its natures and how it affect these countries, there is an urgent need for regional approach to tackle these problems, or more specifically regional integration instruments to enhance the development of the poorest economies, to build mechanisms for conflict management and to build resilience of the countries, as well as that of their communities particularly those at marginalized borderlands. These development approaches are in fact possible given the fact that now the Intergovernmental Authority on Development is doing more that that including coordination and implementation of projects that will surely foster development at national and regional levels.
2. There is a need for promotion of social and economic dimensions of the agricultural systems, while dealing with the productive and bio-physical environment. This may be crucial given that the historical definitions of agro-ecology are embedded within agronomy and ecology without inclusion of the socio-economic dimensions. There is also need for incorporation of the principles of agro-ecological approaches into our education curricula and our development interventions.
3. As poverty alleviating strategy, one could recommend diversification out of one produce into mixture of high value crops with livestock particularly in the so called high potential agro-climatic zones. For those found at low potential zones, resorting to off-farm employment can be one of the solutions out of poverty trap.
4. With more poverty incidences prevailing at the small scale traditional farming systems, there is urgent need for adoption and implementation of an appropriate set of policies at national and regional levels, together with implementation of ecologically sound interventions as scaling-up of agro-ecosystem thinking towards more sustainable agricultural systems.
5. Problems related to soils could be dealt with through encouragement of more sustainable forms of land management practices such as use of natural fertilization, inter-cropping and conserving agriculture.

6. It is crucial to promote the use of appropriate extension approaches including the encouragement of the private sector to invest in this sector.
7. Regarding the pastoral systems, there is need for proper investments with institutional support from the public sector in terms of veterinary services, value addition, and marketing and information facilities. In the region, many studies had shown the significant importance of these systems in the national economies of most of the countries in the region, but more efforts in terms of awareness as these facts are not fully appreciated by governments, policy makers and development partners.
8. For small scale producers whether they are farmers or pastoralists, there is need to advocate for development interventions that are imposed which will make sustainability impossible, so there is need for interventions that are based on participatory development approach. There is also need for adoption of sustainable natural resource management as viable policy option.
9. To tackle problems of marketing and inputs especially for small scale producers (farmers and pastoralists) critically, one of the solutions may be the formation of organizations, policy forums for the producers to help in catering for provision of those services and to advocate for their rights.
10. Support enhancement of policies, regulations and frameworks that foster accessibility to domestic, regional and international markets
11. To enhance solutions of food insecurity and poverty prevalence, problems facing the large scale irrigated farming systems need to be tackled, below are some examples:
 - a. The management-related problems could be dealt with through inclusion of farmers in the management board of these schemes.
 - b. The water-related ones can be solved through formation of water users associations.
 - c. The problems related to land issues could be seen under formulation of proper land policies.
 - d. Soil-related issues such as decline in fertility is better be managed through natural fertilization and inter-cropping.
12. Given the expected incidences resulting from the current risks (environmental, climatic, market), depending on indigenous resilience of the farming systems alone is not enough to create a resilient and transformable agricultural systems. For that, Key technical solutions in terms of sustainable intensifications, policy and market development are helpful to overcome these difficulties.
13. To promote structural transformative change within the studied farming systems, formulation of appropriate set of policies of land, water and rangelands for sustainable co-efficient use of resources.

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