TERRACE CULTIVATION AND RURAL RESOURCES CONSERVATION IN HIGHLAND REGIONS OF ADAMAWA AND BORNO STATES

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Abstract

People are attracted to highlands from time immemorial for socio-economic reasons. Ridge terrace is the most observable feature on hillslope farmlands. Farmers adapt ridge terracing to conserve highland resources such as soil fertility and water against depletion. The scope covers highland areas of Biu, Garta and Kwaja. The research assessed the contributions of ridge terrace in highland resources conservation.The data required are highlandresources, reasons for adopting ridge terrace, systems of crop production and types of crops cultivated. The sets of data were used to realize the contributions of ridge terrace in hillslope resources conservation. The sources of data are the field, respondents and existing related literatures. The results shows that ridge terrace when correctly constructed reduces soil and gully erosion as well as retains soil fertility, encourages infiltration and reduces siltation of surface water.The study recommends that terracing should be intensified so as to retain the environmental resources of the hilly regions. The practice of farmland clearing by burning should be discouraged so as to increase organic matter content of the hillslope farmlands.

Key wards: Ridge terrace, Highlands, Erosion, Arable farming, Environmental resources

Introduction

Study on Environmental Possibilism reveals that man in order to satisfy his existence on the Earth's surface, has been struggling against nature in different ways using different techniques of production at different stages of development (Berdoulay, 2009).Hence, Environmental Possibilism has undoubtedly resulted to the economic activities of the hillslope inhabitants of Biu, Garta and Kwaja in their attempt to utilize the fertile soil to satisfy their food requirements and sources of income. From the concept of Cultural Geography there is interaction between the physical environment and traditions of people (Boyd, 2017). Such interaction between the natural landscape and humans creates the cultural landscape as modified by human activities such as ridge terracing for arable farming (Heatwole, 2006).

The environmental resources of peasant communities include the socio-economic resources such as people and farmlands; cultural resources is landscape while the natural resources include topography, soil, wetlands, floodplains and vegetation (Virginia Department of Transportation, 2013). People living in hills and mountains are predominantly rural and depend on agriculture and natural resources for their livelihoods, and typically have insignificant alternative source of income or employment (Virginia Department of Transportation, 2013).Therefore, farmers embarked on terracing to overcome part of the restrictions against utilization of the fertile highland soils placed on him by the topography because of lack of access to enough arable land to provide food and income(Pidwirny,2006; Wright, 2007). European Commission (2006) reveals that hillslope clearing and plowing produces huge loose material displacement, thus, resulting in the loss of original soil profiles and in rapid reshaping of the terrain.Tulu (2002) reveals that soils on highlands are characterized by poor profile about 50cm deep, poor water retention and prone to erosion. In 1950s water bodies from highlandswere clear and sparking, most of the rivers were deep and perennial, and the velocity was often high (Shaib, 1991). With increase in population and wider utilization of the catchment regions for crop production, more suspended sediments yield from the hillslope farmlands have been deposited into surface waters with adverse effects on siltation of rivers (Pfiffner, 2013).

Hillslope arable farming takes the balance of nature through massive clearanceof vegetal cover, modify the initial placement of stonesaround on the farmlands and growing exotic crops (Roggers, 2014). Because of the intervention, water erosion from hilly farmlands is a critical phenomenon due to the speed at which it occurs, the great losses it does to farmlands by dissection, water quality and availability due to deposition of sediments (Miranda*et al*, 2012). Terraces reduce both the amount and velocity of water flowing across the soil surface on farmlands with broader advantages on environmental resources conservation such as soil fertility, surface and ground waters (Wheaton and Monke, 2013).Furthermore, terrace cultivation allows the use of land that would not normally be able to be used using conventional farming methods; it helps to reduce soil erosion by preventing heavy rainfall from gaining momentum as it runs down the slope; and it helps to reduce flooding in the valleys (Reamer, 2016). Through terrace cultivation rain and run-off water are conserved and the idle hillside become productive and livable, and also maximize use of water soaked intosoil pore spaces by the planted crops (Homesteading, 2017).Virginia Department of Transportation, 2013)

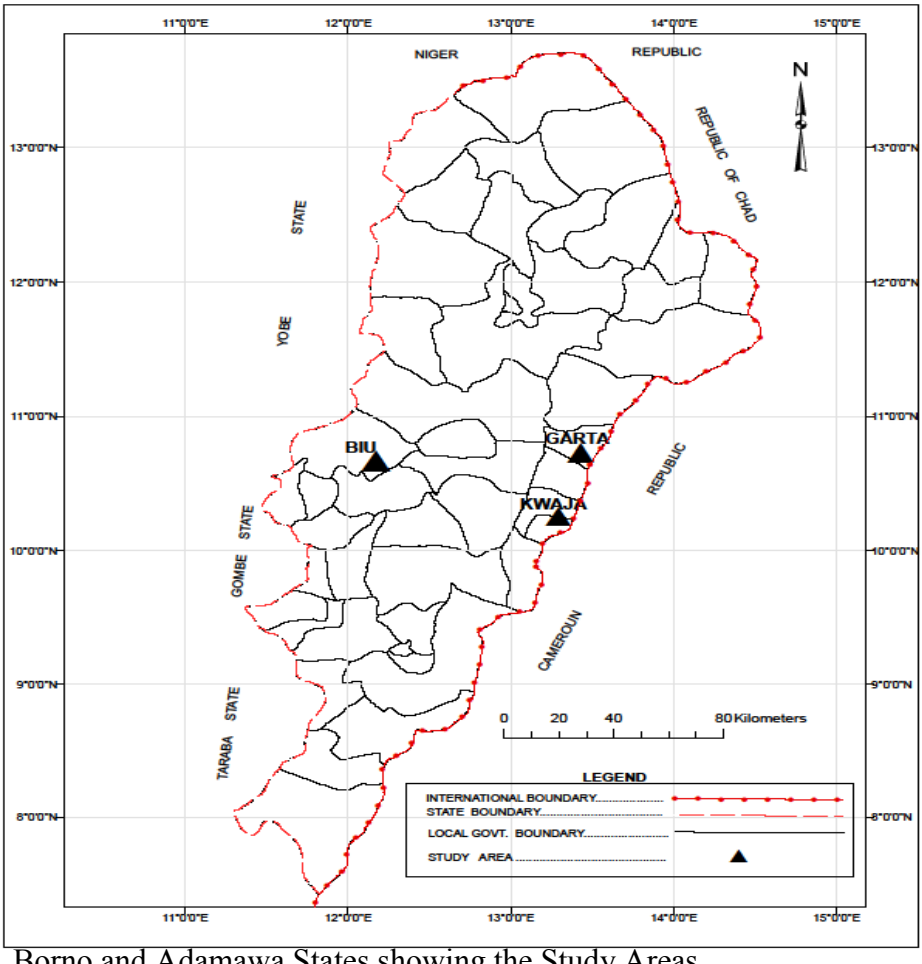
Results of studies on ridge terracing especially those of Reamer (2016); Rogers (2014); Wheaton and Monke (2013); and Virginia Department of Transportation (2013)are important by stating the process of terrace farming, importance of terracing; highland resources, economic activities of the highland communities and characteristics of highland soils. However, the studies did not significantly assess the importance of terrace cultivationin rural areas neither restricted their studies to highland regions of Adamawa and Borno States nor carried out a micro-scale study on the importance of terrace farming among the hillslope settlements of Biu, Garta and Kwaja.

It is observed that significant numbers of residents are attracted to the highlands of Biu, Paka and Nwumo; and their predominant economic activity is arable farming. Farmers cultivate crops such as groundnuts, maize, rice, guinea corn, groundnuts, beans; and vegetables such as pepper, garden egg and tomatoes. Criteria for selecting the crops include those that are adapted to the local rainfall and temperature, topography, are stable food materials and incomeaccruing while the tools are axe, hoe, sickle that are accessible and light weight. They manage crops by weeding and terracingwhich are effective and environmentally friendly by reducing runoff and erosion.

Assessment of the importance of ridge terracing was embarked upon because it is the most observable feature on farmlands.In the areas, it is observed that stones are arranged in ridges on steep slopes,and parked into heaps on farmlands on the plateau. Furthermore, there are insignificant water channels observedon farmlands under terracing despitethesloppy terrain. It is from this perspective that the study was embarked upon to highlight the benefits of ridge terracing onthe highland areas of Biu, Garta and Kwaja. The scope is restricted tohighland regions of Biu, Barta and Kwaja. The issues assessed include identification of theprocess of arable farming,ridge terracing, environmental resources of the highlands with focus to highlight the benefits of ridge terracing to highland communities.

Geographical Background to the Study Areas

The study areas are Biu, Garta and Kwaja. Garta and Kwaja are peasant settlements located in Adamawa State whileBiuis in BornoState as shown on the Figure 1. Biu lies on latitude $10^0$36'N and longitude $12^0$11'E(Olayinka, 2000). It is located on Biu plateau about 762m above mean sea level. Biu is the local government headquarters of Biu Local Government Area of Borno State.GartainMichika Local Government Area of Adamawa State is located on latitude $10^0$37'N and longitude $13^0$29'E on the datum of Nwumo hills about 625m above mean sea level (DUHU, Nigeria, Sheet 156)whileKwaja in Mubi South Local Government Area lies on latitude $10^0$06'N and longitude $13^0$18'E on Paka hills about 1158m above mean sea level(UBA SE, Nigeria, Sheet 156).



Borno and Adamawa States showing the Study Areas

The surfaces of the areas are significantly covered with small and bigger boulders which compel the communities to adapt ridge terracing as arable land management practices. They cultivate cereals such as guinea corn, maize, rice and millet; leguminous crops such as groundnuts and beans, and vegetables. They depend on rural resources such as fertile soil, surface water and vegetal products for domestic uses and sources of cash income. The average lapse rate of 1^0C per 164m (Areola *et al.*, 2006) suggest that areas with highland peaks of about 625m, 762m and1158m above mean sea level experience more rainfall that favours the cultivation of crops and accelerates surface run-off than the surrounding pediments.

Materials and Methods

The types of data required for this study were information onhillslope environmentsuch as sources of water, economic activities, system of crop production and the types of crops grown.Thefield provides data on distances between ridges; the respondents provide data on the benefits derived from terracing; and publishedrelevant materials provided data on background to the study. The sets of data were used to realize the importance of ridge terracing in hillslope resources conservation. Materials used for data collection include interview schedule in which the respondents are the observers; measuring tape to ascertaindistances between terraces; and relevant published materials like topographical map provide data on geometrics.Purposive sampling technique was adapted to sample the terraces for measurement. The parameters measured are distances between terraces. A total of 150 respondents were selected for the discussions. These were drawn from the three sample settlements namely Biu, Garta and Kwaja. In each settlement 50 respondents were interviewed. The sample frame consists of both adult male and female those were selected using availability sampling technique. The generated data were analyzed using simple descriptive technique.

Results and Discussions

It is observed onBiu highlands that stones are collected in heaps or arranged in ridges on farmlands to create space for crop cultivation. The boundary between individual farmland is demarcated with larger terraces. Crops grown are beans, guinea corn, maize, tomatoes and groundnuts; others include rice on small scale on thefloodplains. Fertilizers and animal manure are used to supplement soil fertility. The distance between terraces differ in accordance with the slopes, thus, on steep slopes the distance is about 0.45mapart while about 2.25m on gentle slopes.

Respondents' Views on Benefits Derived from Ridge Terracing

Table 1 below presents thedistribution of respondents' views on the benefits of ridge terracing as a cultural system of arablefarming adapted on the hilly regions of Biu, Garta and Kwaja.

Table 1: Distribution of Respondents' Views on the Benefits of Ridge Terracing

Benefits of Ridge Terracing	Respondents	Percentage
Controls soil erosion	40	26.67
Soil fertility conservation	27	18.00
Increases farmland sizes	22	14.67
Soil moisture retention	18	12.00
Underground water recharge	13	8.67
Sustenance of Surface Water Resources	11	7.32
Improve soil texture	10	6.67
Farmland Limit Demarcation	6	4.00
Reduces road incision	3	2.00
Total	150	100.00

Source: Field Study, 2016

Controls Soil Erosion:From the results, 26.67% of the respondents revealed that terrace farming is adapted to sustainhillsloperesources such as soil fertility. Ridges are constructed to reduce accelerated soil erosion by surface run-offthat is initiated bymassive removal ofvegetation and the compactedstones, for example, on Biu highlands. The massive removal of vegetation and rearrangement of stones for crop cultivation exposes the affected environment to water erosion with adverse effects on reduction in soil fertility, crop yields and incision of community economic lands both on the hillslpes and pediments. As a result of construction ofnumerous ridges at intervals of about 0.45m on steep slopes, and 2.25m on gentle slopes the surface run-off is significantly intercepted at each stage.The choice of distances could be attributed to the difference in velocity of surface run-off, gradient of the slope and the compactness of the surficial stones. Ridge terracing is significant in highland regions because it is culturally accepted since it allows continuous and gainful cultivation of piece of farmland; significantly conserves community land against reduction in utility and productivity; and it is environmentally friendly because it controls erosion.

Soil Fertility Conservation:From the respondents, 18% are of the opinion that conservation of soil fertilityby ridge terracing is the most important concern of the arable farmers for gainful crop yield.With human intervention by massive vegetation clearance, repositioning stones, continuous cultivation and clean weeding on the hillslopesof Biu, Garta and Kwajasoil fertility is depleted by accelerated surface wash. However, by adopting ridgeterracingon the highlands the applied organic matter such ashousehold refuse and animal dungsare retained behind the ridges whichretain nutrients to the domesticated crops such as maize and guinea corn.

The embarked crop residues and weeds remains are acted upon by bacteria in the wet season that produce humus which has positive advantage on soil fertility and crop

yield.From the respondents, the adoption of ridge terracing is the major reason why the hillsides of Biu plateau is cultivated annuallywith insignificant decline in crop yield.

Increases Farmland Sizes:According to14.67% of the respondents, the adoption of ridge terracing like at Biuwhere the surface is significantly covered with small and bigger boulders, large area of the fertile volcanic soils are converted from natural rocky surfaces into productive farmlands. This is because thecompacted small and bigger stones are removed and arranged into ridges of various sizes and heights on steep and gentle slopesobserved for surface erosionwhile it is piled into heaps on the plateau considered by insignificant erosion. These cultural devices createsignificantopen space devoid of stone coveragethat is utilized for crop production.Furthermore, onKwajahighlands the farmland sizes are increased by reclaiming the dissected slopes to productive farmlands using ridge terraces.

Soil Moisture Retention:As attested by 12% of the respondents, the cleared soil surface on the arable land is affected by adverse effects of blowing wind and sunlight which encourages desiccation. However,with the construction of numerous ridges across slopes such as 0.45m apart on steep slopes and 2.25m on gentle slopes, the surface run-off infiltrates into the soil to maintain moisture. The soil moisture is essential because it inhibits local agricultural drought. Furthermore,the moisture softens the soil which facilitates easy planting and weeding, it is essential for seed germination, prevents wilting in crops, and encourages active vegetative growth and flowering. Nonetheless, the soil moisture encourages the activities of soil micro-organisms such as earthworm and bacteriathat convert dead organic matter such as crops and weeds residues into humus under moist conditions. This could be the reason responsible for continuous crop cultivation with insignificant reduction in yield.

Underground Water Recharge: From the table,8.67% of the respondents identified that ridge terraces significantly encourages underground water recharge. As a result of the ridges constructed at intervals (0.45m on steep slopes and 2.25m on gentle slopes), surface flow is embarked behind the ridges. The embarked water infiltrates into the ground to recharge groundwater which could have been lost to surface run-off. It is observed at Biu, Garta and Kwaja the artesian wells, rivers and ponds yields water significantly in the dry season (February to May) despite the hilly terrain. This could be attributed to the infiltration of water embarked by the ridge terraces.The predominant source of water in the areas is river and stream. For example, river Wandu at Biu, Tucha at Kwaja and Mugza at Garta are used for animal watering and domestic purposes.

Sustenance of Surface Water Resources:From the respondents, 7.32% stated that the practices of ridge terracing as a means of crop production have significantly contributed in sustenance of surface water as a resource. This is because the ridges reduce siltation and deposition of floating debrisinto the surface waters such as river Wandu, Tucha and Mugza.The constructed ridges ranging from about 5 to 10m long at intervals of about 0.45 to 2.25m on steep and gentle slopes reduces surface flow by breaking and stabilizing the

slope. Furthermore, the ridges hold back debris that could be deposited into surface waters such as river Mugza, Tucha and Wandu that provide fisheries, animal watering and small scale irrigation.Furthermore, the respondents observed that the organic matters such as manure, slurries, crop reduces and weeds stalks from farmlands could have been deposited into the rivers that could pollute them, but the sediments and other contaminants settle out behind the ridges.

Improve Soil Texture:From the result,6.67% of the respondents stated that the relative proportion of sand, silt and clay on the hillslopefarmlands are improved by ridge terracing. This is because the silt (derived from dead roots, trunks, branches and leaves of the preserved trees; crop residues, weeds stalks; and slurries under the action of bacteria)is retained behind the terraces which significantly converts the coarsesoil on the arable lands on Kwaja hills into loamy by mixing.The silt improves soil texture by cohesionof loose sandy particles together. This facilitates the retention of moisture and nutrients; facilitates development of crop roots; and encourages the activities of soil organisms such as bacteria and earthworm.

Farmland Limit Demarcation: From the respondents, 4% stated that the adoption of larger terraces reducesthe incidence of farmland encroachment. For example, onBiuhighlands the larger terraces either on the plateau or on the slopes serves as an anthropogeographicdemarcation between individual's farmlands on the cultural landscape. This has helped in reducing conflict over encroachmenton farmlands between neighbouring farmers better than the use of lines marked on the ground between individual's farmlands.

Reduces Road Incision:More importantly, 2% of the respondents opined that the numerous constructed ridgesreduce the quantity and velocity of surface flowgenerated from the bare farmland.The series of ridges on the catchments intercept both the surface and channel flows that could wash away the culverts and roads downslope with broader disadvantage on restriction of plying the roads.Because of the ridges the road networks which consist of both main and minor roads are fairly motorable thereby facilitating the socio-economic activities of the regions.

To this end, result of the study is similar to those of Boyd(2017);Virginia Department of Transportation(2013); Wheaton and Monke, (2013); and Miranda *et al*(2012). Hillslope resources such as fertile soils attracted settlements to the regions. People work against nature to produce food from hilly environment by adopting ridge terrace. The cultural technology conserves resources such as soil fertility, surface water and economic lands from reduction in usage and quality.

Recommendations

From the findings of this study, the following recommendations are made for sustainable management of highland resources in the study areas:

The practice of removing crop residues by burning during farmland clearing should be discouraged. This will allow the plant biomass to decompose into humus which reduce

sheet erosion, conserve soil moisture, and above all improves soil fertility and texture. More importantly, mixed cropping on crops such as groundnuts, beans and guinea corn should be intensified. Because the cover crops (beans and groundnuts) controls weeds by smothering. Also the groundnutand bean leaves serve as mulch which conserves moisture for the guinea corn.

Similarly, Hillslope FarmersAssociations should be formed and grantedmicro-credit as well as the right to farm the hillslopes. These strategies will encourage the farmers to develop hillslope management plans.

Conclusion

Based on the results in the study, it can be concluded thathighland preparation for gainful crop production involves clearing the vegetation and construction of ridge terraces to control accelerated erosion and to conserve soil moisture. Farmers embark on hillslope cultivation due to its accessibility and fertility that can support the growth of different variety of crops and to earn their living out of the limited hilly environment. The labour required for terrace construction and maintenance are enormous, and the return incrop yields are pitifully small due to high fragmented farm plots.Hillslope cultivation is characterized by limited farmland sizes, construction of the ridges, slow weeding,the use of crude implement like hoe with narrow blade about 8cm wideand human portage**.**

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