

Research Article

Smallholder farmers' perception on ecosystem-based approaches for remedying land degradation in Nabdam District, Ghana

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Abstract: The co-benefits from the implementation of ecosystem-based approaches in managing land degradation and enhancing ecosystem services have not been adequately explored in the mainstream literature. The study aims at identifying the indicators of land degradation and the associated ecosystem-based approaches used to remedy the situation. The ecosystem-based approaches refer to ecosystems and ecosystem services together with their flexible management in a cultural setting. The paper adopts a descriptive research design with quantitative and qualitative approaches. Principally, it targets 236 smallholder farmers for the survey, key informants for interviews and community members for focus group discussion. The results revealed that land degradation is mainly identified by reduced crop yield (53%). Farmer identification of land degradation is influenced by the age of the farmer ($p = 0.001$) with $\alpha = 0.05$. The ecosystem-based approaches include stone bonding, crop rotation, mulching and particularly, composting (53%). The ecosystem-based approaches are statistically linked to the communities with p-value of 0.020. A p-value of 0.001 shows that the ecosystem-based approaches are beneficial in the various study communities. Farmers' experience over the past five years is statistically related to the age of respondents ($p = 0.008$). The p-value of 0.000 indicates very strong statistical significance of the challenges of ecosystem-based approaches in the communities. The ecosystem-based approaches have long term goals for sustainable land improvement and may not be realized unless there is direct policy to take care of the approaches even in the short term.

Keywords: *ecosystem, farmers, Ghana, land degradation, perception, remedying*

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Introduction

Ecosystem-based approaches and combat against land degradation are directly linked. The twin strategy embodies the landscape approach and integrated ecosystem management principles to maximize the global environmental benefits of combating land degradation (GEF, 2014:5). In this context, ecosystem services are the direct outcomes of ecosystem-based approaches often referred to nature's contribution to people or the benefits that people obtain from ecosystems (Orr et al., 2017; IPBES, 2018). Also, the ecosystem services are dependent on land-based natural capital (Orr et al.,

2017). Hence, land degradation leads to habitat loss, species losses, decreases in biodiversity, reduction in ecosystem services, the decline in ecosystem functions, and weakening of ecosystem resilience (IUCN, 2015). The co-benefits from the implementation of ecosystem-based approaches in managing land degradation and enhancing ecosystem services have not been adequately explored in the mainstream literature.

The ecosystem-based approaches refer to means or strategies developed on the notion of nature-based self-maintaining association of plants, animals and micro-organisms and their

interactions with their physical non-living environment as a unit in which human beings are considered as part of the ecosystem (UNEP, 2004). Already, ecosystem-based approaches are used as climate change adaptation by farmers and the usage is reinforced by the United Nations Convention on Biological Diversity and Framework Convention on Climate Change (Chong, 2014). UNEP (2004) posits that ecosystem-based approach means sustainable management, conservation and restoration of ecosystems. Hence, ecosystem-based approaches include economically rational choices in decentralized adaptive management of land, water and living resources. It considers management effects on adjacent and other ecosystems, conservation of natural structure and functions of the ecosystem and bearing in mind the limits of the ecosystem in terms of functions, temporal and spatial dimensions. The ecosystem-based approaches use long term objectives and ecosystem in a constant flux - change. It seeks a balance between conservation and use of biological resources as well as equitable sharing of ecosystem benefits. Also, it uses scientific and indigenous knowledge and promotes all-inclusiveness of social sectors and academic disciplines. It is designed in such a way as to work proficiently under various environmental and socioeconomic changes (Hernandez, 2016).

People are an integral part of ecosystem and depend on other components of the ecosystems and their interactions – ecological processes – for our existence. Ecosystem-based management attempts to regulate the use of ecosystem so that we can benefit from them while at the same time modifying the impacts on them so that basic ecosystem functions are preserved. In other words, use them, but do not lose them (Pirrot et al., 2000:ix).

By extension, farmers appropriate portions of the natural ecosystem and use it as farms. By so doing, the ecosystem found in the farmers' farm (agro-ecosystem) mimics the natural ecosystem. Hence, agro-ecosystem is the natural ecosystem plus farmers' inputs (Peprah, 2018). Also, the principles of the natural ecosystem are applied by farmers in agricultural land use systems to produce food and industrial raw material while ensuring continuous production without compromising the ability of the agricultural land to provide its ecosystem functions. More often than not, agricultural land use has caused undesirable results – land degradation. The linkage between land degradation and the larger ecosystem is established in land degradation definition such as “any diminishment of biodiversity and ecosystem functioning” and “long term loss of ecosystem function and productivity” (Bai et al., 2013:375).

In this regard, land degradation is assessed using Normalized Different Vegetative Index (NDVI) and Net Primary Production (NPP) taking into consideration land use and land cover change. Using these proxies of land degradation, a quarter of global land surface was found degraded including 18% of cropland and 47% of forest (Bai et al., 2013:378). The major cause of degradation being unsustainable land use and management. Therefore, in reversing land degradation using ecosystem-based approaches, there is a direct relationship between NDVI/NPP through the use of sustainable land use and management practices and land improvement (the opposite of land degradation). Reed et al. (2015) fuses land degradation, ecosystems services, sustainable livelihoods and sustainable land management. It is reproduced that land degradation undermines livelihoods as it reduces the provision of ecosystem services from land. Much emphasis is placed on natural capital of the ecosystem and its proper valuation in order to use the same to replace the loss of ecosystem services to prevent land degradation. Land degradation has an inverse relationship with ecosystem services (Cerretelli et al., 2018). The two move in opposite directions as land degradation degrades ecosystem services and land improvement enhances ecosystem services. Hence, investment in land degradation neutrality is capable of reducing land degradation and ensuring improvement in ecosystem services (Willemen et al., 2018).

Land degradation is conceived of in pejorative sense (Gisladottir and Stocking, 2005). It is defined by expressing negative connotations of degraded lands. Hence, words such as loss, decline, decrease or reduction are used to reinforce the notion of degradation. The object to be destroyed within the land is its productivity as well as its ecosystem functions, goods and services. In this context, land refers to the amalgamation of soil, water, vegetation, rocks, air, climate and relief or simply, terrestrial ecosystem (Stocking and Murnaghan, 2001; Safriel, 2007). Therefore, land degradation means loss or reduction in land productivity (often, biological and economic productivity are emphasised) or, loss or reduction in ecosystem functions, goods and services over time, space, usage, causes, impacts and responses (with concerns on social, physical, chemical, magnitude and scale; as well as reliability and relevance of data) (Millennium Ecosystem Assessment, 2005; Gyasi et al., 2006; Bai et al., 2008; LADA, 2011; UNCCD, 2012). Recent studies blame unsustainable land use and management as the main causes and define land degradation as mismatch between land quality and land use (Bai et al., 2013; Mahala, 2018).

This study contributes to the current debate on land degradation. Most of such debates rest on responses to remedying land degradation by the United Nations Convention to Combat Desertification (UNCCD). So far it is argued that UNCCD has failed to stem land degradation since its inception in 1997, hence, the need for Sustainable Development Goal (SDG) 15 (Bai et al., 2008; Bai et al., 2013; Safriel, 2017). The SDG 15 states that "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss". Inherent in SDG 15 is the assertion that due to continuous use of land, some land degradation is unavoidable. Therefore, the ongoing land degradation should be off-set by a similar restoration of degraded land such that ongoing land degradation minus restoration of degraded land will be equal to zero. In this case, we will not add to degraded land because of zero land degradation and the already existing degraded areas will be restored by actions engineered by UNCCD. This paper argues that land degradation is with us and it is consequential to engendering global response through SDG 15 specifically target 'C', which states that "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world". However, the achievement of this target will happen at fine scale at various local communities and farms. Hence, the contribution of smallholder farmers to the attainment of SDG 15 C is very prominent. To do this effectively, ecosystem-based approaches are required.

The study district is one of the worst land degraded districts in Ghana (Agyemang et al., 2007). Accordingly, the significance of this paper lies in the use of ecosystem-based approaches to remedy land degradation. Specifically, the paper makes contributions in documenting and analysing farmers' actions by their use of ecosystem-based approaches to restore degraded land and prevent further degradation of already fertile lands. The aim of this study was to identify the indicators of land degradation and the associated ecosystem-based approaches used to remedy the situation. The specific objectives of the study were to identify farmers' indicators of land degradation; to assess the effectiveness of adopted ecosystem-based approaches to stem the land degradation; and, to examine the challenges farmers faced in using the ecosystem-based approaches. The ecosystem-based approaches are often linked to climate change impacts. Their use in land degradation is equally appropriate as demonstrated in this study.

The study builds on the theory of ecosystem-based approaches which is an area-based conservation of land with the attendant benefits equal to that of land improvement, land restoration and sustainable land management. This theory is founded on ecosystem approach. According to the Convention on Biological Diversity (CBD) the ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way (Sandra et al., 2011). Every ecosystem is made up of living and non-living things. Ecosystems are derived from the biosphere (the home of all living things). The biosphere is made up of a number of biomes. The subdivisions of biomes are a number of ecosystems. Every ecosystem consists of a number of communities which are further divided into populations and individual organisms (species). The living part of the ecosystem is biotic subsystem and the non-living part is abiotic subsystem. The biotic subsystem contains plants (producers), animals (consumers) and decomposers (fungi, bacteria, etc.). The abiotic subsystem is made up of gaseous cycle, water cycle, minerals cycle, sun and artificials (non-living things). Every ecosystem produces goods and services (benefits). The ecosystem services are divided into four: supporting, provisioning, regulating and cultural services (Millennium Ecosystem Assessment, 2005). Therefore, ecosystem-based approach equals to ecosystem plus ecosystem services. Ecosystem-based approaches are influenced by a number of factors such as resilience, multiple spatial scale, multiple sectors, flexible management, minimization of trade-offs, maximization of benefits, participation, transparency, accountability, culture, gender sensitivity and scientific knowledge. However, in the natural ecosystem there is no waste.

Methodology

This section combines description of the study area and methods of study. The focus is Nabdham District of the Upper East Region in Ghana, which lies between latitudes 10° 47" and 10°57" North and longitudes 0°31" and 1°15" West (Figure 1). It has a total land area of 244.94km² (GSS, 2014). The relief of Nabdham District shows the dominance of relatively undulating lowlands, gentle slopes and some isolated rock outcrops with steep slopes (GSS, 2014). The climate is Aw of the Koppen classification, locally called tropical continental climate. It receives rainfall in May to October with annual rate of 1000 to 1150 mm with relative humidity between 70% and 90%, but

during the dry season, relative humidity goes down to 20%. Temperature ranges between 27°C to 36°C on the average but afternoon temperature could reach up to 40°C. The vegetation is Sudan savannah with few trees which are generally short, sparsely populated, drought and fire resistance, and deciduous in nature. A ground flora of grass is sparse with lots of bare grounds which are severely eroded. Due to dry season burning which has become an annual ritual, rejuvenation of vegetation is extremely difficult and promoting bare land and land degradation (GSS, 2014).

The study adopted a descriptive research design blending quantitative and qualitative approaches. Primary data were collected from smallholder farmers and key informants such as

EPA, Forestry Commission, Lasjoe Consult and leaders of farmer groups in the selected communities. The researchers visited the study communities and made contact with key informants of the study and observed the community entry protocol. In addition, three research assistants, one from each community, were selected to help in data collection. The smallholder farmers' questionnaire was administered to the selected smallholder farmers in the study communities. This was based on the indicators of land degradation, the ecosystem-based adaptive practices of farmers to control land degradation, effectiveness of ecosystem-based approaches and the challenges of ecosystem-based approaches.

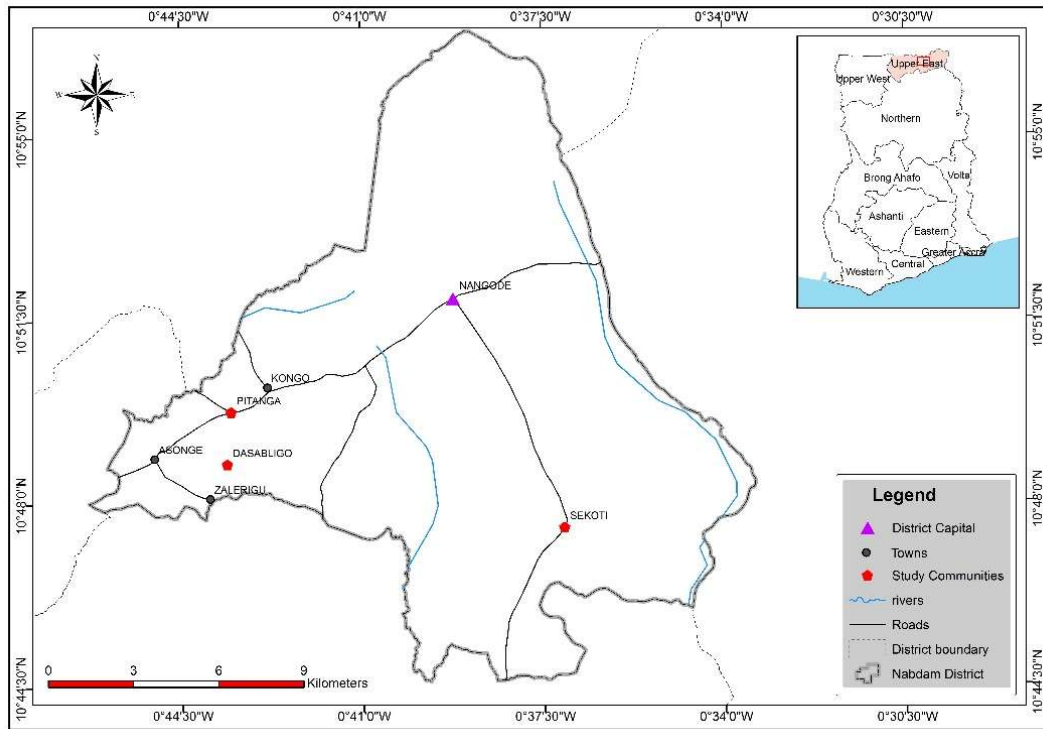


Figure 1: Map of Nabdam District.
Source: Reproduced with data from GSS-GIS (2017).

The sample size of smallholder farmers was calculated using the formula: $n = \frac{N}{1+N(e)^2}$, where, n = sample size, N = sample frame and e = level of precision (5%) (confidence level of 95%), $N = 576$ farmers: $n = 576 / (1+576(0.05)^2)$, $n = 576/2.44$, $n = 236.06$. The sample size was therefore approximately 236 smallholder farmers, to whom the questionnaires were administered. Furthermore, proportionate samples were selected from the study communities using the formula:

$$C_p = \frac{\text{Number of smallholder crop farmers in a community}}{\text{Total number of smallholder crop farmers}} \times n$$

where C_p refers to community proportion and 'n' refers to sample size.

Table 1 shows the samples drawn from each community. Data from the questionnaire were analysed using SPSS version 20 employing central tendencies and descriptive statistics particularly cross-tabulations and chi-square test. The results were triangulated with qualitative results and direct

quotations were used to substantiate the quantitative results.

Table 1. Sample size from the study communities.

Selected communities	Number of smallholder farmers	Sample size
Dasabligo	184	75
Pitanga	136	56
Sakoti	256	105
Totals	576	236

Results and Discussion

The study results are produced from descriptive statistics using cross-tabulation and chi-square test. The alpha value adopted is 0.05. Subdivisions of this section include farmers' knowledge of indicators of land degradation, ecosystem-based approaches to remedy land degradation and the challenges thereof.

Farmers' knowledge of indicators of land degradation

Smallholder farmers perceive the following features of the ecosystem of the Nabdum District to indicate land degradation as well as display effects of land degradation on food crop farming. They include reduced crop yield 53% (125 respondents), loss of soil nutrients 24.6% (58 respondents), hardened land 8.1% (19 respondents), pits and gullies created by erosion 5.5% (13 respondents), water logging 4.7% (11 respondents), floods 3% (7 respondents) and increased cultivation cost 1.3% (3 respondents). Also, Mahala (2018) reproduced the causes of land degradation mainly as physical factors aggravated by human interventions. In arid and semi-arid regions where slopes are involved water erosion is related to degraded land. It came out of the FGD at Pitanga that:

I am aware that rainfall, the soil and topography of our area are some of the features that cause land degradation. The sloppy nature of the land makes our farm lands prone to erosion leading to land degradation whiles sometimes the rainfall is also very intense in short periods washing away the top soil on our farms. Knowing this actually influenced my adaptation attempts to land degradation.

With a p-value = 0.816 which is greater than the alpha value of 0.05, implies that farmer perception on indicators of land degradation is independent of farmer's level of education. Also, gender relations with farmer perception on indicators of land

degradation produced p-value of 0.524 which indicates no significant relationship. Also, a p-value of 0.341 for communities and farmer perception on indicators of land degradation, implies no significant association. However, age and farmer perception on the indicators of land degradation are not independent with a p-value of 0.001. Farmers catalogue three main causes of land degradation as the relief of the land, nature of the soil and topography 45% (106 respondents), wind 33% (78 respondents) and rainfall 22% (52 respondents). The results show that farmers attribute land degradation to natural causes rather than human-induced. The perceived land degradation has affected food crop farming adversely. The results of FGD at Sakoti shows that:

Land degradation is a serious issue affecting our crop farming as the land is prone to erosion causing loss of soil nutrients and ultimately results in a decline in the yield levels of our crops. This affects us in a lot of ways because farming is the major source of livelihood for a majority of us in this community.

However, with a p-value of 0.345 the relationship between study communities and the effects of land degradation are independent. The land degradation effects on food crop farming does not show statistically significant relationship with gender of respondents (p-value = 0.543).

Ecosystem-based approaches to remedy land degradation

Smallholder farmers employed four main measures to remedy land degradation. The main measure reported by the majority of farmer respondents is chemical in nature which is composting 53% (125 respondents). It is a natural way of producing fertilizer organically to replenish degraded soil. It is followed by a mechanical or physical strategy of stone bonding 36.4% (86 respondents). Stones of varying sizes are lined across rills and gullies in the farm to reduce the speed of running water, trap some eroded soil and retain water in the soil. A biological or an agronomic strategy of crop rotation is reported by 8.9% (21 respondents). Farmers alternate the growing of food crops on the same piece of land. The demand for soil nutrients from the land is different by various crops. Beans and groundnuts fix atmospheric nitrogen in the soil for their use and thereby increase soil nitrogen for the use of the next crop in the rotation. Another mechanical strategy of mulching is used mainly by yam (*Descorea spp.*) farmers to prevent evaporation and retain soil moisture in the yam mounds as reported by 1.7% (4 respondents). The FGD at Sakoti revealed that: *I practice composting to help improve the soil fertility on my farm.*

Composting helps increase the organic matter in the soil on my farm which has been affected by soil erosion. Also, the mulching prevents the sun's rays from reaching the yam seeds in the mounds. Table 2 shows that the ecosystem-based approaches are statistically linked to the communities with p-value of 0.020. Table 3 indicates that ecosystem-based approaches and gender of respondents are statistically related with a p-value of 0.014. This

conforms to the assertion that crop rotation has the ability to build fertile soils (Mohler and Johnson, 2009). A majority of farmers (50% or 118 respondents) has practiced these strategies for more than 5 years, 42.4% (100 respondents) has done so for 2 to 5 years and the remaining 7.6% (18 respondents) has used the strategies for about one year.

Table 2. Cross tabulation of reported ecosystem-based approaches and study communities.

Ecosystem-based approaches	Community			Total
	Pitanga	Dasabligo	Sakoti	
Stone bonding	19 (25%)	58 (46.4%)	9 (25.7%)	86 (36.4%)
Composting	47 (37.6%)	57 (45.6%)	21 (16.8%)	125 (53.0%)
Crop rotation	7 (9.2%)	9 (7.2%)	5 (14.3%)	21 (8.9%)
Mulching	3 (3.9%)	1(0.8%)	4 (1.7%)	4 (1.7%)
Total	76 (32.2%)	125 (53.0%)	35 (14.8%)	236 (100%)

p value = 0.020.

Table 3. Cross tabulation of ecosystem-based approaches and gender of respondents.

Ecosystem-based approaches	Gender		Total
	Male	Female	
Stone bonding	65 (32.3%)	21 (60.0%)	86 (36.4%)
Composting	114 (56.7%)	11 (31.4%)	125 (53.0%)
Crop rotation	18 (9.0%)	3 (8.6%)	21 (8.9%)
Mulching	4 (2.0%)	0 (0.0%)	4 (1.7%)
Total	201 (85.2%)	35 (14.8%)	236 (100%)

p value = 0.014.

The age of respondents and the length of time they have practiced the ecosystem-based approaches were statistically significant at p-value of 0.008. The FGD at Pitanga showed that:

In this area mostly it is the youth who have been practicing ecosystem-based approaches for a long time the older people are not so much into the practice of ecosystem-based approaches because some of the practices require a lot of labour and energy for their establishment which the older farmers cannot meet.

However, results on the four strategies and the number of years the strategies have been practiced are not statistically associated at p-value of 0.658. Indicators of effectiveness of the ecosystem-based approaches for smallholder farmers include improves crop yield levels 46.6% (109 respondents), maintains soil moisture and improves water filtration 25.6% (60 respondents), enhances resilience against erosion 15.3% (36 respondents), improves soil fertility and formation 10.3% (24 respondents) and cost effective 2.1% (5 respondents) as shown in Table 4. A cross

tabulation with educational level of respondents shows no significant association between educational level of respondents and the perceived effectiveness of ecosystem-based approaches as indicated by p-value of 0.072. A staff of Lasjoe Consult indicated that:

From our experience here so far ecosystem-based approaches are helping farmers improve degraded lands and also prevent further degradation of the land through practices such as composting that improve upon the fertility levels of the land and stone bonding which prevents soil erosion.

Farmer respondents consider the ecosystem-based approaches as beneficial to farming. A p-value of 0.001 shows that the ecosystem-based approaches are beneficial in the various study communities.

Challenges

In spite of the benefits of ecosystem-based approaches in the study communities, the practices are faced with the following challenges. About 44.1% (104 respondents) reported inadequate

labour, 28% (66 respondents) reported lack of finance, 16.9% (40 respondents) reported lack of knowledge or information and 11% (26 respondents) reported limited or nonexistence of technical assistance. With the Pearson chi-square value of 69.188, degree of freedom of 6 and p-value of 0.000, challenges of ecosystem-based approaches in the study communities are statistically significantly related (Table 5). Quatrini and Crossman (2018) contend that land degradation neutrality should engender co-benefits or synergies with ecosystem services in order to make both worth financial investment. Empirical evidence from southern Africa shows that investment in land degradation neutrality actually leads to enhancement in ecosystem services provisioning (Willemsen et al., 2018). From a FGD at Pitanga it came out that: *I wish to practice*

composting on my bush farm but because of the labour required to carry the compost to my bush farm which I cannot afford, I only practice it on my backyard garden. This revelation agrees with Vignola et al. (2015) that ecosystem-based approaches are often hindered by some key limitations particularly in developing countries. For instance, the use of cover crops has long term benefits but requires significant labour investments in the short term which can hinder its implementation. In most developing countries and as found in this study, the scale and size of the ecosystem-based approaches confine the benefits to fine scale or small areas. The hope lies in the number of farmers implementing the ecosystem-based approaches to stem land degradation. Large numbers mean that the cumulative scale and size could increase.

Table 4. Cross tabulation of ecosystem-based approaches and study communities.

Ecosystem-based approaches	Community			Total
	Pitanga	Dasabligo	Sakoti	
Improves crop yield levels	34 (44.7%)	58 (46.8%)	17 (50.0%)	109 (46.6%)
Maintains soil moisture and improves water filtration	17 (22.4%)	35 (28.2%)	8 (23.5%)	60 (25.6%)
Enhances resilience against erosion	5 (6.6%)	22 (17.7%)	9 (26.5%)	36 (15.4%)
Cost effective	3 (3.9%)	2 (1.6%)	0 (0.0%)	5 (2.1%)
Improves soil fertility and formation	17 (22.4%)	7 (5.6%)	0 (0.0%)	24 (10.3%)
Total	76 (32.5%)	124 (53.0%)	34 (14.5%)	234 (100%)

p value = 0.001.

Table 5. Cross tabulation of challenges facing ecosystem-based approaches in the communities.

Ecosystem-based approaches	Community			Total
	Pitanga	Dasabligo	Sakoti	
Inadequate labour	38 (50.0%)	65 (52.4%)	1 (2.9%)	104 (44.4%)
Lack of knowledge/information	12 (15.8%)	14 (11.3%)	14 (41.2%)	40 (17.1%)
Lack of finance	26 (34.2%)	33 (26.6%)	5 (14.7%)	64 (27.4%)
Limited or in-existent technical assistance	0 (0.0%)	12 (9.7%)	14 (41.2%)	26 (11.1%)
Total	76 (32.5%)	124 (53.0%)	34 (14.5%)	234 (100%)

p value = 0.000.

Conclusion and Recommendations

With the identification of indicators of land degradation, smallholder farmers often define land degradation with relation to the adverse effects on crop yield or production. Majority of farmer respondents (53%) pinpointed on reduced crop yield. Although, the attribution factors are varied farmers have been right in zeroing in on land

degradation. Hence, national policy on food security, particularly, the policy with twin objectives of planting for food and jobs should consider long term environmental sustainability. In the short term the provision of agrochemicals including chemical fertilizers has raised crop yields. However, without ecosystem-based approaches long term goals of sustainable land improvement may not be realized unless there is

direct policy to take care of the approaches even in the short term.

Farmers absorbed themselves from blame for causing land degradation (human-induced). Rather, the three causes reported are natural causes of land degradation as relief (soil and topography) 45%, wind 33% and rainfall 22%. The relief makes the land prone to degradation agents such as wind and water erosion. Human beings (farmers) are seen as land improvers rather than degraders. Farmers do not misuse land rather through ecosystem-based approaches such as stone bonding, crop rotation, mulching and particularly, composting (53%) land is sustainably managed. Therefore, government's decision making regarding policy should concentrate on up scaling composting using biodegradable waste from the larger society. If the quantity of compost is increased, bush farms located far from the compound homes could benefit from ecosystem-based approaches. The ecosystem-based approaches are gender based activities as shown by a statistical relationship of 0.014. Composting is male based (56.7%) and stone bonding is female based with 60%. Hence, provision of materials towards stemming water erosion in the farms will benefit a lot more women than men just as composting is the opposite.

Majority of farmers (50%) have practiced the ecosystem-based approaches for more than five years. Farmers' experience over the five years is statistically related to the age of respondents ($p = 0.008$). The ecosystem-based approaches appear to be sustainable considering the involvement of the youth in the practices. Policy should concentrate on up scaling the co-benefits both in the short and long term. If this happens, the youth would be encouraged to continue with the practices.

The ecosystem-based approaches are perceived as beneficial in the study communities and this is statistically significant ($p = 0.001$). Farmers enjoy improvement in crop yield levels 46.6%, maintenance of soil moisture, improvement in water infiltration and resilience against erosion. The practices are cost effective. For policy purpose, equal attention should be given to all the benefits even though the main aim of crop farming is to increase crop yield or production. However, this objective is supported by soil maintenance and cost effectiveness of doing farming.

With the benefits of ecosystem-based approaches notwithstanding, policy should take care of availability of hired labour to support aged farmers, government investments in ecosystem-based approaches and provision of technical or knowledge support systems. The p-value of 0.000 indicates very strong statistical significance of the challenges of ecosystem-based approaches in the

communities. Hence, policy to address the challenges is warranted.

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