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INTEGRATING SUSTAINABLE LAND MANAGEMENT FOR POST-CONFLICT ECONOMIC RECOVERY

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ABSTRACT

The United Nations estimates that approximately 100 violent conflicts have come to an end across the world. The economic challenges faced by post-conflict countries are way severe than those faced by poor but peaceful developing countries. They include degradation of land, destroyed human and social capital, access denial for livelihood area due to landmines, loss of income and widespread poverty. These conditions cause land uneconomical with gradual loss of fertility due to reduction in nutrient levels. Therefore, economic policy priorities for post-conflict countries should take these differences into account. If sustainable land management (SLM) is neglected or not properly addressed, further land degradation will occur. This paper reflects on the gaps of rebuilding livelihood and economic recovery in a selected post-conflict destination in Sri Lanka and offers a practical and cost-effective approach to secure a more stable future. In Northern Sri Lanka, through interviews and observations we found that livelihood has started in post clearance land following a longstanding ethnic war. The current land use trends are influenced by immediate commercial motives and SLM is overlooked which continues damage to the land. The study suggests a framework to integrate SLM for post-conflict economic recovery.

Contribution/ Originality: This study is one of very few studies which have investigated best possible means to rebuild economic recovery integrating sustainable land management in post-conflict settings subsequent to humanitarian demining activities. This study uses a qualitative approach to help the policy makers in finding the determinants to increase land productivity.

1. INTRODUCTION

For governments, policy makers and residents, post-conflict situations constitute one of the toughest policy arenas to understand, operate and live within. Developing a strategic action plan for land use and management in post-conflict societies is extremely difficult. Augustinus and Barry (2006) argue that conventional conceptual frameworks cannot be used for strategic action planning in post-conflict environments, to do so might prove inefficient. The authors confirmed based on studies undertaken in Afghanistan, South Africa, Somalia, Mozambique, Uganda and Kosovo (Augustinus and Barry, 2006).

Awareness of the importance of residential and cultivation land, property issues in post-conflict contexts has received increasing scholarly attention over the past 15 years. Many studies have been focused on the correlation between conflict and land and the effects of their mutual impacts before, during and after the conflict (FAO, 2005; UN-HABITAT, 2007; Pantuliano, 2009; EU-UN, 2012; Williams, 2013). With the recognition of the important role that land plays in conflict and post-conflict contexts, the paper examines the interventions of land use and management in conflict affected areas in Northern Sri Lanka.

From a global perspective, the United Nations Convention on Combating Desertification (Stringer *et al*., 2009) deals with the threats, yet acknowledges that they require local-scale solutions by local communities, civil society organizations, scientists and the private sector in efforts to move towards land degradation neutrality. There is increased recognition that both the public and the private sectors need to work together with land users to bring transformation in land use and management to restore the land. The most promising response to emerge in the last two decades is the concept of Sustainable Land Management (SLM), which addresses technical and environmental aspects as well as socio-economic dimensions (Schwilch *et al*., 2012). Sustainable Land Management (SLM) can be referred to 'optimal use of land resources for the benefit of present and future generations' (Davies *et al*., 2015). Sustainable Land Management is a knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising food and fiber demands while sustaining ecosystem services and livelihoods (Smyth and Dumanski, 1993).

Many books and scholarly articles have provided numerous recommendations and possible approaches to upscale SLM in lands subjected to erosion, depletion of minerals, salinity and pollution, also loss of biodiversity or deteriorated landscape. While all are useful and cover many key aspects, there is an apparent lack of a practical, structured methodology for fostering SLM in diverse contexts (Schwilch *et al*., 2012) for instance, lands which have been subjected to armed conflicts are overlooked in terms of its potential to transform land quality towards a more sustainable trajectory. The dominance of people who live in war torn areas means that they should be responsible in the maintenance of land quality into the future, especially as land is affected by habitat destruction, pollution, loss of biodiversity and general over-exploitation and degradation of natural resources throughout explosions.

Most importantly, in the precise case under review of this paper, the communities have experienced a thirty-year civil war between Sri Lankan government and the Tamil secessionists, SLM could have been a major modernizing factor to be considered under the post-conflict development strategy. The Government of Sri Lanka reports that 280,000 population was displaced and almost all the housing units were destroyed or left uninhabitable as a consequence of the conflict (National Mine Action Centre NMAC, 2016). The resettlement commenced from year 2010 when the landmine clearance in residential areas were completed. Agriculture remains the basis of the northern economy, with crops, livestock and fisheries as pivotal sub-sectors. The returnees who resettled had to live with food aid for more than six months until the mine clearance was completed in their farmlands and related livelihood areas. The demining activities are still being carried out in livelihood areas and forests while the Sri Lankan government aims a 'mine free country by the end of year 2020'.

To better understand the interventions of land use in post-conflict contexts, a qualitative research approach (informal interviews and focus group interviews) was applied to our case –Mullaitivu District, where final phase of war took place in Sri Lanka. Primary data were collected with relevant local population involved in farming and secondary data were collected from various organisations dealing with agriculture. A comprehensive literature review complements this research.

When it comes to the utilization of agricultural land for any development concerns, not only the economic objectives of land of those community, measures should be taken to reduce the environmental impact and protect natural resources, since the out-break of the conflict ignited from the misunderstandings themselves. In the context of sustainable land management, this study focuses on how to increase land productivity in areas where humanitarian demining operations have been conducted. SLM means technologies which farmers implement in their fields to boost crop yields.

According to the survey findings, strategies undertaken by farmers in Mullaitivu to combat land degradation include: tree planting; cut-off drains; application of livestock manure; application of good agricultural husbandry (use of high quality seeds, following advice from the agriculture extension services); mulching; crop rotation; use of compost; livestock keeping (a source of manure); and use of fertilizer (for good crop cover and yields). Typically, these measures have been used many years ago or before the war. However, only five percent of farmers in the survey adopts such SLM technologies.

The study reveals that tremendous benefits have been derived from the use of exponential trends of conventional farming as people returned to their areas of origin. This includes use of synthetic chemicals and fertilizers to maximize the yield of a particular crop or set of crops, which are genetically modified. Soon after the resettlement, people found conventional farming is the most practical solution to recover from the lost economy during the war time. This has been achieved through the application of synthetic chemicals, genetically modified organisms, and a number of other industrial products. Nonetheless, the farmers have experienced a reduction of anticipated crop yields over the past three years because the soils were exhausted of nutrients. The situation worsened when the entire Northern Province have been hit by a prolonged drought, the worst in recent times, causing an acute water shortage. The prolonged drought hit since mid-2014 where famers undergone crop damage due to adverse weather conditions and lack of access to clean drinking water. According to the Department of Agriculture, Sri Lanka's main Maha season paddy output has already plunged 49 percent to an estimated 1.478 million tons, down from Year 2016 record 2.9 million tons due to the low water levels for rice growing this year.

World Health Organization WHO (2016) has identified that agrochemicals are a potential risk factor for kidney disease epidemic, based on the information on nephrotoxicity of various agrochemicals including such as glyphosate, propanil, chlorpyrifos, diazinon, carbofuran, profenofos, carbosulfan, carbaryl, etc. and the potential contaminants in agrochemicals such as cadmium and arsenic deposited in animals and humans at high doses. We found that 43% of the respondents are having kidney disease.

We examine how SLM can be integrated and scaled up in the target area. Scaling up generally focuses on expanding, replicating, adapting and informing policies, programs or projects in geographic space and over time to reach a greater number of people. Institutional changes – both within public and private sector as well as initiated by policy makers – are needed to create an enabling environment that can promote scaling out via the adoption of SLM practices from farmer to farmer, and community to community.

In what follows, started Section 2 with methodology. Section 3 provides an overview of key elements of increased land productivity through SLM policies and practices are adopted institutionally and on the ground were identified from the literature. Section 4 presents the gaps of SLM based on the current land use and management systems through survey and focus group interviews. Incentives for organic farming are proposed and how it is useful to restore land is explained in Section 5. Finally, the paper presents a practical framework for increasing land productivity to reverse land degradation and help post conflict economic recovery and promote sustainable land management. Section 6 concludes.

2. MATERIAL AND METHODS

2.1. Description of the Study Area

The study was carried out in Mullaitivu District in Northern Province of Sri Lanka, an area about the size of 2516.9km2 (251,690 ha), 3.8% of the country. This district reported the highest affected area due to intense fighting and massive contamination of landmines and ERW. While mine clearance is ongoing, as at 15 June 2017, Regional Mine Action Officer of Northern Province reports a total of 269,762 landmines and ERW were recovered from this district and approximately 253 km2 of contaminated area has been cleared and released for resettlement. The mine clearance is still going on in close proximity to livelihood areas in some parts of this district. Therefore, the study results can be generalized for any post conflict setting as the extreme case has been considered in this research.

As of end 2014, total population of the district was 41,465 families which sums up to 130,332 people. The livelihood is based on agriculture, fishing, livestock, industrial activities, government and private establishments. The estimates based on the Household Income and Expenditure Survey (HIES) conducted by the Census and Statistics Department of Sri Lanka, Mullaitivu district has the highest incidence of poverty in Sri Lanka. Therefore, SLM implications particularly in this district will be beneficial for the residents to uplift economy plus the impact of SLM integration will be evident and be simply measurable for future studies.

2.2. Data Collection Methods

This study employed multiple-methods to provide a room for complementarity and confirmation of the data collected through various modes. Primarily, the information was based on a review of existing literature and relevant progress reports collected at the local agricultural offices, Kachcheri and agrarian sector institutions include those who are with direct involvement in agriculture advise and support and semi-structured interviews were conducted with officers of those institutions. Focus group discussions held with local community (farmers and home gardeners). In addition, field observations whereby through casual walks allowed to witness the field reality in terms of land use status thereof and actions taking place in relation to data gathered. The researchers spent a total of 38 days during August and September, 2017 on-site at Ananthapuram Iranaipalai, Kombavil, Malligaitheevu, Puthukkudiyiruppu West, Theravil, Ampelavanpokkanai, Mulliyawelei North, Mullivaikkal West, Vattapalai villages in Puthukudiyerippu and Maritimepattu divisional secretariats in Mullaitivu district.

2.3. Data Analysis

Data collected through informal interviews, focus group discussion and casual walks in the field were analyzed thematically through content analysis technique. The descriptive analysis of data helped to capture the demographics of the people involved in the study, their selected farming methods, the fertilizer and machinery they use for farming.

3. INCREASED LAND PRODUCTIVITY

Sustainable Land Management is a widely acknowledged concept to combat environmental threats, especially land degradation and desertification, climate change, biodiversity loss, and food insecurity (Schwilch *et al.*, 2012). Given the benefits of SLM from studies reported empirical results from implementation at farm level of the SLM technologies in developing countries (Carter, 2002; Gabathuler *et al.*, 2009; Milne *et al.*, 2010; Zimmer *et al.*, 2017; Bloomfield *et al.*, 2018) we recognized the importance of SLM application in post-conflict areas. Also, transformations to increase the productive capacity and stability of smallholder agricultural production are urgently needed due to the drastic impact of war on land plus consequent poor land use over the past few years. In this section, we summarize findings from a global literature review of the positive change on agriculture production when adopted wide range of SLM practices.

In order to increase production from the land, water use efficiency and productivity need to be improved (Jiang *et al.*, 2017). This can be achieved by reducing high water loss through runoff and unperceived evaporation from unprotected soil, harvesting water, improving infiltration, maximising water storage - as well as by upgrading irrigation and managing surplus water.

3.1. Agronomy

Agronomy enhances soil quality and biodiversity, reduce erosion, and increase biomass production (Branca *et al.*, 2013). A healthy soil can be considered with life of animals living in the soil. The activity of these animals has a strong influence on the soil's physical and biological qualities especially with regards to its structure, water infiltration and nutrient cycling (Branca *et al.*, 2013). Crop rotations and intercropping with nitrogen-fixing crops enhance biodiversity, the quality of residue input and the soil organic carbon pool. Cover crops should be grown in addition to plants in the field, or crops intercropped with the main crop. Cover crops help reduce soil erosion nutrient leaching and grain losses due to pest attacks and build soil organic matter and improve the water balance, leading to higher yields (Kong *et al.*, 2005). Based on 208 projects conducted between 1998 to 2001, Pretty and Hine (2001) found that farmers who adopted mucuna cover cropping benefited from higher yields of maize with less labour input for weeding (maize following mucuna yields 3–4 t/ha without application of nitrogen fertilizer, similar to yields normally obtained with recommended levels of fertilization at 130 kg N/ha).

Crop rotations and intercropping with nitrogen-fixing crops, such as groundnuts, beans, and cowpeas will enhance soil fertility and enrich nutrient supply to subsequent crops, boosting crop yields (Woodfine, 2009). An example brought forward by Branca *et al.* (2013) in the North Rift and western regions of Kenya maize yields increased by 71 % and bean yields by 158%. During a growing season of crop, fallow is practiced allowing crop land to lie idle to build up the soil moisture and fertility content. Improved fallows generally mean the deliberate planting of fast-growing species—usually legumes—that produce easily decomposable biomass and replenish soil fertility (Gathumbi *et al.*, 2002). Increased crop yields after fallow and improved fallow periods have been widely reported.

3.2. Organic Fertilization

Worldwide, adopting organic fertilization (compost, animal, and green manure) is proved to have positive effects on the yields. Soils with low-input and continuous agricultural practices are vulnerable to soil organic content which can be improved using organic fertilizer and strengthening nutrient recycling mechanisms (Yang *et al.*, 2012). Manure management can improve soil fertility and enhance carbon storage by increasing biomass and improving soil equilibrium. The use of organic manure and compost enhances the soil quality more than application of the same amount of nutrients as synthetic fertilizers (Mazancová *et al.*, 2017).

For example, Parrott and Marsden (2002) showed that in Senagal millet yields increased by 75-195 % (from 0.3 to 0.6–1 t/ha) and groundnut by 100–200 % (from 0.3 to 0.6–0.9 t/ha) in 2001. In North China, Xin *et al.* (2017) highlighted the Phosphorous use efficiency and the benefits of soil fertility, replacing less than half the chemical fertilizer with organic fertilizer a promising alternative. A pot experiment was conducted to evaluate the growth and metal accumulation in water spinach by Kamari *et al.* (2014) found that chicken manure and coconut tree sawdust are two promising agents for immobilizing heavy metals in contaminated land.

A two-year research conducted by Arif *et al.* (2017) found that biofertilizer application resulted in significantly higher seed oil concentration, fatty acid composition, and harvest index in both cropping years 2014-2015 in comparison to chemical N fertilizer. McCray *et al.* (2017) conducted an experiment to see how the interaction of organic amendments and fertilizer N influences sugarcane yields in Southern Florida. The results founds that compost/sludge application increased cumulative t sucrose ha^{-1} by 36% averaged across N rates. Long *et al.* (2017) compared six organic waste amendments with a mineral fertilizer control to determine effects on soil quality, soil fertility, crop quality, and crop yield in 2013 and 2014. The experiment was laid out in a randomized block design with three crops: sweet corn, butternut squash and potatoes. Amendment with biosolids/yard waste compost, dehydrated restaurant food waste, gelatin manufacturing waste, multisource compost, paper fiber/chicken manure blend, and yard waste compost did not have a negative impact on soil moisture and proved to be used as sources of plant nutrients.

3.3. Minimum Soil Disturbance

Recent literature reviews show reduced disturbances of the soil structures (Büchi *et al.*, 2017; He *et al.*, 2017) ensures higher rates of soil organic carbon accumulation as compared with conventional tillage agriculture and generally improve ecosystem functioning and services. The practice of minimizing soil disturbance is widely outreached in literature and different terminologies are often adopted. The most important aspect of the is the decreased disturbance to the structure of the top soil layers (He *et al.*, 2017). A reduced tillage method of nursery preparation and crop residue management are two essential farm practices: a reduced tillage method of nursery preparation and permanent soil cover through crop residue management. Following Büchi *et al.* (2017) there are many tillage practices involved in plant preparation, for example conventional tillage. Conventional tillage means animal or mechanical mouldboard ploughing.

Minimum tillage practices include zero tillage, zonal tillage, and ridge tillage. Zero tillage has no mechanical intervention to prepare the seedbed, except for the use of narrow holes for seed placement. In zonal tillage systems, the seedbed is divided between seeding zones that are prepared mechanically or by hand-hoe only where seeds will be planted, and zones that are not ploughed. The undisturbed portion is often also mulched. Finally, 'pit plantings', where small holes are dug and seeds deposited, often used in semiarid areas prone to crusting, in order to retain moisture and build soil fertility (Jo and Park, 2017). When the soil is less disturbed it encourages activity of soil fauna, which supports agroecosystem health (Jat *et al.*, 2009).

The remains of crop residues on the soil surface can limit nutrient leaching, increase water retention, protect the soil from excessive water and wind erosion, and improve soil structure and ventilation (Ranaivoson *et al.*, 2017) with the desired effects on crop yields especially where water availability limits production. Rockström *et al.* (2009) reports increased water retention due to minimum tillage practices and mulching in sub-Saharan Africa, based on farm trials conducted between 1999 and 2003. Similar positive effects of minimum tillage practices were reported by Bhatt *et al.* (2004) and Scopel *et al.* (2005) in severely degraded soils in dry sub-humid areas.

3.4. Water Management

Proper water management in drylands are important to maintain biomass production, and increase the soil organic carbon concentration. The soil organic carbon sequestration will be improved by increasing the available water in the root zone. The rain water harvesting and conservation techniques (e.g., runoff collection, microcatchment, bunds, and tied ridge systems) can help store rainwater (Yazar and Ali, 2016) available to crops, which is crucially important for increased agricultural production (Foley *et al.*, 2011).

These techniques helped increase agriculture produce (Karrou *et al.*, 2011) particularly where increased soil moisture is a key constraint. Pretty and Hine (2001) reported that cereal yields increased 100 % in Zimbabwe between 1999 and 2001 in response to water harvesting technologies.

3.5. Agroforestry

Agroforestry means planting trees and bushes to increase the carbon sequestered above ground. Agroforestry helps reduce soil carbon losses stemming from erosion, thus improving the soil's organic condition. Agroforestry includes (e.g., farming with trees on outlines, bush and tree fallows, establishing shelter belts, and buffer strips with woody species) in which trees are deliberately grown with agricultural crops, varying from simple to complex and dense systems. This improves land productivity by providing a favorable microclimate, improved soil structure and organic carbon content, increased infiltration, reduced erosion, and enhanced soil fertility (Ajayi and Catacutan, 2012). A survey conducted by Soto-Pinto *et al.* (2000) between 1996-1999 found that shade-grown coffee production in Mexico had yields 23–38 % higher than conventional production. Use of live fences (e.g., trees and shrubs) is also expected to increase yields.

4. LAND USE MANAGEMENT GAPS IN MULLAITIVU DISTRICT

According to our field study, we identified the following gaps which contribute to further loss of nutrients due to current land use practices in Mullaitivu districts:

Gap 1: Excessive Use of Synthetic Fertilizer in Cultivation

When people returned home after mine clearance their willingness to engage in organic farming has been reduced. This is to rebuild livelihood and earn fast income; farmers might be worried about the risk involved in organic farming including the demand for product, market, and price factors. They are not much concerned about traditional approaches, instead, they give priority to new farming methods such as using synthetic chemical fertilizers, pesticides and herbicides and genetically modified organisms, modern agricultural machines etc. that can boost yield within a short period of time. When the income increased farmers became more engaged in dumping large amounts of chemical fertilizer in cultivation lands. The suspected rise of new diseases risk owing to consumption of agricultural products dependent on chemical fertilizer and pesticides etc., people are in the look out of alternative solutions.

Gap 2: Social and Behavioral Constraints

Unfavorable social and behavioral characteristics among farmers and home gardeners are a major constraint in the efforts to promote SLM approaches. Poverty which has already been perceived as an underlying cause of land degradation in Northern Sri Lanka is long lasting by external and internal forces such as residual risk of demined land, vulnerability to persistent droughts and continuous heat, unskilled human capital due to poor education levels and poor health due to unsafe drinking water. With limited livelihood opportunities, it is difficult for farmers to adopt SLM practices, some of which seem to take long before benefits can be realized.

Gap 3: Illegal Use of Improvised Explosive Devices to Catch Fish

After the resettlement, people chose multiple jobs to make enough feed for their families. Farmers used to work in their cultivation lands in the day-time hours and catch fish in the sea or lagoons in the evenings. In order to increase the catch of fish, many people are using improvised explosive devices (IED) which kills many fishes and other creatures under the sea. This is also an illegal practice that is done by people who believe that this is the best way of catching fish. This illegal activity destroys coral reefs which affects fish breeding places and encounter a seafood shortage. Also, the chemicals used in making IED are dangerous for human health and contaminates water.

Gap 4: Lack of Knowledge about SLM

It was found during the field study that people are not aware of SLM and the importance of SLM integration in fragile settings as post-conflict areas. The land which may have explosive remnants of war (ERW) and metal particles in the ground even after humanitarian demining activities should be treated carefully to reverse land degradation and improve fertility. At institutional level, lack of expertise/knowledge in extension services for land management even at institutional level (Agriculture Department), which can be partly attributed to low investment in training workshops and capacity building from national resources.

The problem is aggravated by lack of awareness and understanding among land users about the environmental impacts of land degradation and its relationship to poverty and decline in family incomes. These problems need to be addressed in future SLM initiatives to realize long term impacts of correct land management. The inherent vulnerability of soils to degradation particularly in war-torn areas also limit the level of application and success of sustainable land management practices, especially because it is time-consuming. It is therefore expedient to have a balance of organic and inorganic farming at the start before switching completely to organic farming.

Gap 5: Negative Perception of Rural Youth in Productive Agriculture

The study found that challenges to access latest information, lack of credit and negative perceptions around farming are the leading reasons why young people are not interested in small-scale farming. Young people choose to work in factories or migrate overseas as unskilled labourers. Agriculture's lack of appeal to young people reflects i) lack of effective public investment in small holder farming and the public infrastructure needed to link to markets; ii) constrained access to land and uncertain access to inputs among young people, including landmines and other ERW in past few decades; and iii) social change resulting from rapid increases in mass education provision but which have often resulted in a perceived decline in the status of agriculture. The government has a key role to play in making agriculture attractive to youth with the corrective measures for a valued sector and farming a worthwhile profession.

5. SLM APPROACH THROUGH ORGANIC FARMING

The study found that organic farming should be the priority to start SLM in post-conflict areas to reverse land degradation, preserve soil fertility, water quality and reduce the overall environmental impact. Current livelihoods should aim at preserving the natural resource base, especially soil and water, relying on minimum artificial inputs in cultivation. A viable approach to address soil decline is combined application of organic resources and mineral fertilizers and then gradually shift to 100% organic fertilizer. Farmers should adopt conservative practices (crop rotation, integrated pest management, natural fertilization methods, minimum tillage, biological control), in farm management. These practices help enhancing soil health and fertility. Literature shows that minimum tillage/no tillage, have demonstrated valuable strategy to reduce soil loss and restore soil fertility. Soil fertility can be improved by adopting appropriate farming practices (e.g., using cover crops, animal manure and ashes, leaving residues in the field).

Pest control can be achieved by using suitable cropping systems, biological control and natural pesticides like neem and garlic plantation. Weed control, in many cases can be managed by crop rotation, seeding timing, mulching and transplanting. Organic farming can address the eroded soil due to major explosions during the war and reduce the acidity of the remaining harmful landmines and other unexploded ordnances hiding in lands. Organic farming can be effective in improving water use efficiency in water scarce regions. Many scholars have proved that, under drought conditions, crops in organically managed systems produce higher yields than conventionally managed crops (Lotter *et al.*, 2003). This advantage can result in organic crops out-yielding conventional crops by 70%–90% under severe drought conditions (Lotter *et al.*, 2003). The main cause for higher yield in organic crops is due to the higher water-holding capacity of the soils under organic management, up to 100% higher in the crop root zone (Lotter *et al.*, 2003).

The work of Gomiero *et al.* (2011) reports that organic agriculture is generally related with an expressive higher level of biological activity, represented by earthworms, bacteria, fungi, and springtails. A long-term experiment by Fließbach *et al.* (2007) states that soil ecological performance was greatly enhanced under organic management. Soil management is reported to affect pest response. Fließbach *et al.* (2007) reports pest desired plants which have been grown with synthetic fertilizer rather than those growing in organically managed soil, and under conventional management natural enemies are also often doing worse probably due to the use of agrochemicals.

However, we observed that that local specificity plays an important role in determining the performance of agri-system: what works for one region may not be for another region or area. For example, in conflict affected areas of Sri Lanka it may be difficult to straightway give up chemical fertilizers without posing a risk to food security. The land users should gradually shift to organic fertilizer and sound techniques should be employed to limit the use of harmful pesticides, prevent soil erosion and protecting biodiversity.

6. PROPOSED FRAMEWORK FOR INCREASED LAND PRODUCTIVITY

The study found that organic farming should be the priority to start SLM in post-conflict areas to reverse land degradation, preserve soil fertility, water quality and reduce the overall environmental impact caused by landmine/ERW contamination.

Dumanski (1994) developed and propagated a framework for the evaluation of SLM that focusses on determining appropriate technologies in the respective land use systems which should be (1) ecologically protective, (2) socially acceptable, (3) economically productive, (4) economically viable, and (5) effective in reducing risk. They explained different value chains including soil and water conservation, land husbandry, and technologies that aim to reduce negative impacts on the land, such as salinity, physical impacts, or other chemical processes. Scientists and policy makers jointly can use the developed framework by Dumanski (1994) to evaluate potentials for enhancing sustainable land management.

In contrary, this paper focuses more on productivity as opposed to research only where the later involve more the researchers and policy makers while productivity involve more on the farmer as related to other key stakeholder including the policy makers and researchers. Hence, we present a general framework how to increase land productivity in complex areas. The development of this framework as illustrated in Figure 1 is based on the results of the literature review and observations of authors and discussions with land users in Mullaitivu district.

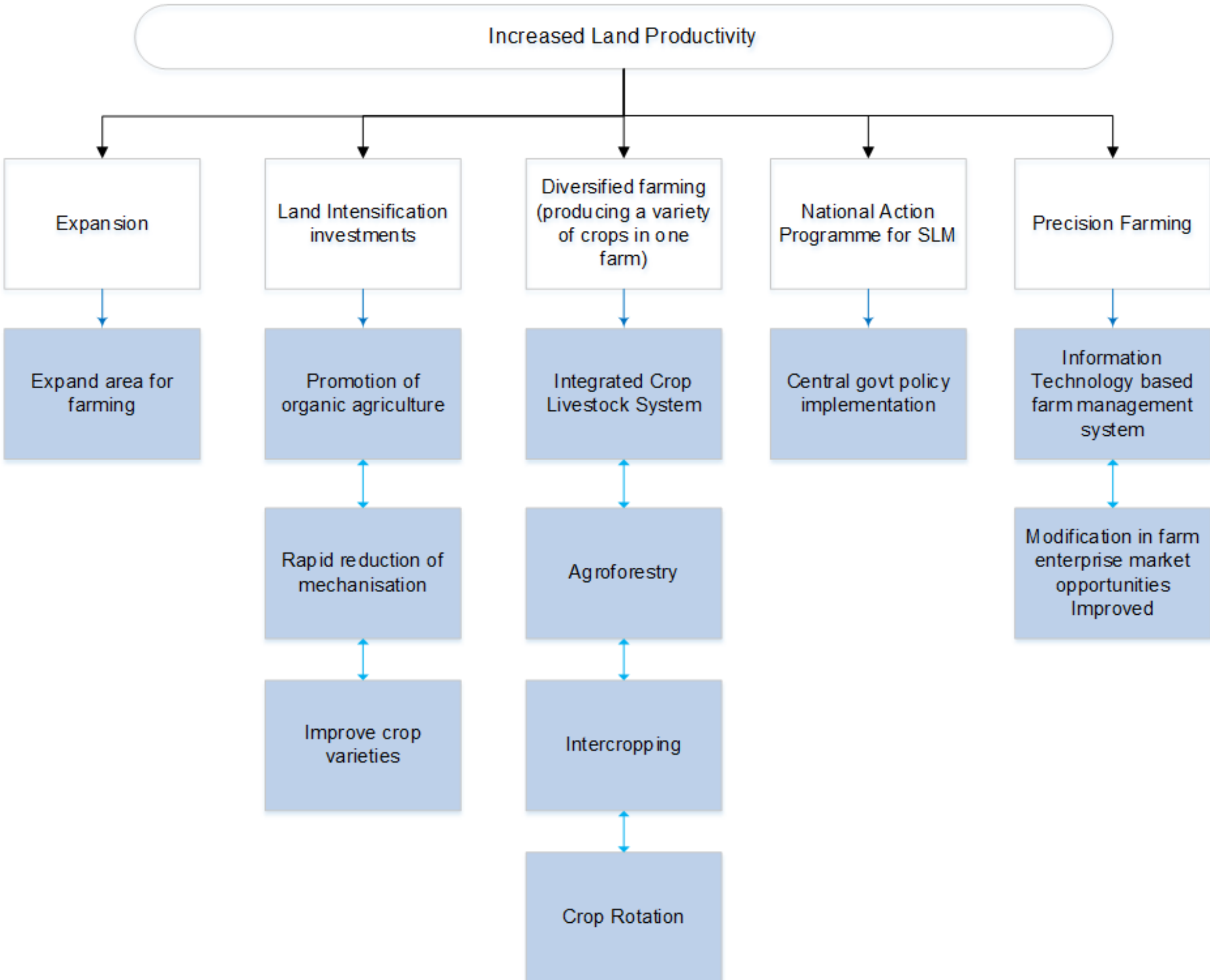

Figure-1. The proposed Framework for increased land productivity

Source: Author created this figure based on the findings of the research

This research proposes the categorization of agricultural activities in the framework to be done into five components by land users and policy makers. The framework also incorporates the technologies, needs and drivers of methods in the SLM domain which are expansion, land intensification investments, diversified farming, national action planning and precision farming.

National action programme will ensure that farmers receive SLM advise for their daily agricultural decision making and share this information with families and friends. The proposed framework provides SLM strategies through an exploitation of both, traditional and new agricultural knowledge that is available in the farming community which this have a significant impact on maximizing yields, reduce costs for fertilizer and reducing efforts for a sustainable rural farming approaches. Relatively, the purchasing price of organic food is increasing in the market. In such a scenario, SLM initiatives will attract the rural youth for farming to earn a better living. The framework enables smart agriculture by providing farmers with necessary information for planning, controlling and managing their farm yield products.

The framework will increase awareness about feasible solution to obtain clean water and prevent future kidney disease in the areas. The framework must be disseminated and explained to the land-users by the Agriculture department officials to farmers and home gardeners. This paper argues that SLM initiatives should be no sooner commenced to save the rest of the post-conflict land which is being further deteriorated by current land use, therefore, SLM is of great importance in situations of land degradation.

7. CONCLUSIONS

Current land use system of post-conflict areas in Sri Lanka exacerbate soil erosion and loss of soil fertility, posing a threat to the long-term sustainability of agriculture, especially under extreme climatic events such as droughts. A behavioral shift is urgently required to improve the overall efficiency of the land use system, in a way that lessens the pressure exercised on the environment and soil. For that we suggest methods to manage land sustainably. People should learn to understand the importance of treating the soil. Social policies (e.g., education and training) should be undertaken in order to introduce and promote SLM. We have mentioned farming techniques that effectively reduce soil erosion, while preserving and enhancing fertility. Reduced tillage and organic farming, along with a shift to perennial crops are providing promising results and should be further explored and researched, particularly concerning weeds and pest control.

To date many studies have proved organic farming to perform better than conventional in improving soil quality both biophysical and biological properties. The SLM, however, has to be addressed from many different perspectives, in a holistic way, and with a long-term perspective in mind. Given the useful role of SLM, our major concern should be to secure that farming practice guarantees the less harm to the soil. More work has to be done to acquire knowledge about the comparative sustainability of different farming systems. Adaptive measures to cope with climate change should treasure knowledge gained from organic and other alternative farming practices. Extensive experimentation should be conducted to gain better understanding of the complex interaction among farming practices, environmental characteristics and agroecosystem resilience.

Eventually land users of post-conflict settings should determine to reconsider their relationship with the land and restructure the agriculture system in view of SLM. That implies to work in parallel on the social, economic and political dimensions of the society.

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