Original Research Article

Exploring the Role of Valley Bottom Farming Systems (*vinyungu*) for Enhanced Food Stability in a Changing Climate Epoch in Rural Tanzania

ABSTRACT

This paper investigates the contribution of valley bottom farming systems (vinyungu) on food stability in rural areas of Tanzania. Two villages from Iringa rural district were selected for this study. Primary data were collected using questionnaires which were distributed to 198 respondents, focused group discussions (FGDs), in-depth interviews as well as the researcher's own observations. Secondary data were obtained from written documents focusing on the research topic. Also, the study used rainfall and temperature data which were obtained from Tanzania Meteorological Authority (TMA). The annual trends of rainfall and temperature were analyzed via linear trend analysis using a regression equation 'b' ($y = bx + a$). Similarly, the Percentage of Normal Precipitation Index (PNPI) was computed to ascertain years which experienced little and standard rainfall over the past 40 years (1982-2021). The results revealed that vinyungu farming systems play a vital role towards food stability in the study area. Respondents reported to depend on vinyungu crops during dry and other seasons. However, despite of its contribution to food stability, vinyungu farming systems can lead to environmental deterioration if the practice is not well managed. Therefore, capacity building to the communities engaging in such activities is essential for its sustainability.

Keywords: Climate Change, Valley bottom farming, Vinyungu, Food stability, Food Security

1. INTRODUCTION

Agriculture is an integral part of inclusive development; the activity is effective in poverty reduction compared to other sectors of the economy. About 48% of the total population living in Africa (almost 70% in East Africa) depend on subsistence agriculture for their livelihood [1, 2, 3]. In Tanzania, agricultural sector contribute to about 50% of GDP, 80% of employment,

and 75% of export [4, 5]. Despite of its socio-economic importance, agricultural outputs have remained lower than the rest of the world. Many factors have contributed to such situation pioneered by climate change which has led to rainfall variability, decline in rainfall amount, drought, floods and outbreak of crop pests and diseases [6, 7, 8, 9]**.** Subsequently, food security has been a pervasive problem in many Sub-Saharan Africa (SSA) with 30% of its population facing food insecurity [10]. It has been reported that one in four undernourished people in the world live in Africa, the continent has witnessed the increase in number of undernourished over the last 30 years. The impact of food insecurity is highly felt by rural communities than cities because the nature of rural livelihood options specifically primary activities depend on the environmental and socio-economic condition. Majority of the rural population live under rampart poverty and thus they are more vulnerable to whatever challenge comes in their way. Climate change and variability has led to increased food insecurity among rural dwellers due to low adaptive capacity and thus they often do not make enough to feed their families and often struggle to buy food [11].

In Tanzania agriculture is practised mostly by smallholder farmers who depend on unpredictable rainfall in the production of food and cash crops. Increased drought due to climate change has severely reduced crop yields. Irrigation farming has been identified as one of the strategies for agricultural development [12]. In the year 1980's the government of Tanzania initiated various efforts in promoting irrigation agriculture for enhanced food security. Much efforts focused on small-scale and large scale irrigation schemes. However, such efforts proved failure as they were highly mechanized and expensive thus most of the farmers in Tanzania could not afford due to low level of economic growth. In such situations, traditional irrigation systems were more favourable to most of the rural farmers. The practice materialized from indigenous knowledge obtained through observations and investigations. Traditional irrigation practices are dynamic processes that vary geographically and where the communities engaging in such activities are proficient in integrating and adapting the outer knowledge and experiences for enhancing their own situations [13].

Throughout history, people have been using various strategies in ensuring food stability at their households. Valley bottom farming is among the traditional practices in ensuring food security. The farming system have different names depending on the localities, in India the practice is called *Kuhls* [14], *Kijungu* in Ruvuma region [15] and *majaluba* in Mara region [16]. In Iringa and Njombe regions the practice is known as *vinyungu* [2]. *Vinyungu* is a Kiswahili version of the Hehe/Bena word *kinyungu* (singular) or *fyungu* (plural) which is the valley bottom dry period farming practice cultivated during the dry season depending on natural moisture or water diverted from rivers/streams to produce food and cash crops [17]. The *vinyungu* farming practices are taken in areas that are wet all over the year specifically along the river valleys [18]. In their shape, *vinyungu* are ridges like structures of substantial width ranging between 4 and 5 meters, their length differ depending on the nature of an area and the source of water for irrigation (Figure 1). Though, the sustainability of such methods is still uncertain due to increased intensity of climate change and variability. The government of Tanzania has been restraining agricultural activities undertaken along rivers, in catchments and in valley bottoms, yet many people in rural and urban areas still practice farming activities in such areas. Valley bottoms are essential landscapes and critical natural ecosystems that give considerable environmental and socio-economic benefits to people's livelihoods [19, 20, 15]. A historical explanation of vinyungu system in Iringa region point out that this farming practice has been around for many years [13]. Nevertheless, the magnitude of farming has been gradually increasing as years goes by depending on various circumstances.

Fig.1: Structure of vinyungu farming systems in Iringa rural district –Ilandutwa village. Photo taken by researcher, 2022.

Theoretical Framework

The study was guided by the Farm System Theory [21], the theory suits to the current study as it perceives a farm as a *unique goal-setting* (i.e., purposeful) normally a man -made entity with the aim of generation income which can either be in cash or in kind for its stakeholders through agricultural production. For this case, traditional valley bottom farming is a purposefully activity aimed at ensuring food stability among rural communities. The theory further explain that the exceptionality of any particular farm system is assured by its location, history, resources and human elements. The farm system involves a combination of abstract and concrete elements or subsystems. The concrete elements are related with the physical activities and processes that occur on the farm. The abstract elements relate to the managerial and social aspects of the farm. Basing on the theory's perception, it is true that the practice of traditional farming systems depend on the location and history of an area, this has made vinyungu systems to have different names depending on the area. Also, the farm-system theory perceives the farm as having various boundaries or interfaces, i.e., contact points with other systems or environments which can either be physical environment such as land and water or non-physical environment such as knowledge and skills possessed by management, labour and the farm system's social organization. The practice of valley bottom farming (vinyungu system for the purpose of the current study) need both physical and non- physical environments, example the practice need knowledge and skills on how ridges like structures (vinyungu) should be constructed as indicated in Figure 1.

Moreover, the farm system theory comprehends any farm having five subsystems including the technical subsystem which involves resources, technology, knowledge and opportunity which used to produce agricultural products. The second subsystem is the 'organizational structural subsystem' which corresponds to the formal structure of authority, communication, job descriptions, responsibilities and task allocation within the farm system. Also, there

is 'informal structural subsystem' which exists in any farm system involving two or more persons. The fourth subsystem is the 'goals and values subsystem' which relates to those goals and values held by the farm system as a purposeful organization. Lastly is the 'managerial subsystem' which deals with the general management of the farm. However, the managerial subsystem depends on the farm size, for the case of vinyungu farming systems, the managerial subsystem may involve the head of the household or any other traditional leader at the family, tribe or community level.

Many other studies on valley bottom farming have merely focused on poverty alleviation, socio-economic and environmental factors as well as water flow in such farming systems [22, 16, 13, 15, 2]. Very little have been reported on the value of valley bottom farming systems (vinyungu) on food stability. This enlightened the need for the current study. Nevertheless, the study stands on the view that; the four pillars of food security (food availability, accessibility, stability and utilization) can best be described if there is stability in food production throughout the year. In its wider context; food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. To be food secure, a population, household or an individual must have access to adequate food at all times throughout the year (food stability). They should not risk losing access to food as a consequence of sudden shocks relating to climate or economic stresses or cyclical events (e.g. seasonal food insecurity). The concept of food stability can therefore, refer to both the availability and accessibility dimensions of food security which implies a sequential dimension [1, 23]. The production of enough food has been affected by climate change, thus traditional valley bottom practices are necessary in subsidising food shortages. Though, the practices have been there for centuries, yet at the local level, farmers perceive it as an indigenous farming system and not a climate change adaptation strategy. In this regard, the study describe valley bottom farming practices as one of the adaptation strategies to the impact of climate change on crop production. In valley bottoms the land is moist throughout the year thus giving room for farmers to produce even during the dry seasons, thus ensuring food stability.

2. MATERIAL AND METHODS

2.1 The Study Area

The study was taken in Mgama ward-Iringa rural District which is located in the southern highlands of Tanzania. The district's main economic activity is agriculture, *vinyungu* system is one among the farming practices undertaken using water from rivers for irrigation. Two villages namely Ibumila and Ilandutwa were selected for this study. The selection of these villages focused on their location characteristics as they are located along river Lyandembera which is essential for *vinyungu* practices.

2.2 Research Approaches

The methodological approach in this study based on mixed methods in which a combination of qualitative and quantitative research approaches formed the basis for data collection and analysis. These approaches were essential to ensure the reliability and validity of the data to be collected. The study used a cross sectional research design. The cross sectional research design allows data to be collected at a single point in time and used in a descriptive study and for determination of relationships between variables [24]. In obtaining a sampling frame which was significant in determining the sample size, village executive officers were consulted and provided a list of households. The lists were compiled and it was found that

the selected villages had a total of 1009 households. The obtained sample frame was used in determining the sample size. The determination of sample size for structured interviews based on confidence and precision level. It has been suggested that, in social science research, 95% confidence level with the precision level of 5% or 0.05 is adequate [25].

$$n = \frac{z^2 \cdot p \cdot q \cdot N}{e^2 (N-1) + z^2 \cdot p \cdot q}$$

Thus, 198 respondents were interviewed during structured interviews.

In obtaining appropriate respondents from each village, the proportionate stratified sampling technique was used. The proportional allocation of households in every sampled village was conducted through a proportionate formula as:

$$P_i = \frac{N_i}{N} n$$

Where, P_i = Proportional sample of each village
N_i = Number of household in each village
N = Total household forming the sampling frame
n = Sample size

Inserting data for each village in the equation above:

1. Ibumila Village: $P_i = 649/1009 \times 198 = 127$
2. Ilandutwa Village: $P_i = 360/1009 \times 198 = 71$

Total = 198

Thus, 127 heads of households were sampled from Ibumila village, 71 from Ilandutwa village making a total of 198 respondents.

2.3 Data Collection Methods

Both primary and secondary data were collected to answer the research objectives. Primary data were collected using survey method. Techniques for survey method included; household questionnaire survey and in-depth interviews. Moreover, direct observation and focus group discussion were used in obtaining the primary data. The primary data focused on the valley bottom farming systems (vinyungu) and their contribution on food stability. The study used secondary data which contributed towards the formation of background information on valley bottom farming. These data were collected through reading documents such as journals, text books, newspapers, library and web- based materials on the research topic. Research tools used included semi-structured questionnaire, checklist of questions for key informants, checklist for direct observation and checklist of themes for focus group discussions (FGD's). Additionally, climate data were obtained from Tanzania Meteorological Authority (TMA). The data consisted of annual rainfall as well as minimum and maximum temperatures between the years 1982 and 2021.

2.4 Data Analysis

The qualitative data collected through focus group discussions and in-depth interview were analysed basing on their contents. Quantitative data were analysed using IBM SPSS version 20 and Microsoft excel. The data on rainfall and temperature were analysed using Microsoft excel, also, the slope of the regression equation (b) ($y = bx + a$) was used in determining the rate of change. Besides, percent of normal precipitation index (PNPI) was used in measuring rainfall deviations from normal rainfall. It has been suggested that, when rainfall deviations

ranges from +20% to -20% it is considered to be normal and below -20% is drought. The following equation was used to determine the PNPI:

$$PNPI = \frac{\text{Actual Rainfall} - \text{Normal Rainfall}}{\text{Normal Rainfall}} \times 100$$

3. RESULTS AND DISCUSSION

3.1 Climate Situation in the Study Area

Characteristically, Iringa region has unimodal type of rainfall with a single rainy season (Masika) from November through May, and dry conditions during the rest of the year [26]. The climate data from Tanzania Meteorological Authority (TMA) indicate that the area has experienced substantial rainfall variation for the period of 40 years covered by this study i.e. between 1982 and 2021 (Figure 2 & 3). For instance in 1982 the total annual rainfall was 732.3mm, in 2020 the area received 1201.6mm this amount decreased to 379.3mm in 2021. The trend line of rainfall patterns in the regression equation indicates the slope *b*= 2.93 at the rate of R^2= 0.05 (Figure 1). Besides, there has been changes in minimum and maximum temperature at (b= 0.03, R^2 =0.4; b=0.02, R^2=0.02) respectively as indicated in Figure 3.

Changes in rainfall and temperature patterns has implication on crop production, the increase of drought can lead to crop failure. In the study area majority of the respondents 87% mentioned to get low yields due to crop failure when there is no enough rainfall. For instance in 1992, 1997, 2003, 2005, 2010 and 2021 the area received low rainfall i.e below average. It has been suggested that when PNPI ranges from +20% to -20% it is considered to be normal and when PNPI is below -20% is drought [27]. However the severity of drought defer depending on the PNPI value, it has been suggested that when the rainfall deviation is below -25% it denote for severe drought and when the PNPI value is between -20.1% and -24.9% entails for moderate drought. In this regard, the study identified years in which an area experienced moderate drought, severe drought and years which had rainfall above normal as indicated in Table 1. Farmers also reported the increase of crop pests and diseases in their areas as an outcome of climate change and variability. All these have adverse impact on agricultural outputs. Similar observations have been reported by others scholars [28, 29]. Crop production specifically maize which is the staple crop in Iringa rural need moderate rainfall i.e. the rainfall should neither be too little or too high. In some years example in 2020 the area received heavy rainfall of about 1201.6mm (almost two times of the normal rainfall), this led to crop failure. Many other studies on maize crop have reported for the need of moderate rainfall for maize production [30].

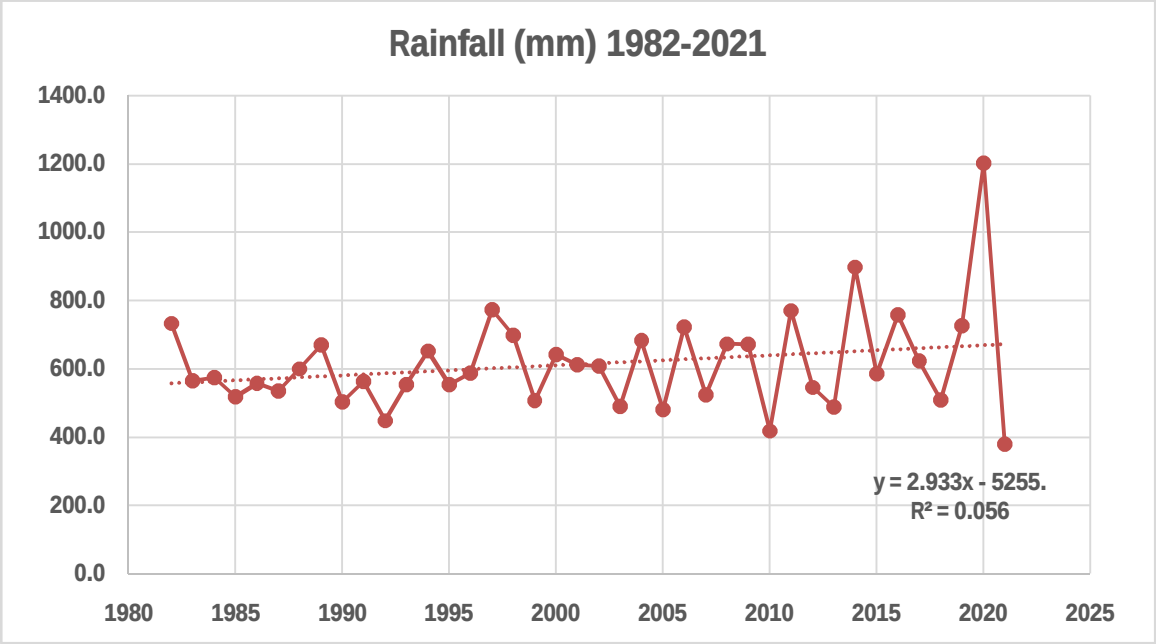

Figure 2: Annual rainfall between1982-2021
Source: Authors' computation from Rainfall data obtained from TMA, 2022

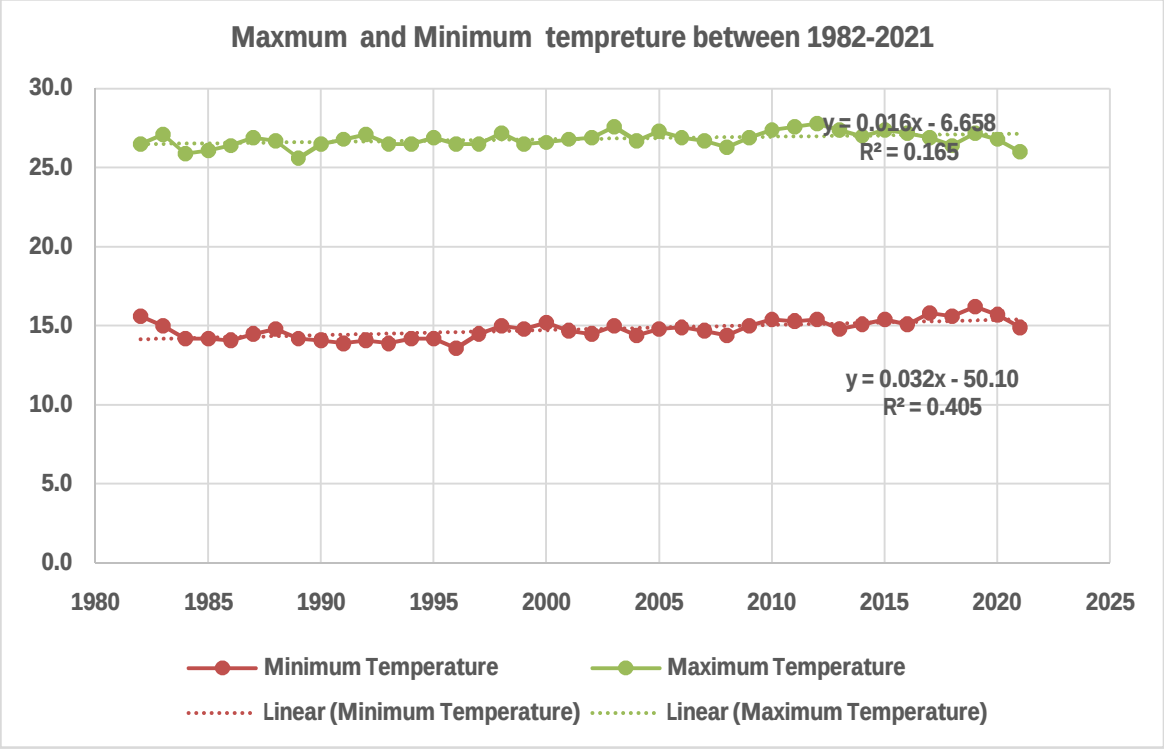

Figure 3: Minimum and maximum temperature between 1982 and 2021
Source: Authors' computation from Temperature data obtained from TMA, 2022

Table 1: Values of the percentage of the normal precipitation index in the study area (1982-2021)

Year	Annual Rainfall	Normal Rainfall	PNPI	Classification
1992	447.7	614.8	-27.2	Severe drought
2003	489.9	614.8	-20.3	Moderate drought
2005	481.1	614.8	-21.7	Moderate drought
2010	417.9	614.8	-32	Severe drought
2013	487.4	614.8	-20.7	Moderate drought
2021	379.3	614.8	-38.3	Severe drought
1997	773.2	614.8	25.8	Above normal
2011	770	614.8	25.2	Above normal
2014	897.2	614.8	45.9	Above normal
2016	757.6	614.8	23.2	Above normal
2020	1201.6	614.8	95.4	Above normal

Source: Authors' computation from Rainfall data obtained from TMA, 2022

3.2 Valley bottom farming systems (vinyungu) in the study area

Valley bottom farming has existed for number of years as a traditional irrigation practice farmed during the dry season. In the study area 83.8% mentioned to engage in vinyungu farming for several years. About 37.9% reported to have involved in vinyungu farming between 21 and 30 years, whereas, 21.1% mentioned to have engaged in the activity between 11 and 20 years. Few of them reported to have involved in vinyungu farming for more than 50 years as indicated in Table 2. This group involved the elders, basing in the findings it can be argued that vinyungu farming is dominated by people aged below 70 years. The nature of the farming land (wet lands) is somehow difficulty for the elders as the activity is mostly done using hand hoe. The prevalence of vinyungu farming for decades in Iringa region has been reported by other scholars [22, 13]. The farming system is practised mostly by small scale farmers who own small plots, in the current study, majority of the respondents (44%) mentioned to own vinyungu plots sized between 0.5 and 1 acre, whereas 27.7% mentioned to have an area less than 0.5 acre. Very few respondents (4.2%) had more than 3 acres of vinyungu plots. The findings are in line with other scholars who have reported the dominance of smallholder farmers in African agricultural activities [31, 32].

Table 2: Involvement in vinyungu farming and its sizes

Variables	**Responses**		
	Ibumila	**Ilandutwa**	**Total**
Involvement in vinyungu farming	**n=127**	**N=71**	**N=198**
Yes	101 (79.5)[1]	65 (91.5) [1]	166 (83.8) [1]
No	26 (20.5)[1]	6 (8.5) [1]	32 (16.2) [1]
Estimated total vinyungu area in acre (s)	**n= 101**	**n=65**	**N=166**
Less than 0.5	29 (28.7) [1]	17(26.2) [1]	46 (27.7) [1]
Between 0.5 and 1	41(40.6) [1]	32(49.2) [1]	73(44) [1]

Between 1 and 1.5	11(10.9) [1]	6(9.2) [1]	17(10.2) [1]
Between 1.5 and 2	9(8.9) [1]	5(7.7) [1]	14(8.4) [1]
Between 2 and 3	7(6.9) [1]	2(3.1) [1]	9(5.4) [1]
More than 3	4(4) [1]	3(4.6) [1]	7(4.2) [1]
Years involved in Vinyungu farming (years)	**n=101**	**n=65**	**N=166**
Between 0 and10	16(15.8) [1]	11(16.9) [1]	27(16.3) [1]
Between 11 and 20	21(20.8) [1]	14(21.5) [1]	35(21.1) [1]
Between 21 and 30	38(37.6) [1]	25(38.5) [1]	63(37.9) [1]
Between 31 and 40	13(12.9) [1]	9(13.8) [1]	22(13.3) [1]
Between 41 and 50	10(9.9) [1]	4(6.2) [1]	14(8.4) [1]
More than 50	3((3) [1]	2(3.1) [1]	5(3) [1]

**1 Denotes percentages*

3.3 Contribution of vinyungu farming systems on food stability

Table 3 indicates various crops grown in valley bottom farms (*vinyungu*) in the study villages whereby majority of the respondents (86%) mentioned to grow maize, 49% mentioned to grow peas and 28% reported to grow Irish potatoes. Also, various vegetables including cabbage, rape and pumpkin were grown (Figure 4). In previous years maize was used to be grown in upland areas, but currently the crop is being grown in valley bottoms given the fact that the areas are moist throughout the year thus crops can reach their maturity stages as opposed to upland farming which need sufficient rainfall. One responded during in-depth interview had this to say:

''I have been engaging in vinyungu farming for more than fifty (50) years now, however, in previous years the main crops grown were vegetables, and the reason was to ensure sustainable supply of the vegetables throughout the year. Maize were rarely grown in vinyungu, but in about 10 years ago, I started growing maize in vinyungu because our area experience rainfall variability. In some years there is little rainfall and sometimes you find there is enough rainfall. These uncertainties have made us prefer growing maize and other crops in vinyungu because if there is little rain, yet the crops in vinyungu will still grow well because we can irrigate the farms using water in the canals (mifereji)''. ***In-depth interview with village elderly aged 72 years in Ibumila village.***

The response given by the aforementioned elderly indicates that the area has experienced climate change and variability over the years. Farmers have adapted to the impact of climate change in various ways including vinyungu practices. Though, for the local farmers, the practice of vinyungu system have been there for years as a traditional farming system which have been inherited over decades. Majority of them do not refer *vinyungu* as a climate change adaptation strategies rather than a traditional farming. But this study consider vinyungu farming as a traditional adaptation strategies to the impact of climate change on crop production for enhanced food stability. Various studies have found that vinyungu farming system had a positive contribution towards poverty reduction due to its contribution on financial assets [13]. It has been reported that poverty is one among the causes of food insecurity as majority of rural dwellers have limited financial accessibility. But with traditional irrigation systems (vinyungu) there is assurance of stable supply of various crops so farmers are likely to enhance their income by selling part of their crops and be able to perchance other food stuffs of their interest, thereby ensuring food stability. The findings also corresponds to the Farm System Theory which denotes that farming is a purposefully activity which enables farmers to generate income which can either be in cash or in kind.

Table 3. Crops grown in *Vinyungu* in the study area *(%)* (n = 198)

Common name	Traditional name (Bena & Hehe)	Swahili name	Part of use	Household growing such crops (%)
Irish potato (*Solanum tuberosum L.)*	*fitofu*	*viazi mviringo*	leaf, tuber	28
Chinese cabbage (*Brassica* sp.)	*chaina*	*kabeji*	leaf	32
Onions (*Allium cepa*)	*vitungulu*	*vitunguu*	bulb	21
Peas (*Pisum sativum*)	*njegere*	*viwolo*	leaf, seed	49
Maize (*Zea Mays*)	*masebele*	*mahindi*	grain	86
Beans (*Phaseolus vulgaris*)	*dogi*	*maharage*	leaf, seed	56
Rape (*Brassica sp.*)	*nyadundwe*	*figiri*	leaf	62
Cabbage (*Brassica oleracea.*)	*kabichi*	*kabeji*	leaf	19
Tomato (*Lycopersicon esculentum*)	*manyanya*	*nyanya*	fruit	41
Pumpkins (*Cucurbita sp.)*	*maboga*	*maboga*	leaf, fruit	58

** Based on multiple responses*

Fig.4: Crops grown in vinyungu; (a) a farmer irrigating germinating Irish potatoes, (b) peas, (c) farmers harvesting peas
Source: Researcher, 2022

Food stability to the communities can be described when the supply of food at the household level remains constant throughout the year and in the long-term. Vinyungu farming systems can increase the stability of household food consumption against seasonality or other temporary shortages. Climate change has affected food production in most parts of the world thus food prices have risen up. This has a tremendous impact to the poor rural communities who cannot afford the increased food prices. Thus, involvement in vinyungu farming systems is essential in ensuring food stability. In the study area 81% admitted to source their foodstuffs from vinyungu during food scarcity seasons as indicated in Figure 5. Besides, 19% admitted to source some food stuffs from the local markets in which such products are from vinyungu farmers. In the view of the above, it is evident that vinyungu farming systems are of vital importance to the rural livelihoods to both farming and non-farming households.

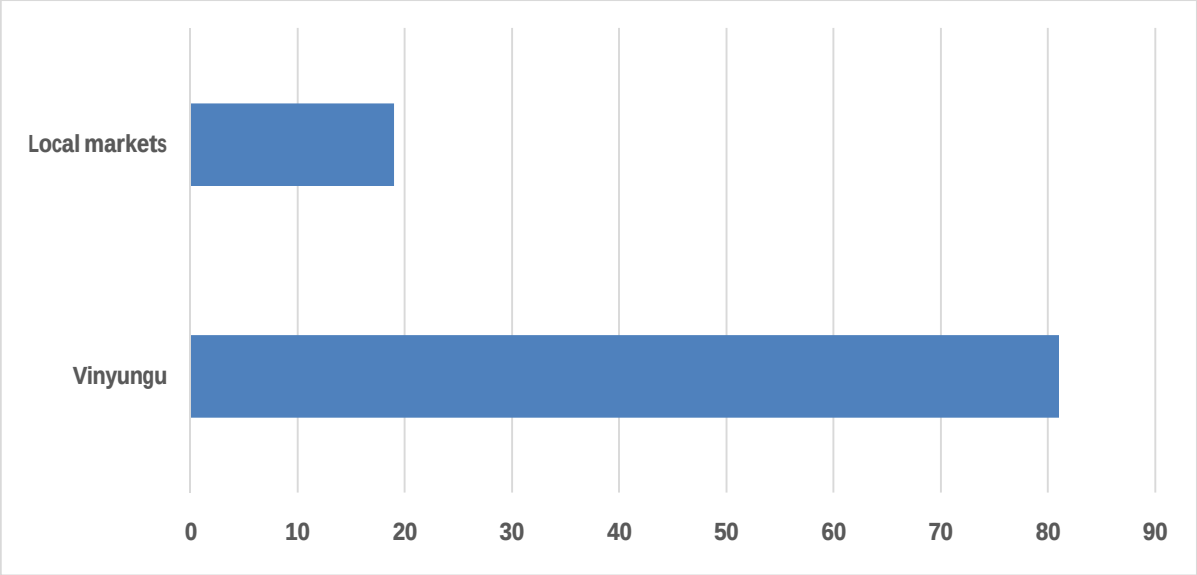

Figure 5: Source of food stuffs during dry seasons in the study area
Source: Survey Data, 2022

Furthermore, as indicated in Table 2, it was found that people in the study areas did not produce all categories of crops, therefore they had to buy some food varieties they don't produce. In this regard, respondents were asked to identify the sources of income used in buying other food stuffs which they do not produce at their households. The results showed that 86.4% mentioned to use money obtained from selling agricultural products sourced from upland and vinyungu farming. Also, majority (80.3%) of the respondents reported vinyungu farming to be very important at their social economic aspects. On the other side, respondents were asked to indicate the trend of production by comparing upland and vinyungu systems. About (83.7%) reported for decrease in upland production due to climate change incidences irrespective to vinyungu farming systems where there has been increased trend in production (81.3%) as indicated in Table 4.

Similarly, vinyungu products complement to upland farming. During the focus group discussion with the vinyungu farmers, they admitted that vinyungu systems had reduced

dependence on food products from upland farming which is highly susceptible to rainfall variability. Thus, valley bottom farming strengthen food stability, many other scholars have reported on the value of traditional farming systems in ensuring food stability [15]. Also, the practice contributes to the availability of food in the local markets during the dry and other seasons. Many other studies in different localities have reported river valley farming in different forms, where by in urban areas the practice has been referred to urban farming in which urban residents cultivate along the river valleys, the products obtained contributes to urban food security [33, 34]. However, the difference between the two forms (vinyungu vs urban farming) focusses on the location of the farming fields whereby vinyungu practices are taken along the river valleys while urban farming can be taken along the river valleys, in upland areas or around the house backyards.

Table 4: Respondents' importance of vinyungu farming and its production trends

Variables	Study villages		
	Ibumila n=127	Ilandutwa n=71	**Overall N=198**
Importance of vinyungu farming at social economic aspects			
Very important	98(77.2)[1]	61(86)[1]	159 (80.3)[1]
Important	29(22.8)[1]	10(14)[1]	39(19.7)[1]
Trend of upland production			
Increase	21(16.5)[1]	12(17)[1]	33(16.7)[1]
Decrease	106 (83.5) [1]	59(83)[1]	165(83.7)[1]
Trend of vinyungu production			
Increase	99(78)[1]	62(87.3)[1]	161(81.3)[1]
Decrease	28(22)[1]	19(26.7)[1]	47(23.7)[1]
Sources of household income			
Upland and Vinyungu farming	112(88.2)[1]	59(83.1)[1]	171(86.4)[1]
Upland farming and petty business	11(8.7)[1]	10 (14.1)[1]	21(10.6)[1]
Salaries and farming	4(3.1)[1]	2(2.8)[1]	6(3)[1]

**1 Denotes percentages*

4. CONCLUSION

The study investigated the contribution of valley bottom farming systems (vinyungu) on food stability to the rural households. Vinyungu farming systems have been practised for several years, initially the activity was regarded as a traditional farming practice, but with the current climate change and variability (CCV), the system has attracted larger number of farmers so as to reduce the problem of food shortages. It was revealed that, the area experiences CCV which affect crop production in the upland zones, therefore, the practice of vinyungu farming systems have enabled rural communities to produce continuously. The study focused on food stability with the view that if there is sequential food production, then, other food security dimensions such as food accessibility and food availability will be fulfilled. Various crops were identified in vinyungu fields, such crops play a vital role in food stability. The study was guided by the Farm System Theory which perceive a farm as a unique-goal

setting entity which enable farmers to generate income which can either be in cash or in kind. In the view of this theory, vinyungu farming systems in the study area have enabled farmers to obtain cash as well as food. However, despite of its contribution to food stability, vinyungu farming systems can lead to environmental deterioration if the practice is not well managed. Therefore, capacity building to the communities engaging in such activities is essential for its sustainability.

REFERENCES

1. Food and Agricultural Organization (FAO). The State of Food Insecurity in the World. Rome. 2002.
2. Kassian L, Tenywa M, Liwenga ET, Dyer KW, Bamutaze Y. Implication of climate change and variability on stream flow in Iringa region, Tanzania. Journal of Water and Climate Change. 2016; doi: 10.2166/wcc.2016.238.
3. Dagos RAT. Assessment of Lowland Rice-based Organic Farming in Selected Municipalities of Occidental Mindoro, Philippines. Int. J. Agr. Syst. 2019; 7(1): 88.
4. Africa Agriculture Status Report (AASR) Focus on Staple Crops. Alliance or a Green Revolution in Africa (AGRA), Nairobi, Kenya. 2013.
5. Mutayoba V, Ngaruko D. Assessing tomato farming and marketing among smallholders in high potential agricultural areas of Tanzania. Int j economics commerce management. 2018; 577-590.
6. Mary L, Majule AE. Impacts of climate change, variability and adaptation strategies on agriculture in semi -arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania. Full Length Paper, Institute of Resource Assessment, University of Dar es Salaam. 2009.
7. United Republic of Tanzania (URT). Guidelines for Integrating Climate Change Adaptation into National Sectoral Policies, Plans and Programmes of Tanzania. Vice Presidents Office. 2012.
8. Bjornlund V, Bjornlund H, Van Rooyen AV. Why agricultural production in sub-Saharan Africa remains low compared to the rest of the world – a historical perspective. International Journal of Water Resources Development. 2020;36:sup1, S20-S53, DOI: 10.1080/07900627.2020.1739512
9. Malekela AA, Lusiru SN. Climate change adaptation strategies through traditional farming practices. The case of Matengo pits in Mbinga District, Tanzania. *International* Journal of Research Publication and Reviews. 2022; Vol 3,no 5, pp 3025 3033. DOI: *https://doi.org/10.55248/gengpi.2022.3.5.18*
10. Pfister S, Bayer P, Koehler A, Hellwe S. Projected water consumption in future global agriculture: Scenarios and related impacts. Science of the Total Environment. 2011; 409(20), 4206–4216. https://doi.org/10.1016/j.scitotenv.2011.07.019
11. New Partnership for African Development (NEPAD). Agriculture in Africa. Transformations and outlook. NEPAD. 2013; 72 p.
12. United Republic of Tanzania (URT). National Bureau of Statistics. Iringa Region Socioeconomic Profile. Printed by Government Printers. Dar es Salaam, Tanzania. 2002; 6 - 7pp.
13. Kyando FE. Impact of Valley Bottom Cultivation (*Vinyungu*) on Poverty Alleviation in Mtitu River Basin, Kilolo District, Iringa, Tanzania. M.A Dissertation. Sokoine University of Agriculture. Morogoro.2007.

14. Gover A, Kant S, Payret A, Pyakuryal B, Seneres L, Singal D.. Incorporating Traditional Methods of Irrigation with Water Management in Mandi, India. Indian Institute of Technology, Mandi. 2013. https://www.wpi.edu/Pubs/E-project/ Available/E-project-101813-045315/unrestricted/Irrigation. Methods with Water management in Mandi.pdf.
15. Kurosaki R (2007). Multiple uses of small-scale valley bottom land: Case study of the Matengo in southern Tanzania.
16. Yanda PZ, Majule AE, Mwakaje AG. Wetland utilisation, poverty alleviation and environmental conservation in semi -arid areas of Tanzania: The case of Singida Region, Tanzania. In: Proceedings of East Africa 'Integrated River Basin Management' Conference, Sokoine University of Agriculture, Morogoro, Tanzania .2005.
17. Majule AE, Mwalyosi RBB. Enhancing agricultural productivity through Sustainable irrigation*:* A case of vinyungu farming system in selected zones of Iringa. Research Report Submitted to ENRECA, University of Dar es Salaam. 2003; 8-57pp.
18. Munishi KTP, Wilfred NN, Nshare JS, Moe SR, Shirima DD, Kilungu HH. . Valley bottom wetlands conserve for both biodiversity conservation and local livelihoods improvements. Ecosystems Biodiversity (O. Grillo and G, Venora, Eds.), InTech. 2011. http://www.intechopen.com/books/ ecosystems-biodiversity/valley-bottom-wetlands-can-servefor-bothbiodiversity-conservation-and-local-livelihoodsimprovement.
19. Silvius MJ, Oneka M, Verhagen A. Wetlands: Lifelines for people at the edge. Physics and Chemistry of the Earth, Part B. 2000; 25:645 - 652.
20. Stuip MAM, Baker CJ, Oosterberg W. The socio-economics of wetlands. Wetlands International and RIZA, The Netherlands. 2002; 135pp.
21. Dillon JL. The Farm as a Purposeful System. Miscellaneous Publication. Department of Agricultural Economics and Business Management, University of New England, Armidale. 1992; No. 10
22. Mkavidanda TAJ, Kaswamila ALThe Role of Traditional Irrigation Systems (Vinyungu) in Alleviating Poverty in Iringa Rural District, Tanzania. Research on Poverty Alleviation (REPOA). Mkuki na Nyota Publishers. 2001; Research Report No. 01.2
23. Shakeel A. Food Security: Theorizing the Evolution and Involution of the Concept. The Arab World Geographer. 2018; 21, no 1, 58-82.
24. Babbie E. Survey Research Methods.2nd Editition. Wadworth Publishing Co. BELMOT California. 1990; 395pp.
25. Kothari CR. Research Methodology: Method and Techniques, (2nd ed). New Age International. Delhi. 2004.
26. United Republic of Tanzania (URT). National Sample Census of Agriculture 2002/2003. Volume Vk: Regional Report: Iringa Region. 2007.
27. Kumar MN, Murthy CS, Sesha SMV, Roy PS On the use of Standardized Precipitation Index (SPI) for drought intensity assessment. Meteorological Application. 2009.
28. Kasimba R. Impacts of climate change on crop production practices among small holder farmers in Guruve district. National Research Database. Zimbabwe. 2012.
29. Kikoyo DA. Climate Change and Variability Impacts on Agricultural Production in Uganda. University of Dar es Salaam. Dar es Salaam. 2013.
30. Mtongori HI, Stordal F, Benestad RE, Mourice SK, Pereira-Flores FE, Justino F. Impacts of Climate and Farming Management on Maize Yield in Southern Tanzania. African Crop Science Journal. 2015. Vol. 23, No. 4, pp. 399 – 417. DOI: http://dx.doi.org/10.4314/acsj.v23i4.9.

31. Debone N, van Vliet J, Ramkat R, Snelder D, Verburg P. Farm scale as a driver of agricultural development in the Kenyan Rift Valley. Agricultural Systems. 2020; 186. 102943.
32. Mathinya VN, AC Franke AC, Van De Ven GWJ, Gillerh KE Productivity and constraints of small-scale crop farming in the summer rainfall region of South Africa. Outlook on Agriculture. 2022; Vol .51, Issue 2, Pp 139-154. https://doi.org/10.1177/00307270221091839
33. Syonga E. Assessment of Urban Agriculture as a Livelihood Strategy. A case of Mbeya City. Tanzania. M.A Dissertation. University of Dar es salaam. Dar es salaam. 2015.
34. Malekela AA. Impact of Urban and Peri-Urban Agriculture on Food Security in Dar Es Salaam City, Tanzania. PhD Thesis. University of Dar es salaam. Dar es salaam. 2018.