Irrigation Agriculture and Sustainable Rural Livelihood in Dry Land Ecologies

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Abstract

The importance of agriculture to the economy of most developing nations cannot be over emphasized. Regrettably, agriculture alone can no longer provide a reliable means of livelihood for the population of these countries especially in the dry lands where rainfall is unreliable and unpredictable due to climate change. Globally, these problems are more pronounced in the rural than urban areas, mostly characterized by frequent drought and low level of productivity. As a result, poverty and food insecurity are wide spread in the rural areas of the dry lands. Therefore, to improve productivity and reduce poverty, it is necessary to supplement rain fed with irrigation agriculture in order to minimize the risk and stress associated with rain fed agriculture in the dry lands. This review shows that irrigation agriculture will be a key source of agricultural growth and sustainable livelihood for peasant farmers who depended on erratic rainfall for their livelihood. Irrigation agriculture has the potential to provide sustainable rural livelihood not only in agriculture, but also in aiding the population to diversify their means of livelihood.

Keywords: *Irrigation Agriculture, Sustainable livelihood and Dry lands*

Introduction

Agriculture serves as the mainstay of most developing countries. It is the only means of livelihood of members of the rural communities in those counties (Girei and Dire, 2013). Unfortunately, agriculture alone no longer provides a reliable livelihood for the growing population in these countries (Mhazo et al, 2003 in Madu and Phoa, 2012). The major challenges facing developing countries are food insecurity (insufficient food production and poverty). Poverty can be perceived in two broadly distinct ways: absolute poverty (lack of access to a basket of basic survival needs) and relative poverty (lack of access to the level of resources acceptable as normal in a society (FAO, 1999). Despite Nigeria's plentiful agricultural resources and oil wealth, poverty is widespread in the country and has increased since the late 1990s. Some 70 per cent of Nigerians live on less than US$1.25 a day (IFAD, 2012). The world's population is set to exceed 8,000 million people by 2025, and most of the increase occurring in developing countries could nearly double resulting in great pressure on agriculture to increase overall production and yields (IPTRID, 1999).

Agriculture is of pivotal importance not only providing food and income for the rural poor, but also meeting the food needs of growing urban population (AIRCA, 2013). About 90 percent of Nigeria's food is produced *by* small-scale farmers who cultivate small plots of land and depend on rainfall (IFAD 2012). Increasing the output and value of resources and reducing negative shock and stresses on production is particularly important in the dry lands of the world where rainfall is unreliable and unpredictable. Dry land ecosystems are characterised by frequent drought, inherent low levels of biological productivity and low soil

fertility (Thomas, 2007, MCA, 2005 cited in Mtisi and Nicol, 2013). Around one billion people rely directly on dry land ecosystem services for their daily survival, whether through rain fed or irrigated farming, or through widespread pastoralism. Dry land populations on average lag far behind the rest of the world in human well-being and development indicators. Existing water shortages in dry lands are projected to increase over time due to population increase, land cover change, and global climate change (UNEP, 2011 p625). To ensure the future livelihoods of dry land farming communities, it is critical to manage risk more effectively and enhance productivity and sustainable intensification of production systems (CGIAR, 2011). It has been noted that the rapid spread of small-scale irrigation will be a key source of agricultural growth and poverty alleviation for small farmers who are otherwise dependent on low and erratic rainfall (World Bank, 1991, in Agwu and Edun, 2007). This paper is an attempt to look at the importance of irrigation Agriculture in sustainable rural livelihood in the dry lands.

Statement of the problem

The developing nations contained majority of the Worlds dry land populations, these populations increasingly find it difficult to secure sustainable livelihoods due to desertification, land degradation and climate change. Population growth rates also remain highest in dry land countries, increasing the pressure on the environment to supply food, shelter, energy and water. Dry lands are perceived as desolate ecosystems with low production potential, subject to desertification or land degradation, and as 'investment desert' plagued by chronic underinvestment from governments and private sector (Thomas, Steward and Schaaf, 2014). However, the reality is different as several studies have shown that the dry lands contain vast natural resources which if harnessed, can provide means of sustainable livelihoods to the populations, contribute to economic development, and subsequently poverty alleviation and reduction. UNDP (2013) stated that 'there are important economic and ecological assets in the dry lands-including pasture lands, forest areas, drought-resistant plant, valuable minerals and energy resources that can contribute to economic development if they are effectively managed and marketed. In spite of their extent and economic/ecological importance, the impacts of global environmental change on dry lands remain poorly understood compared to other ecosystems (Maestre, Salguero-Gomez and Roberto 2012). People living in dry lands have already shown their capacity for resilience over many generations, adapting to environmental challenges and accumulating valuable knowledge about dry land ecosystem (UNDP, 2013). Introduction of new technology could greatly improve the sustainability of the rural population in dry lands. One of such technology is irrigation developments. Irrigation agriculture has the potential to boost agricultural productivity especially when combined with other productive inputs. Agricultural growth is essential for economic development, poverty reduction the provision of sustainable means of livelihood.

Among the world's major ecosystems, those of the dry lands receive the least attention in proportion to their size, their population, and their importance for global sustainability. They are inadequately understood by the world's policy makers and even by those of dry land countries (Mortimore 2008). This paper is therefore an attempt to highlight the economic potentials obtainable in dry land ecosystem, and also show how irrigation agriculture can contribute to sustainable rural livelihoods in dry land areas.

Objectives of the paper

The main objective of the study is to examine the role of irrigation agriculture in sustainable rural livelihood in dry lands ecologies.

The specific objectives include:

1. To examine the environmental and social challenges faced by farmers in the dry lands.
2. To examine the role of irrigation agriculture in sustainable rural livelihood in the *dry* lands.
3. To highlight the resources available in the rural areas of the dry lands.
4. To find out from the literature alternative livelihood strategies obtainable in the rural areas of the dry lands.

Method of Study

The study is based on a comprehensive literature review of dry land systems and livelihoods particularly sustainable rural livelihoods and irrigation agriculture. The literature reviewed includes journal articles, books and reports. In addition, a search of the internet was conducted to obtained relevant data. It is important to note that a key limitation of the literature review was that most of the literatures were written with a specific purpose in mind, and not in line with the objectives of this study.

Literature Review

Dry Lands

There is no single agreed definition of the term dry lands. Two of the most widely accepted definitions are those of FAO (2000) and the United Nations Convention to Combat Desertification (UNCCD, 2000). The FAO has defined dry lands as those areas with a length of growing period (LGP) of 1-179) days (FAO, 2000). The UNCCD (2000) classification employs a ratio of annual precipitation to potential evapo-transpiration (p/pet). This value indicates the maximum quantity of water capable of being lost, as water vapour in a given climate by a continues stretch of vegetation covering the whole ground and well supplied with water (UN, 2011). UNESCO (2006) also defined "Dry lands as arid, semi-arid or dry sub-humid lands receiving less than 500mm annual rainfall with an aridity index between 0.05 and 0.653 (the aridity index is the ratio precipitation/precipitation - evapo-transpiration). Dry lands cover 41.3% of the earth's surface, including 43% of Africa, 40% of Asia, 24% of Europe, and 15% of Latin America (Safriel and Adeel, 2005). Dry lands have three primary economic functions: as rangelands (65% of the global drylands including deserts); as rain-fed farmland and irrigated farmland (25%); and as forest or sites for towns and cities (10%) which are growing rapidly (UN, 2011). It is estimated that globally two billion people reside in the drylands and 90% of these vibrant population live in developing countries (Desta, 2017).

Sustainable Livelihood

A livelihood may be defined as the sum total of ways in which households obtain the things necessary for life, both in good and in bad years. These necessities include food, water, shelter, clothing and health care (with education often include too) (UNESCO 2006). According to DFID (2001) a livelihood comprises the capabilities, assets (including) both materials and social resources and activities required for a means of living. Ellis (2000) cited in Morris et al (2001) pointed out that livelihood include not just issues about claims and

access but encompass the impacts of social relations and institutions that mediate an individual or family's capacity to secure a means of living. He further stated 'livelihood comprises the assets (natural, physical human, financial and social capital), the activities and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household. Pertinent activities can include crop and livestock production, fishing, hunting and, gathering, bartering and other endeavours and income generating activities (including off-farm work).

Livelihoods vary significantly within a country from rural to urban areas, and across countries. A livelihood can be assessed at various levels, for instance, at the level of the individual, household, community, country, region etc., in most cases the household is used for the assessment of livelihood. The household is taken as the unit of reference because it is by far the most important institution through which populations anywhere organise production, sharing income and consumption (FAO 2006, in UNESCO 2006). The concept of 'sustainable rural livelihood' is increasingly central to the debate about rural development, poverty reduction and environmental management (Scoones, 1998). A livelihood approach can be distinguished from production base approach in that it makes the household the centre of the analysis, taking an integrated view of all its assets or forms of capital (UNESCO 2006).

The ability of a livelihood to be able to cope with and recover from stresses and shocks is central to the definition of sustainable livelihood. Such resilience in the face of stresses and shocks is key to both livelihood adaptation and coping (Davies 2006, in Scoones 1998). Those who are unable to cope (temporary adjustment in the face of change) or adapt (longer term shifts in Livelihood strategies) are inevitably vulnerable and unlikely to achieve sustainable livelihoods. Different types of shocks or stress, in turn may result in different responses, including avoidance, repartitioning, resistance or tolerance mechanisms (Payne and Lipton 1994 in Scones 1998). Sustainable rural livelihood is multifaceted concept and refers to maintenance and enhancement of access of rural families to food and income generating activities on a long-term basis. It encompasses secured ownership of or access to resources, assets and income earning activities to offset risks, ease shocks and meet contingencies (Kumar et. al, 2006).

Most rural livelihoods are reliant on the natural resource base at least to some extent. Natural resource base sustainability refers to the ability of a system to maintain productivity when subject to disturbing forces, whether a 'stress' (a small, regular, predictable disturbance with a cumulative effect) or a shock (a large infrequent, unpredictable disturbance with immediate impact) (Conway 1985, Holling 1993 in Scoones 1998).

Resources of Livelihood

The ability to pursue different livelihood strategies is dependent on the basic material and social, tangible and intangible assets that people have in their possession. Such livelihood resources may be seen as the 'capital' base from which different productive streams are derived from which livelihoods are constructed (Scoones 1998). It is important to note that within each of these areas there is a wide literature and debate about definition and measurement. It is beyond the scope of this paper to go into the details. However, some of the different types of ‘capital’ which constitute the building blocks of such livelihoods are presented and defined below.

Natural Capital

Natural capital is about natural resources, the natural resources stocks (soil, water, air, and genetic resources etc.) and environmental services (hydrological cycle, pollution sinks etc.) from which resources flows and services useful for livelihoods are derived (Scoones, 1998).

Many poor households rely on the environment for key inputs in their production and consumption activities. In arid areas with substantial population density, demands placed on natural resources can exceed the sustainable supply. Severe degradation of natural resources can reduce the livelihood status of households that depend on them for production and consumption (UNESCO 2006). According to Scoones (1998) in semi-arid areas there is potentially no better way to reduce rural vulnerability and ensure the viability of people's livelihood than to enhance natural capital and productive base.

Social Capital

Social capital is about solidarity and community action. It refers to the institutions, relationships and norms that shape the quality and quantity of society's social interactions. Increasing evidence shows that total cohesion is critical for societies to prosper economically and for development to be sustainable (World Bank,' 1999 in DFID 2001). Many small- scale irrigation schemes are operated by community associations. These associations and farm villages more generally represents a form of social capital that provides value to individual households. For example, a village or community can assist individual households in times of financial stress. Inadequate social capital can leave households more vulnerable to unexpected shortfalls in crop yields (UNESCO 2006). The ability to develop social networks helps build resilience, expose people to innovations, as well as livelihood diversification alternatives.

Human Capital

Human Capital includes the skills, knowledge, ability to labour and good health and physical capability important for successful pursuit of different livelihood strategies (Scoones, 1998). Many farmers and families have adequate knowledge and skills for operating within a given level of technology and given their resource constraints. Efforts to intensify or diversity production requires investments in new knowledge and skills. In such cases, assistance might be provided by a public extension service or private firm with interest in boosting agricultural productivity. Such method might involve small changes in existing techniques, or the use of complementary inputs (UNESCO, 2006).

Physical capital

Physical capital is the basic infrastructure like transport, shelter, water, energy, communications and the production equipment and means that enable people to pursue livelihoods. Typically, investments in irrigation enhance physical capital. New or refurbished irrigation systems add to the physical capital of households and communities. So do investment in other forms of infrastructure. The likelihood of maintaining physical capital is strongly related to the other four types of capital available in a given community (UNESCO, 2006).

Financial capital

Financial capital are the financial resources which are available to people and which provide them with different livelihood options. These include cash, savings, credits, pension and remittances. Many poor households are faced with inadequate financial capital. Inadequate finance can prevent households from investing in new methods of crop production and irrigation. Limited finance also prevents farmers from accessing all of the complementary inputs required to maximize the productivity of land and water resources (UNESCO, 2006).

These are the capital resources or assets of livelihoods which households can draw upon to build sustainable livelihoods. In order to create livelihoods, therefore, people must combine the 'capital" endowments that they have access to and control over (Scoones 1998).

Livelihood strategy outcome at the household level depends to a large degree on the amounts and qualities of assets owned or controlled by the household (UNESCO, 2006). Different people clearly have different livelihood resources. This is dependent on institutional arrangement, organizational issues, power and politics. Understanding institutional processes allows the identification of restrictions/barriers and opportunities (or gate ways) to sustainable livelihoods. Since formal and informal institutions (ranging from tenure regimes to labour sharing systems to market networks or credit arrangements) mediate access to livelihoods resources and in turn affects the composition of portfolios of livelihood strategies and understanding of institutions and organisations is therefore key to designing interventions which improve sustainable livelihood outcomes (Scoones, 1998).

Rural Livelihood Strategies

A key issue in the analysis of livelihood strategies is the scale at which an assessment takes place. Livelihood strategies, for example, can be described at an individual, household and village level as well as at regional or even national levels. In this paper the focus of assessment is the household. Most people's livelihood can be characterized by a predominant activity, which is then supplemented by several other activities. The livelihood strategies in all social, economic and ecological setting encompass a wide range of activities in the dry lands (Desta, 2017). In most communities in developing countries, farming-based activities are the principal source of livelihood, and household complements them with other food and income-earning activities (UNESCO, 2006).

Generally, three broad clusters of livelihood strategies are identified in the literatures. These are agricultural intensification/ extensification, livelihood diversification and migration. Broadly, these are seen to cover the range of options open to rural people. Either you gain more of your livelihood from agriculture (including livestock rearing, aquaculture, and forestry e.tc) through processes of intensification (more output per unit area through capital investment or increases in labour inputs) or extensification (more land under cultivation), or you diversify to a range of off-farm income earning activities, or you move away and seek livelihood, either temporarily or permanently, elsewhere. Or more commonly, you pursue a combination of strategies together or in sequence (Scoones 1998). These livelihood strategies require the combination of the various livelihood assets (Natural, physical, human, social and financial capitals) depending on the strategy adopted to achieve a sustainable livelihood outcome.

Agricultural Extensification/ Intensification

Extensification simply means opening up more land for agricultural production. Extensification is mostly associated with developing countries in the dry lands. Growth of food production in sub-Saharan Africa has during the last decades primarily been achieved through expansion of agricultural land and increased in water use (Rockstom, Folke, Gordon, Hatibu, Jewitt, Penning de Vries, and Shulze, 2004). For example, a study conducted in Ayirebi a Ghanaian community by Dei (1992) showed that the majority of local farmers do not intensify their crop production by adopting improved methods such as improved seeds and artificial fertilizers. They increase total farm input through an extensified crop production, that is increased land acreages.

However, AIRCA (2013) caution that increasing the amount of land dedicated to agriculture cannot be easily accomplished and could have significant global impacts on biodiversity and ecosystems service particularly water resources, terrestrial carbon and climate change. According to AIRCA (2013) a far better approach is to produce more food on the same or less land in a way that minimizes negative impacts on air, water, soils, and biodiversity.

Intensification can be defined as increasing -the value of output per hectare by increasing inputs of labour, capital or new knowledge (Tiffen et al, 1994 in Mortimore, 2003). Production can be intensified for example by growing more than one crop on the same plot of land, and also by using productivity enhancing inputs such as drought resistant variety of seed, pesticides, fertilizer, early maturing variety' etc. A form of agricultural intensification of particular interest in this paper is irrigation agriculture.

Livelihood Diversification

Expansion of the non-farm labour market also provides opportunities for diversification of livelihoods for rural households (DFID, 2001). Diversification is a key feature of livelihood strategies. It is defined as the process by which rural families construct a diverse portfolio of activities in order to survive and to improve their standards of living (Ellis, 1998 in DFID 2001). Diversification of livelihoods is a strongly established and increasingly popular strategy for managing risk. Small holders and landless workers may earn around half their total household income from non-agricultural sources. The diversification of income for the rural poor is vital to reducing the risks of (i) cropping from marginal lands and (ii) environmental pressure on erodable or degradable lands towards more sustainable levels (IFAD, 2000).

Livelihood diversification reduces the risk of losing all income sources simultaneously, for example in an emergency (Elli 2000 Start 2001 in DFID 2001). In the sub-Saharan Africa context, exceptional population pressures probably render agricultural sector doubly saturated, necessitating alternative employment through artisanal crafts, petty trading or food processing (IFAD, 2000). DFID (2001) also added 'they may engage in all of these activities, farming a small plot and selling some of the product, earning wages as labourers, purchasing agricultural products and other commodities on the market, and collecting wild resources'. Poor farmers and landless in the rural areas often offer their labour for wage employment especially during the cropping season. Employment in cities or areas of commercial agriculture, often in the informal sector, provides income that may be taken home or sent as remittances to support consumption or investment by the family (UNDP, 2008). Such investment can be made for instance in the form of buying additional farm inputs thereby increasing the productivity of the household.

Exploitation of wild or forest resources also enable poor households to earn additional income and improved their food security. A typical poor rural household will harvest wood for sale, graze whatever animal they have and gather fruits, plant material, medicinal plants, game and building materials for their own use from these lands (IFAD, 2000). Dei (1992) stated that wild resource use is significant to the adaptive success of particularly poor farming households. Women, the aged, children as well as young adults of both sexes generally gather wild products, while adult males engage in the hunting and trapping of game. In addition, diversification through increased cultivation of neglected and underutilized species (NUS) has the potential to enhance the resilience and adaptability of agricultutal systems (Desta, 2017). These NUS are known for their resistance to drought and other stressful conditions. The terms neglected and underutilized species referring to animals, wild or semi-wild plants and cultivated crop plants applies to those species which appear to have considerable potential for use yet whose potential is scarcely exploited, if not totally neglected in agricultural production (GTZ, 2002).The potential of NUS to reduce food and nutrition insecurity, their adaptability to water stress and increased temperature make them essential for sustainable agro-biodiversity in African dry lands (Desta, 2017). The forest also provides raw materials for artisan crafts which are sold to supplement income in rural households.

Income can also be diversified through adding value to agricultural products by processing and selling them.

One form of diversification of utmost importance in rural livelihood strategy in dry lands is increased pastoralism. Pastoralism provides a prime example of flexibility and the ability to adapt to changing conditions, and livestock provide a major source of livelihoods in dry land regions (De Jode, 2010, Scoones et al 2010, Thornton 2010 in UN 2011). According to UN (2011) in Chad pastoral animals make up over one third of exports and feed 40% of the population. The story is similar in Uganda where pastoralist and small holder livestock producers contribute 8.5% of total GDP, and in Mauritania livestock contributes 70% of total agricultural GDP. Pastoralism and livestock production can also be a major foreign exchange earner. In 2006, Ethiopia earned USS 121 million from livestock and livestock products and Mali exported live animals worth US$ 44.5 million, while in Kenya, livestock raised by pastoralists is worth USS 800 million a year. IFAD (2000) further stated that livestock- raising renders multiple benefits to small holders both as a source of food and as coping strategy for low potential areas. Livestock can even serve as a buffer during civil conflicts and natural calamities as in Burundi, northern Kenya, Mali, Rwanda, Somalia and the Sudan (Mortimore 2003). In addition to livestock specialist, farmers in dry lands keep very large numbers of livestock, especially sheep or goats, and buy and sell according to circumstances (e.g buying after harvest and selling at price peaks before religious festivals UNDP 2008). However, pastoralism is increasingly corning into conflict with modem governance systems. As Liao, Agrawal, Clark, Levin and Rubenstein (2020) observed ‘reduced mobility exacerbates bush encroachment and land degradation, as sedentarized pastoralists use the rangelands more recursively’. In many countries, sedentarisation policies dominates and even though legislation in many areas of West Africa is now designed to accommodate the needs of pastoralists, it may not be fully implemented (MC Gahey 2011 in UN 2011).

This is not an exhaustive list; other forms of livelihood diversification can be identified. The most important thing to note is that rural farmers in the dry lands engage in diverse non-farm activities to enhance their livelihoods. Despite the diversification of rural livelihoods and increasing urbanization, at least half of the poor people are expected to remain in rural areas by 2035, and a significant number of them will defend on small holder farming as their main source of livelihood (IFAD, 2001 in UNESCO 2006).

Migration

Livelihood can also be generated through migration. A household strategy or response to stress worth mentioning here is population dispersion to relieve pressure on scare resources (Dei, 1992). Migration has become a predominant survival strategy for rural poor. As a consequence, rural livelihood systems in many parts of the developing world have become highly diversified and highly mobile multi-focal livelihood systems (UNESCO, 2006). Lack of job opportunities and resulting desperation are driving forces behind migration from dry land countries as well as internal displacement of people from rural to urban areas. For example, as many as 60 million people may migrate from sub-Saharan Africa to North Africa and Europe by 2020. Migrants may choose this option by taking human and financial capital out of rural areas, but then sending back remittances that can be used to improve dry land ecosystems (Thomas et al, 2014). Cash remittances, in particular are crucial in the farming economy because the cash so obtained can be used to hire seasonal or casual wage labourers on the farms (Dei, 1992). The remittances can equally be used to purchase other farm inputs such as fertilizer, tools, and improved varieties etc. Thereby improving productivity and making livelihood a sustainable one.

The combination of activities that are pursued can be seen as a livelihood 'portfolio'. Whether such livelihood portfolio combinations result in positive or negative change in relation to the range of sustainable livelihood outcome indicators is a critical issue.

Irrigation Agriculture and Sustainable Rural Livelihood

As earlier stated, one of the livelihood strategies in dry land areas is the intensification of agricultural production system. As increases in agricultural production are central to improvements in the livelihood of the rural poor, irrigation development is only one of a range of strategies of agricultural intensification (DFID, 2001). Irrigation is the artificial application of water to the land or soil. Irrigation has been around for as long as humans have been cultivating plants (USGS, 2014). It is used to assist in the growing of agricultural crops, maintenance of landscapes, and re-vegetation of disturbed soils in dry lands and during periods of inadequate rainfall (Mustsvangwa et al., 2006 cited in Chazovachi 2012). Irrigation makes agriculture possible in areas previously unsuitable for intensive crop production. Irrigation water is obtained from either ground or surface water.

Irrigated agriculture can be defined as agricultural production where the supply of water is increased by artificial means, involving the use of water control technology and including drainage to disposal of excess water (IPTRID, 1999). Irrigation farming is another way of improving agricultural production both in subsistence and commercial farming. Irrigation agriculture is an essential component of any strategy to increase global food supply (Chazovachi, 2012). According to IPTRID (1999) irrigated agriculture provides 40% of world food production on only 17% of total cultivated land. The world food summit in 1996 estimated that 60% of the extra food required to sustain the world in the future must come from irrigated agriculture. Of the near doubling of world grain production that took place between 1966 and 1990, irrigated land (working synergistically with high-yielding seed varieties and fertilizer) was responsible for 92% of the total production (DFID, 2001). Irrigation can contribute to poverty reduction primarily by enhancing the productivity of labour and land (Smith, 2004 in UNESCO, 2006).

The importance of irrigation to rural livelihoods is highlighted by the fact that irrigated farm lands provides 43% of global cereals production and 60% of the grain production in developing countries (IFAD 2000). Irrigation is also the key to developing high value cash-crops, and by helping guarantee consistent production, it stimulates agro-industries and create significant employment (World Bank 1997). Analysis of information from Asia shows that yields per area, for most crops have increased by between 100-400% as a result of irrigation (FAO, 1996). Irrigation schemes spread in Africa with large scale irrigation schemes such as the Kano River project of 1970, and the South Chad irrigation of 1974. Many southern African governments began to embark on large and small scales irrigation schemes mainly in areas with little annual rainfall total in order to supplement water shortages. While large scale schemes are more profitable and have greater socio-economic advantages, small scale schemes are more effective in terms of empowering the local people as they occupy small land readily available in the rural areas (Chazovachii 2012)'. Chambers et al (1989) in DFID (2001) further stated that a growing body of evidence showed that support to small scale, privately managed ground water irrigation targets poor rural households better than other poverty reduction interventions and improves more livelihood than larger agency managed irrigation schemes. This approach is more sustainable than reliance on large irrigation structures, which the public sector may have to operate and which in most countries the public sector is seeking to privatize (IFAD 2000).

In many developing countries, small scale irrigation schemes were counted on to increase production, reduce unpredictable rainfall and provide food security and employment to poor

families (Chazovachii 2012). The devastating effects of desertification and drought in the last three decades on the dry sub-humid and semi-arid agro ecological zones of Nigeria have made the Nigerian government to embark on massive investment in small holder irrigation (Adeola and Taiwo in Madu and Phoa 2002). The government established the Fadama based, privatized irrigation scheme for crop production (Girei and Dire, 2013). It is an alternative to large scale irrigation, which failed to meet the food self- sufficiency and food security[7] of the country (Baba, 1999 in Girei and Dire, 2013).

According to DFID, (2001) in irrigated agriculture there are four interrelated mechanisms which have the potential to enhance and sustain rural livelihoods. These include:

i. he potential to improve in the levels and security of productivity, employment for the poor and landless, and also increased incomes for the household and farm labour.
ii. Irrigated agriculture has multiplier effects, in that it leads to agricultural growth, and wider economic growth.
iii. More opportunities for rural livelihood diversification to non- farm activities.
iv. Water supplied for irrigation can be used for multiple purposes, thus improvement on hygiene and general water supply.

It is important to recognize that irrigation and use of high yielding seed varieties and fertilizer use complement each other.

The linkages from irrigation development may expand the non-form labour market as well as providing rural households with opportunities for livelihood diversification. Many rural households may therefore have complex livelihood strategies that cross the simple boundaries of hunting and gathering, farming, labouring, and being an entrepreneur and a consumer. For such households, the farm output, price, employment wages, and natural resources that may arise from irrigation development may have complex effects (DFID, 2001). Resources obtained from diversification enable farmers to increase their productivity by investing in farm inputs. Irrigation further enables farmers to diversity their crop production.

Conclusion

Agriculture is the bedrock of the economy of most countries, especially, developing countries. It is the major source of income and employment for majority of the populations in these countries. However, climate change and population growth has seriously hampered the ability of many nations to satisfy the food needs of their populations through conventional rain fed agriculture. This is especially true in the dry lands of the world which are seriously affected by desertification. As a result, livelihood sustainability in most rural households in the dry lands are constantly under threat compared to other regions of the world.

The rural populations in the dry land have therefore resorted to adapt alternative means to sustainable livelihood. These include livelihood diversification, migration and agricultural intensification. Irrigation is one form of agricultural intensification. This paper critically looked at the role of irrigation in sustainable rural livelihood. It was established that irrigation agriculture has the potential to boost agricultural and economic growth which are critical for livelihood sustainability and poverty and reduction. Though, irrigation may have some negative impacts on the environments, it is still one of the best alternatives for combating food insecurity, poverty alleviation and ensuring sustainable livelihoods of the World.

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