A Study on the Human Dimension of Land Degradation:

The Case of Rain-fed Uplands of the Cascaded Tank-Village System in the Dry Zone of Sri Lanka

土地劣化の人間的側面に関する研究

―スリランカドライゾーンにおけるカスケードタンク灌漑システム後背畑地の事例―

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Sepala Mudiyanselage Chinthaka Bandara Karalliyadda

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

AC	Awareness of Consequences
AMOS	Analysis of Moment Structures
AR	Ascription of Responsibility
AT	Attitude
AVE	Average Variance Extracted
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CR	Construct/ Composite Reliability
CTVS	Cascaded Tank-Village System
GDP	Gross Domestic Product
Int	Intention
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
KADE	Ken-Q Analysis Desktop Edition
LCDZ	Low-Country Dry Zone
LD	Land Degradation
LDN	Land Degradation Neutrality
NAM	Norm Activation Model
PBC	Perceived Behavioural Control
PEB	Pro-Environmental Behaviour
PN	Personal Norms
RMSEA	Root Mean Square Error of Approximation
SD	Standard Deviation
SDG	Sustainable Development Goals
SLM	Sustainable Land Management
SN	Subjective Norm
SPSS	Statistical Package for The Social Sciences
TEK	Traditional Ecological Knowledge
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UNCCD	United Nations Convention to Combat Desertification
USD	United States Dollar
α	Cronbach's Alpha
X^2	Chi-Square
df	Degree of Freedom

ABSTRACT

Land degradation (LD) in rain-fed uplands of the cascaded tank-village systems (CTVS) in the low-country dry zone (LCDZ) of Sri Lanka is a leading environmental issue that needs interdisciplinary resolutions. Studies' biasedness towards its biophysical aspects, however, has led policymakers to judge its human aspects intuitively and to marginalize stakeholders and their views for achieving land degradation neutrality. Therefore, this thesis is aimed at investigating the human dimension of LD in rain-fed uplands of the CTVS in the low-country dry zone using four studies that focused on the decision-making and the behavior of traditional and current farmers and other stakeholders. Primary data were collected–among farmers in *Ranpathwila* CTVS and stakeholders interested in rain-fed uplands of the CTVS in the LCDZ.

The first study, focusing on shifting cultivation (the earlier use of rain-fed uplands) and its embedded conservation insights, emphasized that farmers' traditional ecological knowledge contributed to uphold the sustainability of past rain-fed uplands. Gradually, these shifting farms were converted into settled farms in which decisions of other stakeholders (E.g., the government and private sector) affect its land use.

The second study, investigating farmers' awareness on LD, revealed that farmers are aware of relevant indicators of soil erosion, soil fertility decline and deforestation in rain-fed uplands by qualitatively assessing the physically examined consequences of LD. Also, farmers are aware of relevant natural and anthropogenic causes and interlinkages between processes of LD, reflecting their holistic view of the land resource. Although farmers express moral responsibility for causing LD, they articulate partial obligation to halt LD perceiving that the government possess part of the needed capacities and power.

The third study, using the integrated model of the Norm Activation Model and the Theory of Planned Behavior to elucidate the causal mechanism of land users' behavior to

conserve soil, revealed that farmers' soil conservation intention is a complex process that includes direct and indirect determinants. Of which, personal norm and perceived behavioral control are the salient predictors, indicating that higher moral obligation and, stronger perceived self-efficacy (E.g., confidence and competence) and controllability (E.g., resourcefulness) towards soil conservation increase farmers' likelihood to conserve soil.

Delivering appropriate solutions for LD needs to understand how stakeholders perceive farmers and solutions for sustainable rain-fed uplands. Thus, the fourth study analyzing stakeholders' subjective perspectives on solutions for sustainable rain-fed uplands, revealed that stakeholders are grouped around four distinctive perspectives (i.e., improving farmers' awareness of the consequences of LD, introducing farmers' practicable conservation methods, orienting people and farms with the ecology, and controlling farmers' behavior by legal and institutional interventions) sometimes irrespective of their expertise. Interestingly, stakeholders are consensuses in few solutions (E.g., introduce soil conservation methods which are appropriate and feasible to biophysical and socioeconomic context) that can enable soft discussions among them on common grounds.

The study concludes that LD in rain-fed uplands is something that farmers are aware of, morally responsible for, and are likely to halt if facilitated. Yet many stakeholders perceive that farmers are ignorant of it. Therefore, the study recommends evidence-based mutual understanding among stakeholders for solving LD.

要　旨

スリランカ低地乾燥地帯のカスケードタンク灌漑システム（CTVS）の構成要素である後背天水畑地の土地劣化は，学際的アプローチによる解決を要する深刻な環境問題である。しかし，従来の研究は，その生物物理学的な側面に偏重し，人間の意思決定過程や行動は直観的に理解してきた側面がある。そこで本論文は，この問題の人間的側面に着目し，過去や現在の農民，その他の利害関係者の土地劣化に関わる意思決定過程と行動に焦点をあてた 4 つの研究を行った。調査対象地は，CTVS の典型事例の一つ *Ranpathwila* である。

第 1 の分析は，以前の利用形態であった焼畑移動耕作とそこに内在する土地保全の知見に焦点を当て，当時の農民の経験的な生態学的知識が焼畑移動耕作の持続可能性を保証していたことを示した。しかし，今日，そうした移動耕作は土地利用形態の規制が強まる中で次第に常畑化し，その土地利用をめぐっては政府や民間を含む多くの利害関係者がかかわるものに変容した。

つぎに，現在の土地劣化に関する農民の認識を調査し，農民は土地劣化の科学的指標である土壌浸食，土壌肥沃度の低下及び森林破壊を経験的に十分認識していることが明らかになった。また，農民は土地劣化の自然的及び人為的原因とその発生過程の相互関係も理解し，土地劣化に対する道義的責任を感じていた。ただし，政

府が土地劣化対策に関する権能を有するため，農民自身は部分的に責務を負うに過ぎないと考えていることも明らかになった。

第3の分析は，*Norm Activation Model* と *Theory of Planned Behavior* の統合アプローチによって農民の土壌保全行動の原因メカニズムを解明した。その結果，農民の土壌保全に関する意思決定が直接間接の決定要因からなる複雑な過程であること，中でも個人の規範意識と自覚的な行動制御が重要な予測因子であり，土壌保全に対する道義的義務感，問題解決への自信や能力面での自己肯定感，物的資源の賦存状況が，土壌保全行動の蓋然性を高めることが明らかになった。

最後に，土地劣化対策にかかわるさまざまな立場の利害関係者が，農民および持続的土地利用にむけた方策についてどのよう捉えているかを検討した。その結果，それぞれの専門知識や立場とは無関係に，農民の土地劣化に対する認識向上，農民の適用可能な保全方法の導入，自然環境調和型の耕作への農民の誘導，法や制度による農民行動の規制，の必要を主張する4つの主観的認識に分類されることが明らかになった。

以上4つの研究から示唆されることは，土地利用者である農民が土地劣化の原因やそのメカニズムの認識と当事者としての責任や解決の義務を負うことを自覚し，その解決に向けて一定の貢献意欲を持っている一方，それを支援する側の利害関係

者は依然として無知や無自覚といったステレオタイプの農民像に固執している実態である。今後，CTVS における後背畑地の土壌劣化対策を効果的に推進していくには，農民と利害関係者の，エビデンスに基づいた相互理解を深めることが肝要である。

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ありがとうございます

CHAPTER 01

Introduction

1.1 Background

Land degradation (LD) that encapsulates deterioration of soil, vegetation, or water resource, is not a novel issue, but still, a critical environmental issue that undermines the wellbeing of humanity and ecosystem services in every region of the world (IPBES, 2018; Jie, Jing-zhang, Man-zhi, & Zi-tong, 2002). It has estimated that the rise of demand to feed almost 10 billion of world's population in 2050 could elevate LD, particularly in developing countries while bringing USD23 trillion loss to the global economy (Fróna, Szenderák, & Harangi-Rákos, 2019; IPBES, 2018; UNCCD, 2018).

Some historical evidence has already spoken about how humanity has suffered from severe repercussions of LD. For example, LD has collapsed some of the greatest civilizations like Maya and kingdoms like Aksum. In addition, LD associated incidences like "Dust-bowl" in the United States, has devastated human wellbeing by displacing their habitats, causing diseases, and losing lives and properties (Alexander, Nugent, & Nugent, 2018; Butzer, 1981; Roman, Palmer, & Brede, 2018). Meanwhile, LD has also affected the existence of other species that ensure life on earth. For example, the extinction of almost 600 plant species since 1975 and four animal species in this century, has found to be associated with LD (Humphreys, Govaerts, Ficinski, Nic Lughadha, & Vorontsova, 2019; Ruiz, 2020). In these circumstances, it is apparent that achieving land degradation neutrality[1] (LDN) is not a choice but an essential need for the existence of humanity and the sustainability of life on earth.

The world has agreed to accomplish LDN by 2030 by setting it as a global target under the 15th of 17 Sustainable Development Goals[2] (SDG), Life on Land. According to the essential guidelines for its achievement, it requires a systematic approach from the understanding of the key features of the human-environment system, the LD issues being faced, and their drivers until monitoring its achievement (Cowie, 2020). The scientific conceptual framework proposed for LDN has explained that the pursuit of LDN required efforts to avoid or reduce further degradation and reverse past degradation in which it can receive a zero net loss of the land-based natural capital relative to a reference state, or baseline (Orr et al., 2017). For that, Sustainable Land Management[3] (SLM) and restoration & rehabilitation interventions are concerned with an adequate focus on LDN associated biophysical and socioeconomic aspects and their interactions (Cowie et al., 2018; Orr et al., 2017).

The human dimension is found to be crucial in achieving LDN as it represents both problem and the solution. For example, the most widespread drivers of LD (E.g., grazing land, cropland, and agroforestry management) globally are those that are directly linked to human decisions

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[1] Land degradation neutrality (LDN): A state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems (UNCCD, 2016).

[2] Sustainable development goals: The blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including poverty, inequality, climate change, environmental degradation, peace and justice (https://www.un.org/sustainabledevelopment/sustainable-development-goals)

[3] Sustainable land management: ‘A knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising food and fibre demands while sustaining ecosystem services and livelihoods’(World Bank, 2006).

and actions (Barger et al., 2018). On the other hand, their decisions and actions are necessary to avoid, reduce and reverse LD by planning, adopting and monitoring SLM, rehabilitation and restoration interventions (Cowie et al., 2018). However, the studies of LD are often biased towards its biophysical aspects both in terms of its processes and its observed physical indicator. Even if human aspects are cited as drivers of causing or neutralizing LD, they are often limited to the identification instead of attempting to elaborate their underline causal mechanisms (Barger et al., 2018).

In those circumstances, interestingly, there is a growing body of literature on human aspects of LD. In that, some studies have attempted understanding LD through the lens of local land users (Bewket, 2011; Joshi, Wani, Chopde, & Foster, 1996; Kuria et al., 2019; Moges & Holden, 2007; Odendo, Obare, & Salasya, 2010; Okoba & Sterk, 2006), and appreciating the importance of people's traditional ecological knowledge in handling LD (Asmamaw, Mereta, & Ambelu, 2020; Ghorbani et al., 2013). Besides, some studies have given more attention to understand the mechanisms of individual and group decision making or behaviour on handling LD (Abadi, Yadollahi, Bybordi, & Rahmati, 2020; Belachew, Mekuria, & Nachimuthu, 2020; Bijani, Ghazani, Valizadeh, & Fallah Haghighi, 2017; Wang & Aenis, 2019; Werner et al., 2017). Insights from these studies can deliver a multidisciplinary (i.e. anthropological, psychological, and sociological) comprehension of the association of human dimension in LD. Subsequently this comprehension facilitates policymakers understanding of people's decision making and behaviour on a broader scope and then to facilitate establishing better solutions for achieving LDN. For example, understanding what traditional aspects are closely bound with environmental conservation and what determines current land users' conservation behavior would facilitate designing cultural and people-oriented conservation programs.

Unlike biophysical aspects of LD, human aspects are relatively challenging in generalizing as they are rooted in individual, community and cultural aspects, and interactions with ecological conditions of their surrounding landscapes. For example, the cultural value given to trees or forests may vary among communities, awareness of LD may be determined by what people perceive as LD and people who live near forests may have frequent interactions with forest than people in urban settings. In this regard, it is essential to investigate the human dimension of LD by focusing on a specific group of individuals whose decisions and behaviours can affect or can be affected by the condition of a particular landscape.

This thesis is concerned on the human dimension of LD, particularly in the rain-fed uplands of cascaded tank-village system[4] (CTVS) in the low-country dry zone (LCDZ) of Sri Lanka. Among seven distinguishing Agro-ecological regions[5] in Sri Lanka (Figure1.1), the LCDZ accounts for 60% of the land area and nearly 40% of the agricultural inhabitants. This area mainly contributes for the domestic food and feed production. The CTVS is a unique socio-ecological system that has long existed in the LCDZ while facilitating agriculture and life in the dry zone. Due to its remarkable values it has been recently recognized as a globally important agricultural heritage (FAO, 2018). Total number of CTVSs are 1162 which 90% of them are included in cascade zones {North and North-Central province (617), North-Western (255) and South and South-Eastern (177)} covering 37 river basins, while others are scattered. Figure 1.2 clearly illustrate that many of these CTVSs are distributed in the LCDZ.

[4] Cascade tank-village system: 'An ecosystem, where water and land resources are organized within the micro-catchments of the dry zone landscape, providing basic needs to human, floral and faunal communities through water, soil, air and vegetation with human intervention on sustainable basis'(Dharmasena, 2020)

[5] A detailed explanation for the basis of agroecological regions is given in the section 1.3 Study area

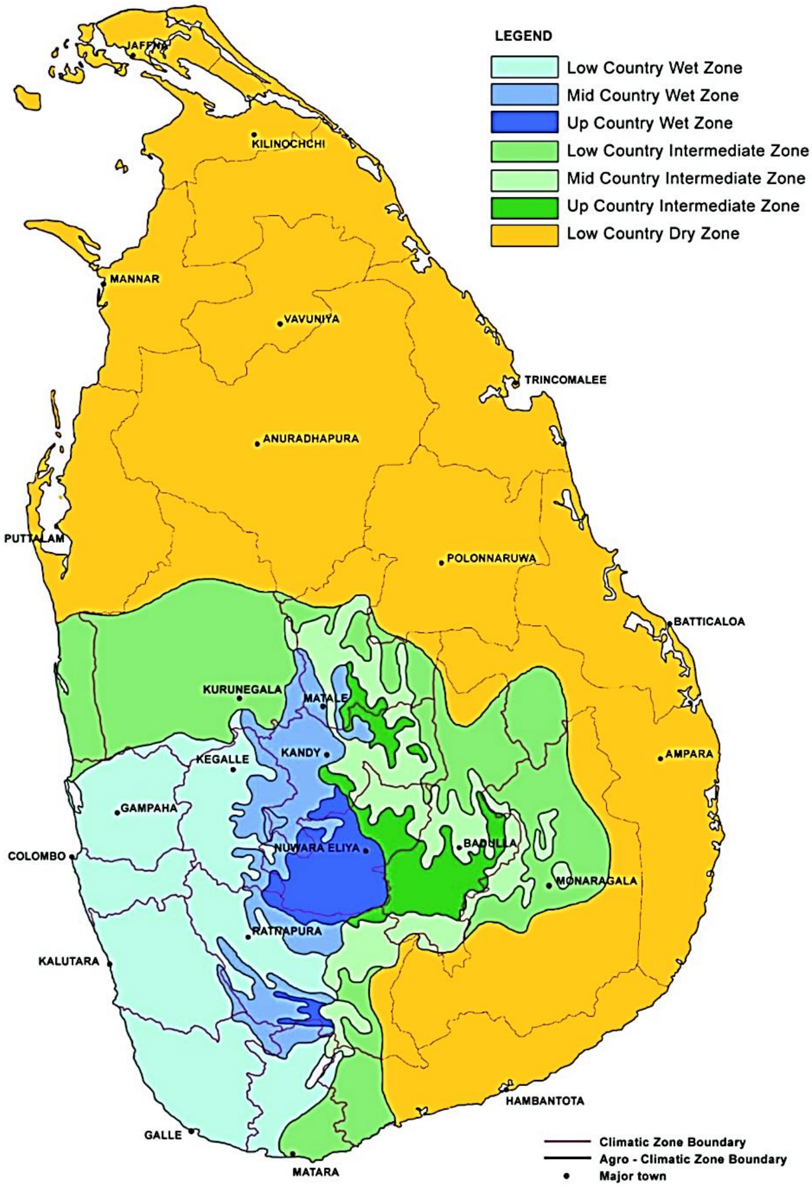


Figure 1.1 Agroecological regions of Sri Lanka

In CTVS, there are several unique components (Figure 1.3). Among these components, the rain-fed upland (rain-fed upland farms and forest in the catchment) is a distinctive zone that is located in just above the tanks and closely interact with three other distinctive zones, i.e. 1) tank bed and bund; 2) irrigation channels and paddy fields and 3) hamlet (Geekiyanage & Pushpakumara, 2013). Associated with unsustainable farming practices and lack of soil conservation efforts, soil erosion and soil fertility decline were found to be the most significant LD processes in rain-fed uplands (See Appendix1) that reduce the upland productivity and increase the sedimentation of low-lying small tanks (Ministry of Environment and Renewable Energy, Sri Lanka, 2014).

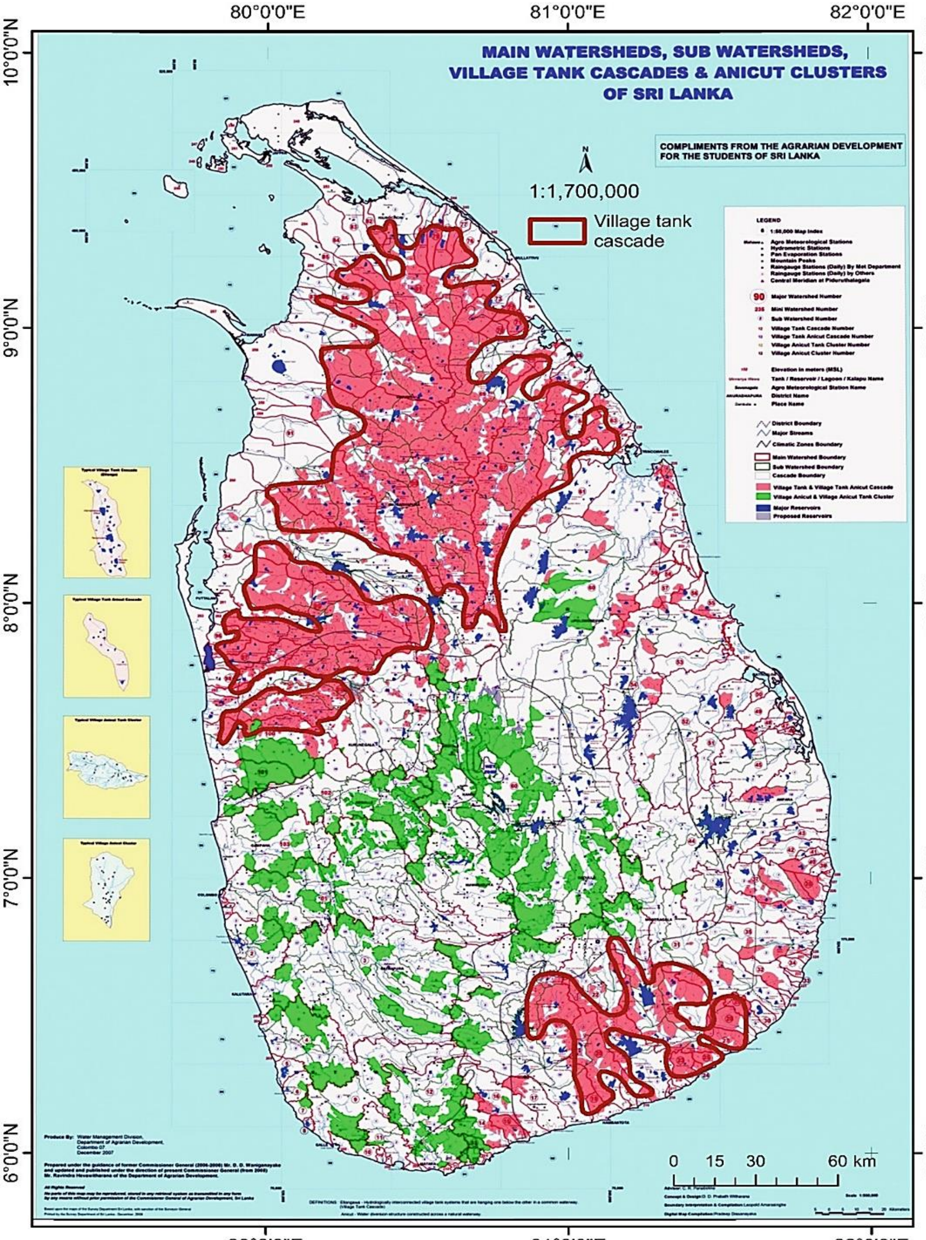
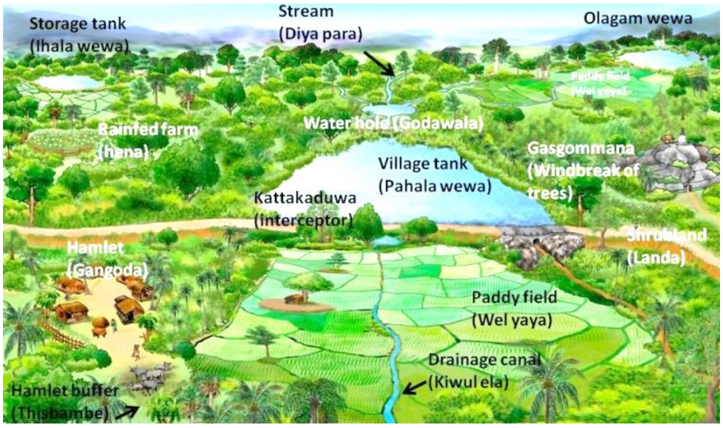


Figure1.2 Distribution of cascaded tank village systems (Source: Dharmasena, 2020)

Besides that, the forest in the catchment area is undergoing a rapid reduction in the recent past decreasing the Net Primary Production[6] of the dry zone (Fernando et al., 2015; Ministry of Mahaweli Development and Environment, Sri Lanka, 2017).

Schematic view of a cascaded tank-village system (Schütt, Bebermeier, & Meister, 2013)



Components of a tank-village system (http://iucnsrilanka.org/Kapiriggama/cascade-2/components-of-a-village-tank-system/)

Figure 1.3: Schematic view of a CTVS and components of a tank-village system

Threatening the sustainable existence of CTVS, issues mentioned above challenge the domestic food security, rural economy, and ecological sustainability of the country. According to previous studies and national reports related with LD, land users and their unawareness of LD are some of the root causes of unsustainable farming practices including limited soil conservations (Ministry of Environment and Renewable Energy, Sri Lanka, 2014; Samaratunga & Marawila, 2006). Although some solutions to halt LD are introduced with certain conservation attempts, lack of collaboration among stakeholders has been one of the

[6] Net primary production is 'how much carbon dioxide vegetation takes in during photosynthesis minus how much carbon dioxide the plants release during respiration' (https://earthobservatory.nasa.gov/global-maps/MOD17A2_M_PSN.)

challenges for their successful adoptions (Aheeyar, 2013). Despite what has been concluded as the causes on aforementioned issues, they seem to be highly based on limited evidence.

Particularly there has been limited investigations on the human aspects of LD from anthropological, psychological and sociological perspectives (Fernando et al., 2015; Ministry of Environment and Renewable Energy, Sri Lanka, 2014). The knowledge gap arises from the lack of empirical evidence often tend to cause policymakers to follow their intuitive perspectives on people's decision making and behaviour, possibly enabling conflicting situations in achieving land degradation neutrality (Ministry of Environment and Renewable Energy, Sri Lanka, 2014; Samaratunga & Marawila, 2006). Therefore, this thesis has attempted filling this knowledge gap by investigating the human dimension of LD in rain-fed uplands of CTVS using four distinctive, but interrelated studies conducted from 2018 to 2020.

1.2 General objectives of the thesis

This section briefly explains the general objectives of the four studies conducted in this thesis. The specific objectives and comprehensive explanations of those four studies are presented in Chapter 02, 03, 04, 05 consecutively.

Study 1

Former farming in rain-fed uplands of CTVS was a shifting cultivation, which is locally known as *Chena* or *Hena*. It was managed by the decisions of primary land users and abundantly practiced in in the dry zone as it was necessary for the survival of rural people. It is often argued that the traditional *Chena* was successful due to abundant forest resource, relatively low population growth and traditional ecological knowledge[7] (TEK) Despite several descriptive studies about traditional *Chena* in the dry zone, there is limited understanding of how its TEK contributed to the sustainability of the environment. Therefore, this study attempted to investigate traditional *Chena* farming and its embedded conservation insights retrospectively.

Study 2

With the time, the decision making for land uses, particularly for agriculture including rain-fed upland farming under CTVS, became a task of multi-stakeholders such as individuals and government. In the vein of current LD in different land uses, land users' irresponsible actions and their unawareness on LD are often been indicted by policymakers as some of the leading root causes of LD. However, these arguments are hardly backed by sufficient empirical investigations. Perhaps, land users are already aware of LD and the relationship of their actions on it. A systematic investigation of land users' awareness of LD and their perceived responsibility for it can provide answers to those questions, and possibly useful for finding an entry point to investigate the real human behaviour related root causes of LD. Therefore, this study aimed at investigating farmers' awareness of LD in in rain-fed uplands and their perceived responsibility for it.

Study 3

Soil erosion is one of the most prominent processes of LD in the rain-fed upland farms in CTVS. Lack of soil conservation efforts has been identified as one of the main anthropogenic reason behind this. Results of study 2 revealed that land users are aware of the issue and perceive that

[7] Traditional Ecological Knowledge (TEK): 'A cumulative body of knowledge and beliefs handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment' (Berkes, 1993, p. 3)

they are responsible for the causes of it. However, in reality this awareness and perceived responsibility have not directly led to any soil conservation interventions. Therefore, the concern was directed to understand the causal mechanism of the awareness, perceived responsibility, and other related factors to their soil conservation behaviour. In this respect, this study attempted understanding the factors affecting land users' soil conservation intension using an integrated model of two popular behavioural theories, i.e., the Theory of Planned Behaviour and the Norm Activation Model.

Study 4

Adoption of sustainable land management practices to neutralize LD is not always vested in individuals like land users but also in other stakeholders whose collaboration and partnership is essential for its success. Competing interests challenge creating a common platform to enable soft discussions among stakeholders and complementary interests lead to finding common grounds for better cooperation. There are various options for sustainable rain-fed uplands from scientific and non-scientific discussions. However, stakeholders and their competing and complementary perspectives towards those options are not recognized to the date. Assuming that competing interests among stakeholders as one of the main challenges for lack of collaboration among them. This study, therefore, aims to reveal stakeholders' distinctive perspectives and shared interests for approaches towards the sustainability of rain-fed uplands.

1.3 Study area

Sri Lanka is a tropical island nation of the south of India in the Indian Ocean. The topography of its southern half is mountainous which elevates up to nearly 2500 meters, while much of the remnants is flat. The country has been categorized into three main elevation categories, i.e. Upcountry (>900m), Mid country (300-900m) and Low country (<300m), in which the mean temperature markedly varies. Sri Lanka gets two distinguished monsoon rainfalls, i.e. North-East Monsoon (from May to September) and South-West Monsoon (from December to February), and inter-monsoonal rains. The mean annual rainfall of the country ranges from 900mm in the driest parts to over 5000mm in the wettest parts. Depending on the total annual rainfall, the country has been divided into three major climatic zones, i.e. Wet zone(>2500mm), Dry zone (<1750mm) and Intermediate zone (1750-2500mm). As a result of rainfall and elevation variations, seven agroecological zones have been identified in the country (Figure1.1). Besides that, there are two cultivation seasons namely, *Maha* and *Yala* which are synonymous with two monsoons. *Maha* Season falls during “North-east monsoon” from September to March in the following year. *Yala* season is effective during “South-west monsoon” the period from May to end of August.

This study was focused on the rain-fed uplands in the CTVS in the LCDZ of Sri Lanka. With a relatively dry climatic condition and a flat topography, LCDZ accounts approximately 2/3rd of the total land area of the country. This area is highly susceptible for soil erosion mainly due to low aggregate stability of the abundantly available soil group (Reddish Brown Earth), intensity and seasonality of rainfall and undulating topography (Dharmasena, 1992; Jayasekara, Kadupitiya, & Vitharana, 2018; Moorman & Panabokke, 1961). This area holds many of the county’s CTVS, which derived from clustered small tanks[8] (Dharmasena, 2020; Panabokke, Sakthivadivel, & Weerasinghe, 2002) .

[8] Small tanks are ‘those having an irrigated command area of 80 ha or less, as defined by the Agrarian Service Act No. 58 of 1979’ (Panabokke, Sakthivadivel, & Weerasinghe, 2002).

The *Ranpathwila* CTVS, which is located in *Kahatagasdigiliya* divisional secretariat of Anuradhapura district was purposefully selected to conduct field data collections for the first three studies (Figure 1.2). Meanwhile, the fourth study was focused on the general phenomenon of the rain-fed uplands of CTVS in the LCDZ. Anuradhapura district (See Appendix 02) is the largest district in the LCDZ. It covers 7,179 km^2 land area and holds 2,481 operating small tanks representing the second-highest density of small tanks following Kurunegala district. Many of these small tanks are arranged in CTVS.

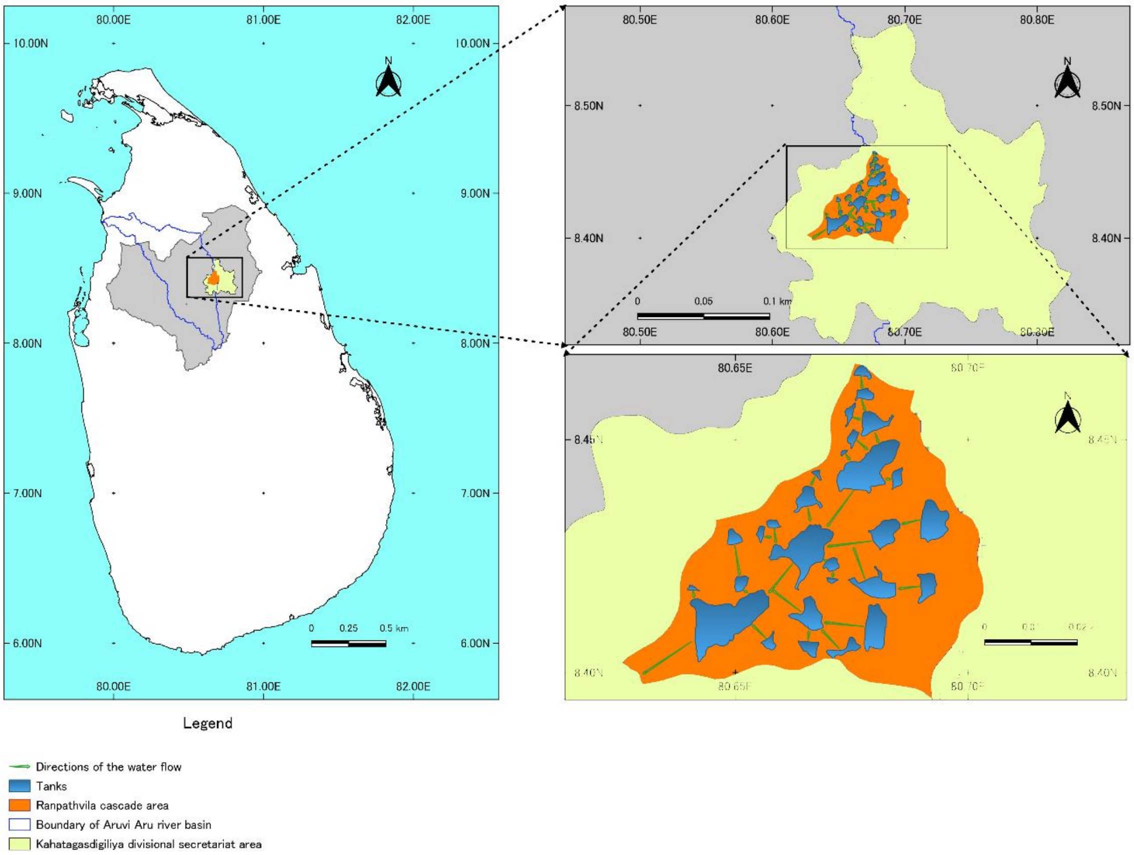


Figure 1.4: The geographical location of the study site

Among 23 divisional secretariats in this district, *Kahatagasdigiliya* divisional secretariat is 4th in the poverty rank. It is situated approximately 40 km away from the sacred city of Anuradhapura and represents one of the rural areas of the LCDZ. It covers 352 km^2 land area, which is divided into 40 *Grama Niladari* divisions (lowest administrative divisions) and holds 276 small tanks (Department of Census and Statistics Sri Lanka, 2018).

The *Ranpathwila* CTVS is one of the relatively less exposed CTVS to conservation and development programs and empirical investigations. It covers approximately 35km^2 of the land area and is consisted of 25 small tanks. Although the area of this CTVS not necessarily recognized as one administrative boundary, it falls into the area covered by nine *Grama Niladari* divisions[9].

1.3.1 Land-use change in the *Ranpathwila* CTVS around two decades

Land use data of the *Ranpathwila* CTVS was collected from the satellite images of Landsat 7 and Landsat 8. Rain-fed upland farms were formerly under subsistence-oriented shifting cultivation where limited external agricultural inputs were used. Gradually these shifting farms were changed to settled commercial mono-cropping systems which use many external inputs like synthetic fertilizers and hybrid seeds.

In *Ranpathwila* CTVS area, commercial-oriented rain-fed farming became visible around two decades ago. Assuming that period was critical on the LD of the study site, land use images on 17th July 2000 were compared with images on 27th July 2018. The results (Figure 3.1) revealed that around the last two decades, the extent of several land-uses has considerably increased while been compensated by a decrease in the extent of other land uses. Sparse

[9] Nine *Grama Niladari* Divisions are namely *Thurukkaragama, Maha Kiribbewa, Kokmaduwa, Kahatagasdigiliya East, Kahatagasdigiliya West, Bethkewa, Maha Messalawa, Diganhalmillewa* and *Ranpathwila*

croplands(+433.8ha) have gained the highest extent during the last two decades followed by built ups (+188.7ha) and paddy fields (+31ha). Extent under vegetation (-352.0ha) got highly diminished, followed by the area under forests (-224.1ha) and tanks (-67.1ha).

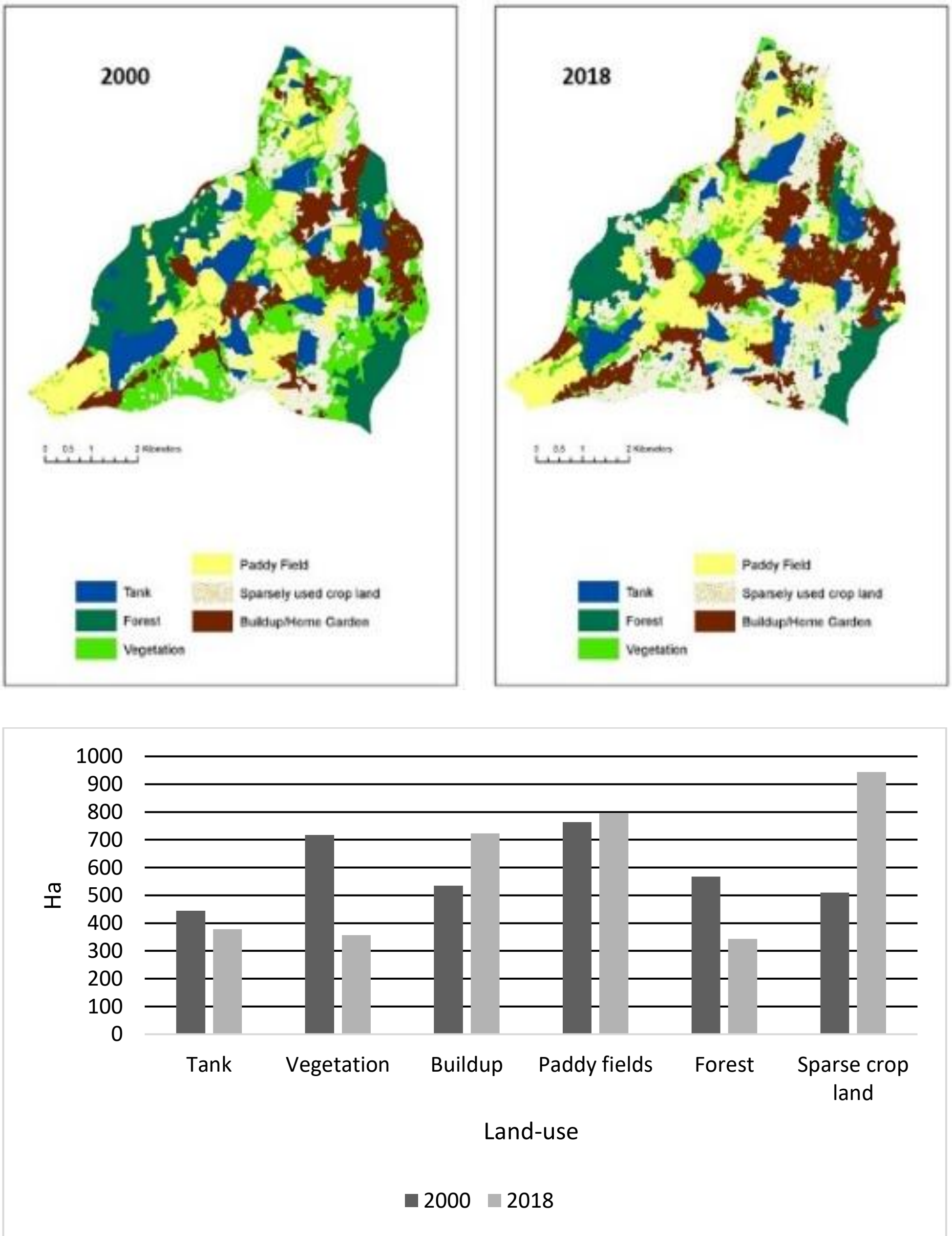


Figure 1.5: Land-use change in *Ranpathwila* cascaded tank-village system from 2000 to 2018.
(Source: Satellite image data of Landsat 7 on 17th July 2000 and Landsat 8 on 27th July 2018)

Land-use change indicates that the rapid swap of the land extent under vegetation and forest use to sparse croplands and buildups is probably associated with the rapid expansion of rain-fed upland farms and the area under dwelling structures.

CHAPTER 02

A Summary of Conservation Insights from Traditional Ecological Knowledge Embedded in Shifting Cultivation in the Dry Zone of Sri Lanka

2.1 Introduction

In Sri Lanka, shifting cultivation is called as *Hena* or *Chena* cultivation. It has been practiced in the dry zone since circa 400 B.C. (Panabokke, 2009) and is a key component in the traditional tank-village system (Figure 1.3), which is the basis of dry-zone human settlement and irrigated paddy cultivation (Dharmasena, 2010; Panabokke, 2009). The shifting cultivation produced various essential crops, such as coarse grains, grain legumes, fruits, vegetables and cotton (FAO, 1999), in the catchment area of tanks under rain-fed conditions, while paddy was mainly produced in the command area of the tank under irrigated conditions. Both cultivations used family or shared labour and were subsistence-oriented and in harmony with one another.

The colonial rulers restricted traditional shifting cultivation, as they perceived it to be primitive and spiteful (Farmer, 1954; Gunasena & Pushpakumara, 2015; Leach, 1961). Claiming ownership by the Crown, they forcefully acquired shifting farms to promote plantation crops (Bandara, 2007). Consequently, many shifting farms in the wet zone were converted into permanent plantations, while in the dry zone, the practice was continued in a controlled way, as it was an essential practice for the subsistence of people (Gunasena & Pushpakumara, 2015). Hence, the distribution of shifting cultivation was extensive in the dry zone compared to the wet zone (Farmer, 1950).

During the post-colonial era since 1948, shifting cultivation was marginalized. Although cultivation permits were given by the district governments to regularize shifting cultivation, it was discontinued in 1981 (Gunasena & Pushpakumara, 2015). During this period, the rural population increased, new settlement areas were established in newly created irrigation zones, protected areas were demarcated, and settled agriculture was initiated (FAO, 1999; Gunasena & Pushpakumara, 2015). Currently, almost all rain-fed upland farms in the dry zone are settled and have been transformed into mono-cropping systems that produce crops such as maize and chili for commercial demands. Encroachment on State forest is an offence under the Forest Ordinance.

Studies have pointed out that the traditional shifting cultivation in the dry zone was practiced successfully until the 1980s with the support from relatively low population growth, abundance of the forest and rich traditional ecological knowledge (Bandara, 2007; Farmer, 1954; Gunasena & Pushpakumara, 2015; Leach, 1961). Because of the changes in land use, it is unlikely that traditional knowledge will be available and intact. However, it is important to know how traditional farmers perceived the environment and linked their farming practices with the environment, mutually benefiting their future and the environment. Therefore, this study attempts to clarify the traditional shifting cultivation and its embedded ecological knowledge in the Dry Zone of Sri Lanka.

2.2 Methodology

The studies were conducted in three villages, i.e., *Mahakiribbawa, Kokmaduwa, Bethkewa* of which the significant portion of extent falls in the boundary of the study site (*Ranpathwila* CTVS). In 2017, the population in the above villages numbered 1730, 451, and 449, respectively.

Participants and data collection

Shifting cultivation was practiced at the beginning of the 19th Century. Thus, the study was targeted at people who involved in rain-fed upland farming during that time. Accordingly, 24 farmers who were experienced in shifting cultivation were selected intentionally with the support of community leaders. Primary data were collected using three focus group discussions along with a field visit in rain-fed uplands. Focus group discussions are useful for exploring people's knowledge and experiences or little-known topics or those with unclear issues (Hennink, 2014; Kitzinger, 1995).Moreover, they are simple, inexpensive, and quick and can conveniently collect data from several people at the same time (Kitzinger, 1995; Leung & Savithiri, 2009). Each focus group discussion was conducted for two hours to collect information about their indigenous shifting cultivation and was concluded by acknowledging respondents with a token of appreciation. Data were recorded using whiteboards, voice recorders and field notes.

Questionnaire and measurements

A schedule was prepared, including guiding questions (See Appendix 03). These guiding questions were mainly to keep the focus group discussions on specific topics such as the activities of shifting cultivation and their underline reasons, and resources used.

Data analysis

The data were assessed through the descriptive narrative way as it is reasonably appropriate understanding in-depth of a topic which is little known (Stewart, Shamdasani, & Rook, 2007)

2.3 Traditional ecological knowledge of *chena* farming practices

Background of the respondents

The total number of farmers who joined the focus group discussions was 24, including 22 males and two females. They were approximately in their 50s and 60s. Most of them (17) had either up to a secondary or advanced education level, while 7 had less than a secondary education level. They had started their upland farms when they were approximately 22 years of age and had nearly 35 years of experience in shifting cultivation. According to these farmers, traditional shifting cultivation was gradually changed to settled cultivation and disappeared from their uplands two decades ago with the introduction of machinery and commercial crops like maize. The knowledge of shifting cultivation is also disappearing, as the generations who hold that knowledge are passing away and younger generations have no interest in such knowledge.

Classification of Chena farms

Farmers classified their shifting farms mainly based on vegetation that was cleared for farming. This classification resulted four groups of shifting farms as follows.

1. *Nawadeli-hena*: A farm that resulted after slashing and burning a matured forest.
2. *Mukalan-hena*: A kind of *Nawadeli-hena* but having high dense of matured towering trees. Clearing these forests requires substantial physical work, time and labour to cut and move large trees. Therefore, these forests were not usually slashed unless there is a real need.
3. *Athdanduwa-hena*: A farm that resulted after slashing and burning secondary vegetation that has remained fallow for nearly 10-15 years. The girth size of a tree is similar to the forearm size of adults. These farms were common as farmers often cleared secondary vegetation than matured forests for their shifting farms.

4. *Kanathu-hena*: A farm that has shrub vegetation or high weeds that resulted after continuous farming. They were primarily considered for abandonment. However, there are instances which feeble people cultivate these lands for their survival.

Besides the above classification, farmers mentioned two other farm groups which based on the formation of farms (Figure 2.1 and 2.2).

1. *Mulketa-hena*: A cleared forest area divided into a cartwheel shape. The centre of the land is referred to as the *mulkete*, and typically, a tree is located here at a higher elevation as an identifiable landmark.
2. *Irawili-hena*: A cleared land area divided into strips among members.

As farmers explained, when they engaged in shifting cultivation as a group, they cleared the forest area together and allocated land portions among themselves using either of two patterns (cartwheel shape or stripe), that allows each farmer to receive an equal portion of land with equal quality. It was a custom for senior farmers to decide which pattern is suitable and how to allocate portions among farmers.

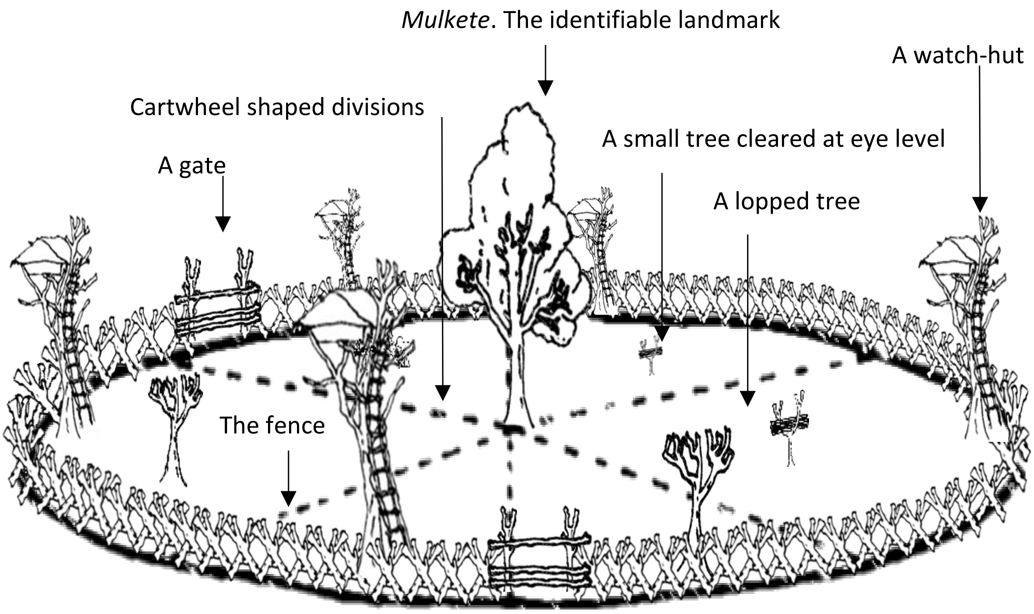


Figure 2.1: Schematic view of *Mulketa-hena* (Author's focus group discussions, 2019)

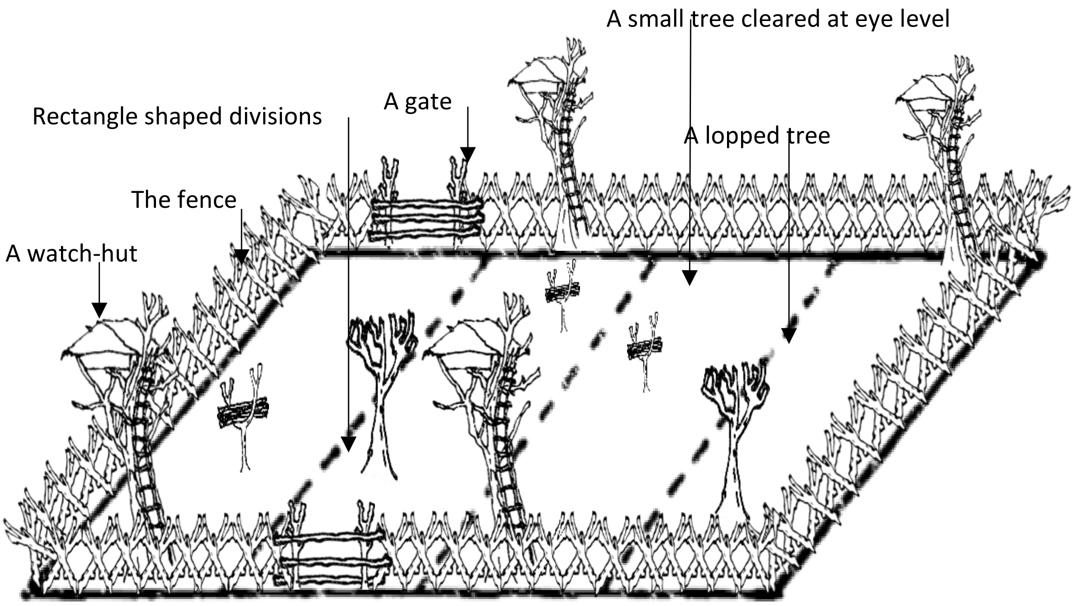


Figure 2.2: Schematic view of *Irawili-hena* (Author's focus group discussions, 2019)

Schedule of chena and paddy cultivation

The dry zone experiences two monsoon rains (northeast and southwest), delivering two main cultivation seasons (*Maha* and *Yala*). With ample rain, the *Maha* season (from September to March) enables farmers to cultivate substantial areas in both the uplands and lowlands. Conversely, while the rains in the *Yala* season (from May to August) are adequate to secure much of the lowland paddy production with the use of stored tank water, they are insufficient for adequate farm production in the uplands.

A cultivation schedule was prepared including farmer responses to weather conditions and cultivation practices. According to the schedule, cultivation practices corresponded well with the weather conditions of each period in a cultivation year (Figure 2.3). Farmers completed land selection and preparations in the dry period from June to mid-September. Then, at the onset of *Maha* season, they sowed seeds for germination. During the rainy season, farmers spent their day times in lowland paddy cultivation, while night times were spent at watch huts, protecting the crops of the shifting farms. As the rain gradually faded away, farmers started harvesting, drying and storing the crops. During the *Yala* season, farmers cultivated only a few crops, such as sesame, due to limited water supply.

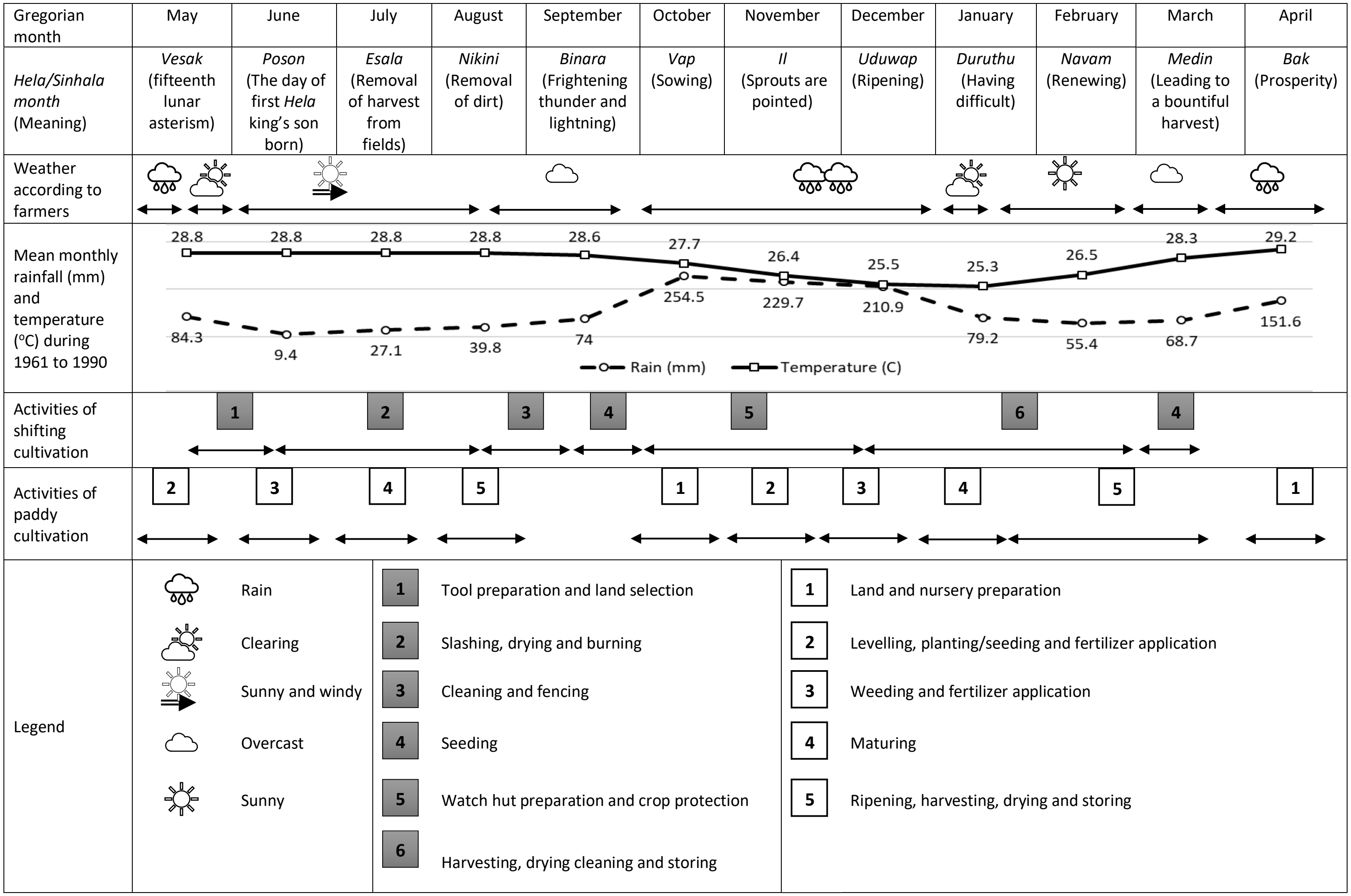
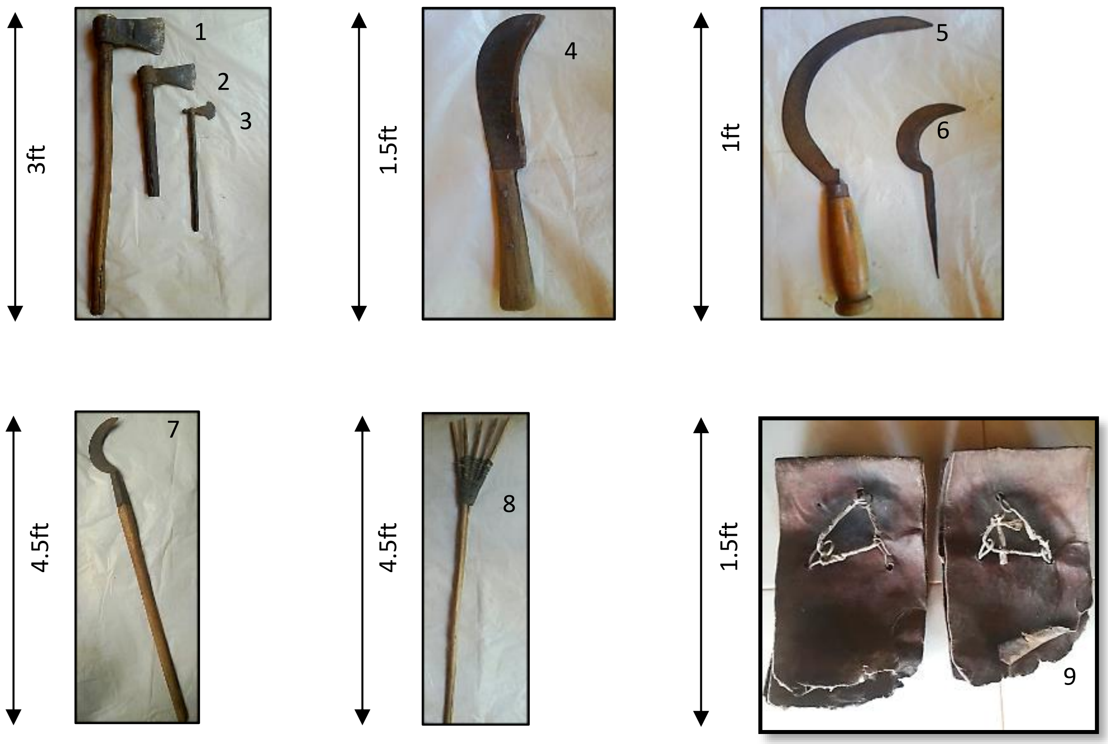


Figure 2.3: Schedule of shifting cultivation (*chena*) and paddy cultivation (Author's focus group discussions, 2019,Department of Census and Statistics Sri Lanka, 2019; Kalyanarathna, 2016)
Note: The *Hela* or Sinhala calendar follows the lunisolar calendar. *Vesak* and *Poson* names consecutively have astrological and historical meanings, while other months have agricultural meanings.

Farm tools

Tools in shifting cultivation were mainly rudimentary and reflected the nature of farming activities (Figure 2.4).



No	Local name (Sinhala)	English term	Main activity
1	*Porawa*	Axe	Felling trees and chopping wood
2	*Ath porawa*	Hand axe	Lopping branches
3	*Keteriya*	Hatchet	As a weapon and for hunting
4	*Wak pihiya*	Billhook	Lopping branches
5	*Goyam dekeththa*	Sickle (for paddy)	Harvesting paddy and cutting weeds
6	*Pannam ketta/Pan ketta*	Sickle (for finger millet)	Harvesting finger millet and reeds
7	*Kaththa*	Scythe	Slash the shrubs and small trees
8	*Gadal karuwa*	Rake	Collecting debris
9	*Waan pathul*	Thong sandal made of leather	To protect the soles of the feet from thorns, spikes etc.
Note: The handle of the sickle for finger millet is not available in this photo; it is a small version of the handle of the sickle for use in paddies. People have also used mamoties for planting seeds, such as pumpkin and corn			

Figure 2.4: Tools used in shifting cultivation (Author's focus group discussion, 2019).

They were manufactured by local artisans or individuals using materials which can be returned to soil or recyclable (E.g., wood, steel or animal leather) and were operated by manpower instead of through the use of animal power or sophisticated operating techniques. The primary uses of these tools include forest clearing, cleaning debris and harvesting, but with less or no tillage.

Clearing the forest

Clearing the selected forest area included rituals and specific techniques. Farmers specified two rituals, namely, *Wal atta allima* and *Mulwal keteema* before slashing and *Kana kari kima* before burning, respectively. These rituals encompassed prayers and vows to the local deity asking permission to enter the forest, forgiveness for destroying the forest, and protection for the animals, crops and their lives. Leaving the older, giant trees unharmed, the slashing was done in three steps: 1) ground-level undergrowth clearing, 2) eye-level clearing and 3) branch lopping (Figure 2.5).

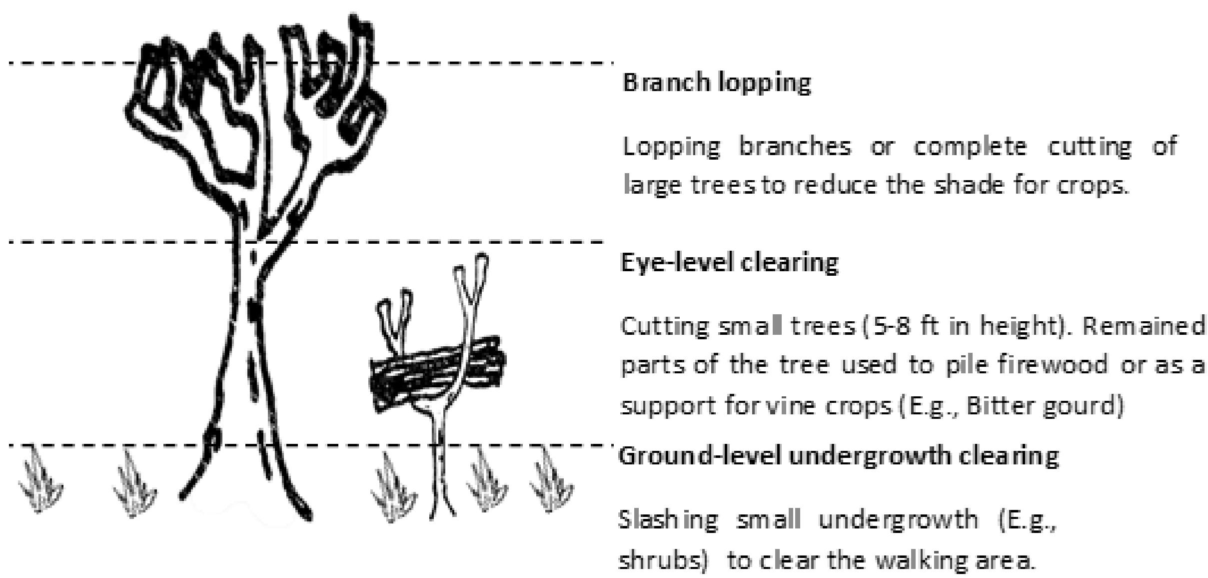


Figure 2.5: Three steps clearing of forest vegetation (Bandara, 2007)

Slashed vegetation was burned after making noises by tapping trees with metal objects and "hooting" for three consecutive days to chase animals away. In addition, the wind direction was considered to avoid spreading fire to the uncleared forest.

Land preparation, crop establishment and nutrient management

The land was prepared by clearing the remaining wood and plant debris for fencing, firewood, and setting *Kadamulang veti* (logs and sticks that were piled as ridges diagonally across possible water flow) (Bandara, 2007). Then, it was raked to collect plant debris, mix the ash with the soil and spread ash evenly in the farm, but no tillage was performed. The seeds included various crops, such as cereals, vegetables, oil crops, grain legumes, fruits, and tuber crops. Seeds were mainly spread as an assortment, while a few crops (E.g., corn, sweet potato, pumpkin) were planted in specific places (E.g., near termite mounds). Farmers said that a newly cleared forest was fertile to cultivate for up to 3-4 consecutive seasons; thus, there was no need for external fertilizers.

Crop protection

Crops were mainly protected by fencing and night watches at watch huts (Figure 2.1 and 2.2). A fence was established around the farm with a height of approximately 1.5 -2.0 meters using timber and thorny woods that mainly resulted from slashing and burning. An auspicious time[10] called *Divi Karana* was selected for the establishment of the fence; it was believed that the fence was imbued

[10] The auspicious time was calculated by dividing the phase cycle of the moon into a seven-day sub-cycle, and each day was considered to have a characteristic 'energy' that was represented as a name of the animal and known as *Karana* (Smith, 2013).

with the energy of a tiger to protect the crops from wild animals, such as wild boars, rabbits, and deer. Watch huts were prepared on top of the trees close to the fence, which provided a clear view of the farm and the surroundings as well as protection from elephants. Night watches were spent at these huts, where the farmers shared folk songs with other farmers in other watch huts and observing threats specifically from elephants. Planting pest-vulnerable crops, maize and finger millet, near the watch huts for close supervision; maintaining fires close to the watch huts; using mechanical structures to scare and trap animals; and using Buddhist chanting, mantras, and talismans were some other means of crop protection.

Harvesting and fallowing

Considering the maturity of different crops, only the edible portions were harvested, leaving crop residues on the farm. After harvesting, the lands were left until the next cultivation season. After 3-4 cultivation seasons, the farms were fallowed entirely for 10-15 years to become *Athdanduwa*-type forests.

2.4 Conservation insights from traditional *chena* farming practices

The TEK that was embedded in the traditional shifting cultivation seems to have facilitated sustainable use of land and reduce damage to the environment from different dimensions. It seems that there were some aspects on which farmers probably had sufficient awareness that eventually influenced their environmental decision making. First, vegetation characteristics comprised one basis of farm classification. Farmers likely attributed the vegetation to soil fertility because the soil fertility is high in matured forests followed by secondary vegetation and shrub vegetation. Farmers were probably aware of those aspects and classified lands and considered whether to cultivate or fallow for soil fertility regeneration. Second, land quality and its distribution were considered in land allocation. It is known that land quality is not equally distributed in a locality. Farmers were probably aware of this fact and were able to effectively allocate land resources equally among community members, avoiding competition. Third, cultivation practices were well aligned with weather conditions. This was probably a result of farmers' understanding of the weather due to long-term exposure to weather conditions. This understanding seems to have facilitated effective resource management and conservation. For example, finishing land preparations during the dry period from June to mid-September probably enabled farmers to use the onset of rains for sowing and seed germination, avoiding seeds being washed away during subsequent heavy rains and allowing early seed germination to cover the ground and reduced soil erosion. Finally, farmers probably had an understanding of the ecology of pests and their threshold levels of tolerance as they could establish different physical, mechanical and cultural crop protection methods that had no persistent effect on the environment.

Cultivation practices seem to limit the disturbance in natural resources, which might have contributed to conserve them. For example, the use of tools such as scythes, billhooks and axes and a three-step slashing technique rarely removed complete vegetation but rather retained many stumps and root suckers, which can facilitate the regeneration of secondary tree growth and revitalized the forest and soil coverage within a short time (Bandara, 2007; Kammesheidt, 1999; Perera, 2001). Additionally, retaining more giant trees in the proximity of a cleared forest may have created biodiversity reservoirs by providing habitats for many useful animal species, fostering better forest resilience (Norgrove & Beck, 2016). Moreover, the zero or minimum tillage and setting *Kadamulang veti* have probably conserved soil, as they can result in low soil and nutrient erosion, high soil moisture in topsoil layers, reduced soil aeration and low soil temperature (Baeumer & Bakermans, 1974; Bandara, 2007). Crop diversity, which possibly resulted from traditional dietary patterns, seem to have facilitated higher environmental services, as it can increase biodiversity conservation, nutrient recycling, soil and water conservation, absorb more carbon, and make farms less vulnerable to insect infestations (Malézieux et al., 2009). Even during fallowing, the retention of residues on the land surface may have improved the physical, chemical, and biological properties related to soil health because more extended fallow periods can re-establish soil fertility, sometimes to the pre-cultivation level (Kleinman, 1995).

Cultural aspects seem to have controlled the community pressure on common resources by establishing well-grounded restrictions on land and forest use. For example, compulsory rituals like *Kana kari kima* to chase animals away before setting a fire seem to reflect farmers' attention to the possible destruction of forests and animal habitats and to reduce unnecessary harm on natural resources.

2.5 Conclusion

This study attempted to clarify the traditional ecological knowledge (TEK) that was embedded in the practice of traditional shifting cultivation in the dry zone. Farmers have classified their farms for better recognition and scheduled cultivation closely overlapping with weather conditions. A new farm was started by clearing a forest following a unique three-step approach, and then mixed crops were established on minimally disturbed lands. Crops were protected using both mechanical and cultural methods. Use of customs, traditions and rituals was a common practice in farming. The edible portion of crops was selectively harvested. After 3-4 consecutive cultivating seasons farms were fallowed for longer periods. Traditional farmers possibly were aware of certain aspects such as weather, land quality and pests. Along with that their cultivation practices and cultural aspects seems to have facilitated sustainable use of natural resources from various angles, such as minimizing resource degradation, enhancing biodiversity conservation and controlling harmful anthropogenic activities such as competition for land resource. However, their sustenance is under risk due to losing their local repositories, leaving fewer receptive successors. Therefore, if initiatives to further investigate and to preserve TEK are considered, it might be useful in finding suitable solutions for sustainable use of natural resources in future.

CHAPTER 03

An Empirical Investigation of Farmers' Awareness and Responsibility towards Land Degradation in the Rain-fed Uplands of the Cascaded Tank Village Systems in the Dry Zone of Sri Lanka: The Case of *Ranpathwila* Cascaded Tank Village System

3.1 Introduction

Land degradation (LD) is an environmental issue which needs cognizant and responsible stakeholders for developing technical solutions and economic, social and psychological recommendations. Particularly land users like farmers need to be aware of LD and responsible for directly and actively engaged in halting LD as they are the primary users of the land resource (Kohler et al., 2018). However, land users' aspects including their awareness of LD has been often overlooked by policymakers and scientists than that of biophysical aspects of LD (Reed, Dougill, & Taylor, 2007). Land users' limited awareness and responsibility towards LD can cause challenges in achieving land degradation neutrality. Therefore, it is apparent that the understanding and improving primary land users' awareness and responsibility in LD and their power to solve the issues are useful prerequisites for effective handling of LD.

According to the American psychological association, awareness is a person's accurate reportability of something that person has perceived or knows. Applying popular theoretical models such as Norm Activation Model and Value-Belief-Norm (Schwartz, 1977; Schwartz & Howard, 1981; Stern, Dietz, Abel, Guagnano, & Kalof, 1999), studies have recognized that peoples' awareness of environmental consequences which can be recognized as someone's awareness of negative consequences for others or for other things one values when not acting pro-environmentally is a key antecedent of the psychological process of environmental behaviours (Johansson, Rahm, & Gyllin, 2013; Rezaei, Safa, Damalas, & Ganjkhanloo, 2019). Previous studies have attempted to investigate farmers' awareness of LD, particularly the LD processes such as soil erosion and soil fertility decline (Bewket, 2011; Kuria et al., 2019; Moges & Holden, 2007; Odendo et al., 2010; Okoba & Sterk, 2006). In these studies, it has evident that farmers are aware of LD processes including their underlined reasons and consequences. Farmers have perceived those issues by both biological indicators (E.g., reduced crop performance, presence of weeds that unique in degraded lands) and physical indicators (E.g., soil sedimentation in reservoirs and water canals, soil becoming coarse and soil color becoming pale). Despite complex analytical protocols or mathematical formulas as it is in scientific approaches to confirm the accuracy of perceived LD, comparing perception with available scientific evidence found that perceived indicators closely overlaps with scientific findings in many instances (Okoba & Sterk, 2006). Moreover, those land users have recognized both anthropogenic and natural causes as the underline reasons for their perceived LD processes. Furthermore, some of these studies have elaborated how the awareness of land users has been benefited for various other activities. For example, to evaluate the severity of LD (Bewket, 2011; Kuria et al., 2019; Moges & Holden, 2007; Okoba & Sterk, 2006) and to implement appropriate conservation strategies even without government supports (Joshi et al., 1996; Kuria et al., 2019). However, sometimes it has shown that land users' awareness of LD may not lead for conservation attempts possibly due to other factors which are beyond their control (Bewket, 2011; Moges & Holden, 2007).

Responsibility towards environment can be ascribed by individuals and institutions. However, it is still controversial to what extent it is reasonable share the responsibility for environment by individuals and institutions. Studies have cited that ascribing responsibility not only for individuals but also for institutions like government and corporation is necessary for increasing the chances for society to act in an environmentally friendly way (Fahlquist, 2009). The individual's responsibility or ascription of responsibility which can be recognized as feelings of responsibility for the negative consequences of not acting pro-environmentally is a significant antecedent of the psychological process of environmental behaviors (Han and Hyun, 2017; Kim and Hwang, 2020; Liu et al., 2020; Rezaei et al., 2019). In general, an individual's responsibility towards the environment is recognized in two-folds i.e. conventional and moral (Kaiser & Shimoda, 1999). Moral responsibility is the person's judgment that he/she is morally responsible for his behaviour which arises exercising certain powers and capacities attributed to that person (Talbert, 2019). Conventional responsibility, on the other hand, explains a person's responsibility for others such as authorities, often for receiving positive feedback. However, studies suggest that people feel morally rather than conventionally responsible in the environmental behaviors (Kaiser & Shimoda, 1999). Often people who ascribe responsibility for environmental issues to them are likely to sacrifice for the environment than those who ascribe it to others (E.g., the government) (Chen & Zheng, 2016).

Awareness raising and education of relevant stakeholders are often recognized at the initial stages of many conservation attempts to halt LD. According to the report by Ministry of Environment and Renewable Energy, Sri Lanka, (2014), UNCCD 10-Years Strategic Plan and Framework to enhance the implementation of the convention (2008-2018) in Sri Lanka has set its first out of five operational objective as the rising awareness and education to make aware/educate international, national and local stakeholders on Desertification, Land Degradation and Drought (DLDD) issues.

Failing to achieve the above strategic plan has brought a new plan for 2014-2024 with 15 operational objectives which again set a similar objective as the first objective which included an estimated cost of 110.9 Mn Rupees[11]. Generally these action plans-based national documents has cited that primary land users' are irresponsible and unaware of LD, thus recognized as some of the primary root causes of many anthropogenic activities of LD such as unsustainable farming practices and lack of soil conservation attempts (Ministry of Environment and Renewable Energy, Sri Lanka, 2014; Samaratunga & Marawila, 2006). However, those judgments have been weakly backed by sufficient empirical evidence. In that respect, stereotyping primary land users' as ignorant or irresponsible of LD seem to be irrational. Moreover, it can undermine achieving the objective of raising awareness and education as there is less comprehension on specific awareness or responsibility gaps. Author assumes that land users may be aware of LD processes in their way which is probably different from a scientific point of view and they may have not felt that they are responsible for the LD to take necessary actions perhaps due to causes and solutions for LD are beyond their control. Based on these concerns, the questions raised by the author is that whether farmers are really unaware and irresponsible of LD. In order to find answers to these questions, this study has aimed at investigating farmers' perceived indicators of and reasons for LD in rain-fed uplands and to examine farmers' perceived responsibility for causes and actions of LD in rain-fed uplands.

3.2 Methodology

This study was conducted in five purposefully selected *Grama Niladari* Divisions, i.e. *Thurukkaragama*, *Mahakiribbewa*, *Kokmaduwa*, *Bethkewa*, *Ranpathwila* in *Ranpathwila* CTVS

[11] 1USD=108 Sri Lankan Rupees in 2008

area. According to the 2018 records of *Kahatagasdigiliya* divisional secretariat, the selected administrative divisions had 1,377 farmers who possibly engaged in rain-fed upland farming.

Participants and data collection

Then a questionnaire survey was conducted in March 2019 among 291 farmers who engaged in rain-fed upland farming activities. Farmers who joined from each *Grama Niladari* Divisions are as follows, i.e. *Thurukkaragama-40*, *Mahakiribbewa-40*, *Kokmaduwa-53*, *Bethkewa-77*, *Ranpathwila-81.* Face-to-face interviews were conducted by the principal researcher and a team of 4th-year agricultural undergraduates who were experienced in the dry zone ecosystems. to collect data. After the survey, voluntary participation of the responded farmers was acknowledged with a token of appreciation

Questionnaire and measurements

The questions used in this questionnaire (See Appendix 04) was categorized into two sections, namely background characteristics and perception of LD. The English questionnaire was translated into Sinhala (local language that common in the study area), and local experts were consulted to check the suitability and the clarity of the questions. Finally, the questionnaire was pilot tested along with a field visit in the CTVS.

Data analysis

The data were analyzed using descriptive statistics, including multiple response analysis in the SPSS (Statistical Package for the Social Sciences) Version 18.0.

3.3 Farmers and their farming practices in rain-fed uplands of the *Ranpathwila* CTVS

According to Table 3.1, many responded farmers in this study area were elderly males, who possessed secondary or higher education level and nearly 27 years of experience in farming. Farming was their primary employment, while for others, it was secondary employment. They had at least one parcel of land from both upland and lowland that extent about two acres.

Table 3.1: Background characteristics of farmers (N=291).

Particulars		n	Value
The average age in years (SD)		287	51.86 (10.95)
Gender %	Male	243	83.5
	Female	48	16.5
Education level %	Primary or less	53	18.7
	Secondary level	188	66.4
	Advanced level or higher	42	14.8
The average farming experience in years (SD)		249	26.81(13.55)
Farming %	Primary employment	240	82.5
	Secondary employment	51	17.5
Number of upland parcels %	One	232	86.6
	More than one (2-4)	36	13.4
Number of lowland parcels %	One	176	66.4
	More than one (2-8)	89	33.6
The average total extent of uplands in acres (SD)		267	2.14 (3.00)
The average total extent of lowland in acre (SD)		263	2.06 (2.07)

(Authors' field survey 2019)
Note: n= number of respondents and N= number of responses

Results (Table 3.2) revealed that rain-fed farming is conducted in two seasons, i.e. *Maha* season and *Yala* season. Former gets an abundance of rainwater and enabled farming for many farmers, while the latter gets less rainwater and less opportunities for farming. Many farmers intention of rain-fed farming was to earn cash income while for few farmers, it was still for subsistence. Maize was the extensively cultivated crop by many farmers in *Maha* season while sesame was the popular crop among farmers who cultivate *Yala* season.

Table 3.2: The current farming practices in rain-fed uplands (N=291).

Particulars		n	Value
Main crops cultivated in *Maha* season (%)	Maize only	196	75.1
	Paddy only	32	12.3
	Maize with paddy/finger millet	10	4.2
	Others (E.g., finger millet, sesame, vegetable, condiment, pulses)	23	8.4
Main crops cultivate in *Yala* season (%)	Sesame	28	58.3
	Vegetables or condiments	8	16.7
	Paddy	5	10.4
	Others (E.g., finger millet, maize)	7	14.6
Purposes of cultivation (%)	Selling only	211	83.7
	Consumption only	30	11.9
	Selling and consumption	11	4.4
Land preparation methods (%)	Four-wheel tractor disk plough only	239	93.7
	Two-wheel tractor rotavator only	5	2.0
	Tractors and hoes	11	4.0
The average fertilizer usage for maize (kg/acre) (SD)	Urea	198	149.32 (90.97)
	Muriate of potash (MOP)	181	46.97 (27.80)
	Triple superphosphate (TSP)	184	39.53(21.85)

(Authors' field survey 2019)
Note1: n= number of respondents and N= number of responses
Note2: Paddy was cultivated in water stagnating upland areas.
The government recommended fertilizer application rate for rain-fed maize cultivations (Kg/acre) Urea=90, TSP=40, MOP=20 (Department of Agriculture Sri Lanka, n.d.)

According to results and field observations, the majority of farmers have ploughed their farmlands using hired four-wheel tractors which are mounted with disk plows. However, field observations revealed that farmers are less concerned on aspects such as ploughing direction as some farmers ploughed their lands along the slope. Moreover, it has been observed that there are no or limited attempts to conserve soil. It was also observed that popular crops such as maize, sesame, and chili were planted in mono-cropping pattern and paddy was cultivated only in water logging areas which sometimes include the upper parts of the tank boundary. Discussion with farmers revealed that farmers' have a high tendency to use synthetic fertilizers for crops that are grown for commercial purposes. According to the results, many farmers have used three types of straight synthetic fertilizers for maize (urea, muriate of potash and triple supper phosphate). The average applying rate of muriate of potash (46.97Kg/acre) and urea (149.32Kg/acre) was approximately 134% and 67% higher than the government recommended level consecutively while triple superphosphate (39.53Kg/acre) was around the government recommended rates (40Kg/acre). Applying rates of these fertilizers were widely distributed among respondents.

3.4 Perceived indicators and causes of land degradation in rain-fed uplands

Farmers were asked to mention the indicators which they use to recognize deforestation, soil erosion and soil fertility decline in rain-fed uplands and their perceived causes for those issues. Results (Table 3.3) found that on average, a farmer could mention one deforestation indicator and two soil erosion and fertility decline indicators. A similar pattern of responses was obtained for their perceived causes for those issues.

Table 3.3: Descriptive results of land degradation indicators and causes (N=291).

Land degradation type	Indicators					Causes				
	n	N	Mean	Median	Range	n	N	Mean	Median	Range
Deforestation	260	396	1.52	1	1-4	250	317	1.27	1	1-2
Soil erosion	272	611	2.25	2	1-7	273	542	1.99	2	1-5
Soil fertility decline	275	498	1.81	2	1-5	273	492	1.80	2	1-6

(Authors' field survey 2019)
Note: n= number of respondents, N= number of responses

Deforestation

According to the results (Figure 3.2), farmers mentioned eight indicators for deforestation. They were mainly associated with changed land-use, meteorological conditions, and animal behaviours. The most frequently cited indicator was the increased extent of rain-fed upland farms (34%) followed by water scarcity (22%) frequent droughts (19.4%), changes of rainfall pattern (13.9%) and few others (10.5%) such as elephant encroachments, and reduction of wildlife. Among those indicators, many farmers (52.3%) have mentioned the increase of croplands in uplands as a deforestation indicator.

Farmers perceived that the deforestation is associated with five causes (Figure 3.2). Among them, encroaching for cultivation (70.7%) was the highest perceived cause followed by illegal timber felling (27.8%) and few others (1.6%) such as settlement and population growth. Among perceived causes, nearly 90% of farmers cited encroaching forest for cultivation as a cause of deforestation.

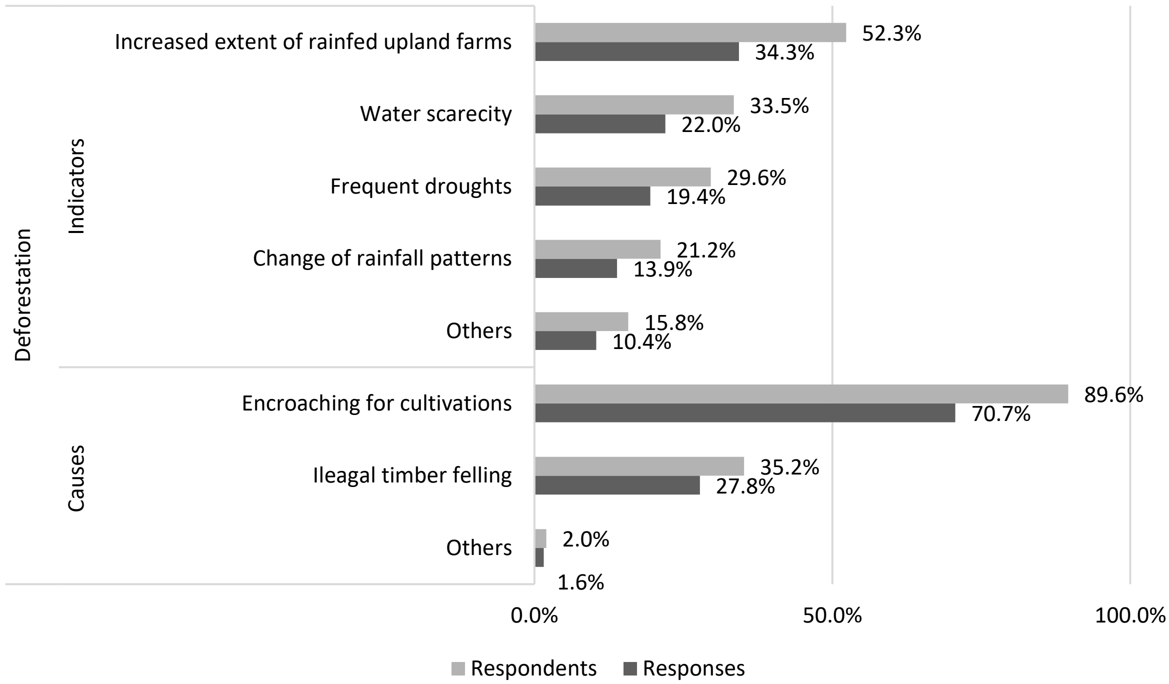


Figure 3.1: Perceived indicators and causes of deforestation
(Authors' field survey 2019)
Note: Other indicators include current forest extent compared to past, elephant encroachments, reduction of wild animals, intense sunlight. Other causes include settlement, population growth, political influences

Soil erosion

As results found (Figure 3.3), farmers mentioned 14 indicators of soil erosion. Many of these indicators were associated with onsite impacts of water erosion while few were associated with offsite impacts of water erosion. Among these indicators muddy runoff during rainstorms (29%) was the most frequently cited indicator followed by the reduction of topsoil layer (23.1%), the increase of soil gravelliness (20.3%), sedimentation of tanks (10.3%) and ten other indicators such as soil hardness, expose of bottom soil layers and rill formation. The majority of farmers have mentioned muddy runoff during rainstorms (65.1%) and reduction of topsoil layer (51.8%) as indicators of soil erosion. Meanwhile, nearly half of the farmers (45.6%) mentioned the increase of soil gravelliness as another indicator.

Farmers have perceived 13 causes that are associated with soil erosion (Figure 3.3). Eight of them were related to farming practices or related human activities, and the rest were associated with natural reasons, i.e. meteorological conditions and land characteristics. The absence of soil conservation measures (26.1%) was the frequently cited cause of soil erosion followed by the slope (23.5%), deforestation (13.1%), nature of the soil (12.4%) and several others. The majority of farmers (51.6%) have cited the absence of soil conservation as a reason for soil erosion, while nearly half of farmers (46.5%) have mentioned slope as another cause.

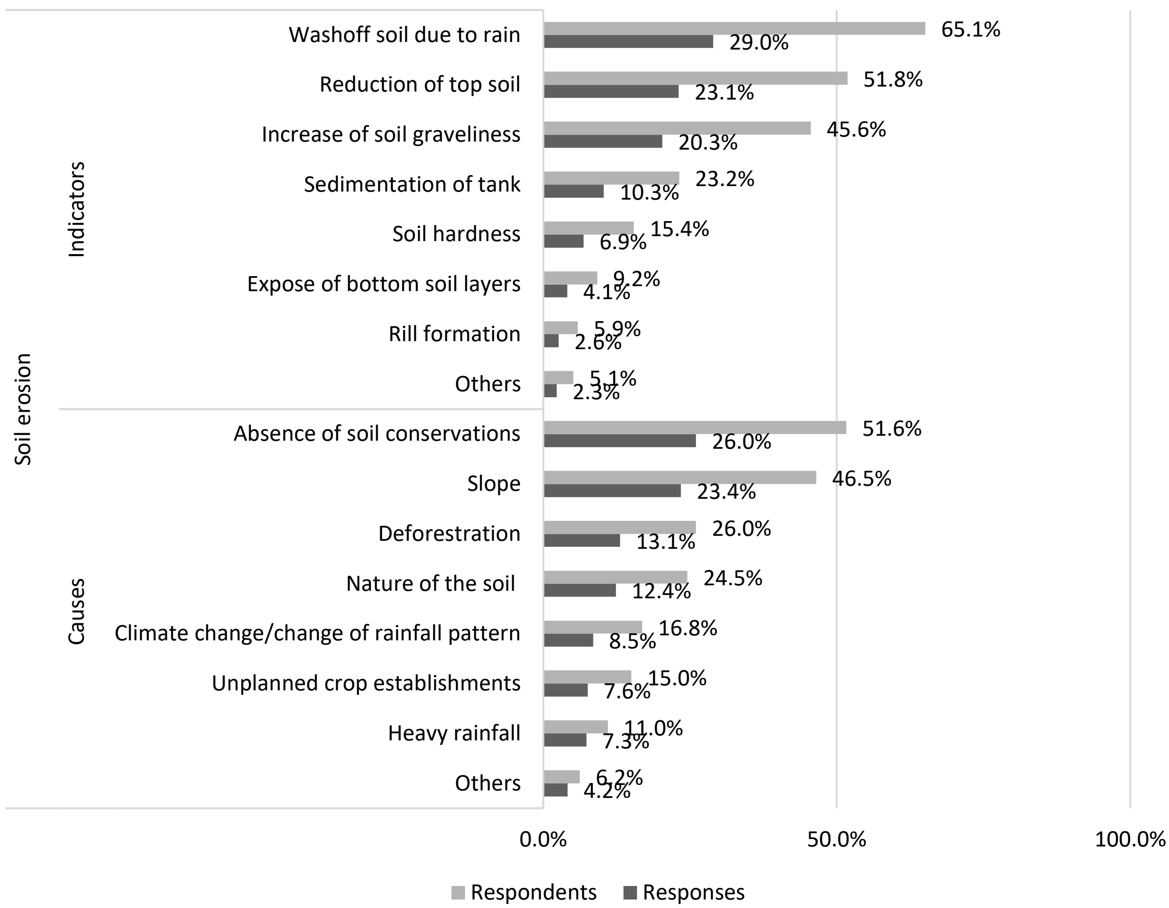


Figure 3.2: Perceived indicators and causes of soil erosion

(Authors' field survey 2019)

Note: Other indicators include flood, exposure of roots, sedimented canal, levelled slopes, low plant growth, low soil fertility, loosen soil. Other causes include heavy tillage, unmanaged drainage, weedicide application, drought, lack of attention, cattle trampling

Soil fertility decline

According to the results (Figure 3.4), farmers mentioned 11 indicators of soil fertility decline. Many of them are associated with plant performance, followed by soil condition and farm income. The most cited indicator was low crop performance (yield/growth) (43%) followed by low plant response to added fertilizer (18%), low vigour in plants around the farm (16%), paling of leaf colours (13.9%) and several others such as reduction of soil color and soil becoming sandy.

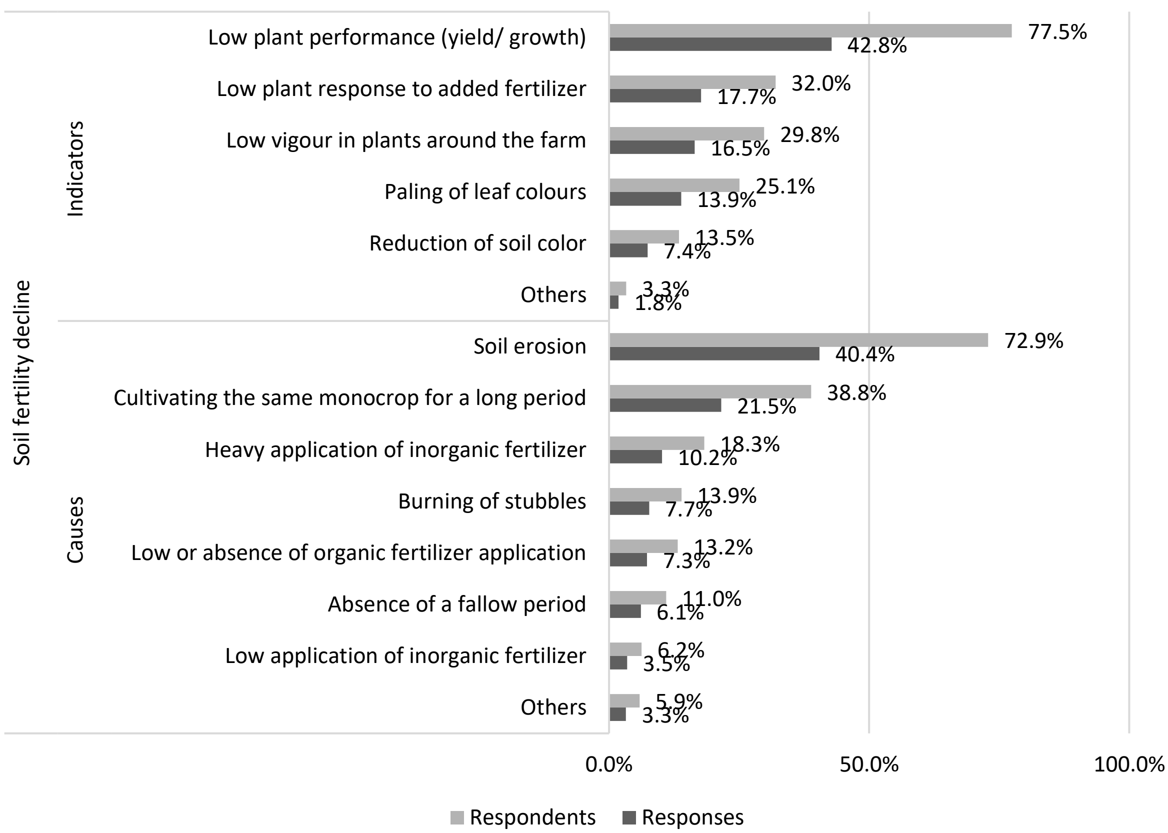


Figure 3.3: Perceived indicators and causes of soil fertility decline
(Authors' field survey 2019)

Note: Other indicators include soil becoming sandy, low income, dry soil, many weeds, hard soil, many plant diseases. Other causes include agrochemical, low microorganisms, deforestation, expose soil to sunlight, soil gravels, natural depletion, lack of rain, removal of crop residues

The majority of farmers (77.5%) have cited low plant performance as an indicator of soil fertility decline.

Farmers have perceived 15 causes of soil fertility decline (Figure 3.4). Many of those causes are related to fertilizer applications followed by cropping pattern, other types of LD, i.e. soil erosion and deforestation, and residue management. The most frequently cited cause was soil erosion (40.4%) followed by the cultivation of the same crop for a long period (21.5%) heavy application of inorganic fertilizers (10.2%) and several others such as the burning of crop stubbles and low or absence of organic fertilizer application. The majority of farmers cited (72.9%) soil erosion as an indicator of soil fertility decline.

3.5 Perceived responsibility for land degradation

In order to understand whether farmers are in control of LD, farmers were requested to mention who are mainly responsible causes of deforestation, soil erosion and soil fertility decline and taking actions to halt them. Among various responses given by farmers, three responsible parties were identified as farmers, government and others. According to Table 3.4, the majority (76%) accepted that farmers are responsible for causing deforestation, soil erosion and soil fertility decline. However, when it comes to action to halt those issues, farmers have perceived that both them (42%) and the government (57%) are responsible for it.

Table 3.4: Farmers' perceived responsibility for causing and halting land degradation in rain-fed uplands

Particulars	Farmers		Government		Others		Total responses	
Perceived responsibility for causing LD	233	76%	57	19%	16	5%	306	100%
Perceived responsibility for halting LD	147	42%	195	56%	6	2%	348	100%

(Authors' field survey 2019)

3.6 Farming practices, awareness of land degradation and moral responsibility for land degradation

Maize found to be the most extensively cultivated crop in *Maha* season in rain-fed uplands for commercial purpose. This perhaps mostly associated with the increased market demand for maize by the industries such as animal feed and ready-mixed cereal (Esham, 2014). Meanwhile it can be assumed that the popularization of hybrid seeds and mechanization have possibly facilitated extensive cultivation of maize in rain-fed uplands. Besides that it can be argued that the rapid expansion of rain-fed upland farms during the past two decades (See section 1.3.1) possibly associated with maize cultivations (Fernando et al., 2015). The less popularity to cultivate rain-fed farms in *Yala* season possibly due to the limited rain-water availability in this season. Moreover, it indicates that farmers possibly have no or limited access to other water sources such as ground water from agro-wells. This can be further understood as *Yala* cultivators mainly attempt to cultivate drought tolerant crops such as sesame (I. A. J. K. Dissanayake, Ranwala, & Perera, 2019).

Machinery usage for land preparation is possibly due to a lack of cheap labour in the main cultivation season. This perhaps due to the labour migration from agriculture sector to other industrial and service sectors for attractive job opportunities. Thus, it can be assumed that the use of machinery could become the new normal in future rain-fed upland farming. Deep ploughing up to 45cm is recommended for maize that have deep growth and drainage of excess water is highly encouraged during heavy rain periods[12]. Disk plowing facilitates reamended ploughing depth yet lack of concern on soil conservation would amplify the water erosion deeply ploughed lands during the heavy rains. Even if lands that are ploughed along the slope facilitate drainage of excess water

[12] https://www.doa.gov.lk/FCRDI/index.php/en/crop/43-maize-e

during heavy rainy seasons it would also accelerate the runoff and increase water erosion unless appropriate soil conservation strategies are not placed (Lindstrom, Nelson, Schumacher, & Lemme, 1990).

Application of synthetic fertilizer is a plus point for maintaining soil fertility, and it is probably supported by the government fertilizer subsidy program (The Government of Sri Lanka, 2018). However, its widely distributed application rates create a doubt on the usefulness of applied fertilizer and farmers' concern on government recommended rates. Perhaps farmers are unaware of recommended rates for their lands or they are using their own rates due to other reasons such as unawareness of exact land extent they cultivate and assuming that the quality of fertilizer is low.

Farmers' awareness of land degradation

The main objective of this study was to investigate farmers' awareness of LD that occurs in rain-fed uplands in the CTVS of the dry zone. Results indicate that farmers are aware of LD in their own ways. Perceived indicators imply that the farmers' recognition of LD is mainly qualitative assessments based on their physical examinations (E.g., visually observed and touched). Some of these physical examinations can be identified as onsite and offsite consequences (E.g., muddy runoff as onsite and low plant growth as offsite soil erosion indicators) or current and past consequences (E.g., muddy runoff as current and sedimentation as a past consequence of soil erosion) of LD. Farmers' perceived causes of LD indicate farmers' concern not only on natural factors but also on anthropogenic factors which closely associated with farming practices. Farmers' perceived causality among kinds of LD (E.g., soil erosion as a cause of soil fertility decline and deforestation as a cause of soil erosion) indicates that farmers are aware of interlinkages between kinds of LD, thus implies their holistic view of the land resource. Similar indicators and causes are found in other studies conducted in different localities (Bewket, 2011; Fernando et al., 2015; Kuria et al., 2019; Moges & Holden, 2007; Odendo et al., 2010; Okoba & Sterk, 2006; Twongyirwe, Bithell, & Richards, 2018; Yiran, Kusimi, & Kufogbe, 2012).

Findings indicate that the most perceived indicators are associated with certain contextual factors such as farmers' proximity to forest, morphological characteristics of the soil, and condition of the farmland. Cropland expansion, the most frequently cited deforestation indicator is probably due to farmers' proximity to the forest. The forest is a primary component in the traditional tank-village system (Dharmasena, 2010); thus, it is in the vicinity of farmers' hamlets and farms. Since farmers activities were completely bounded with the outdoor environment, their focal attention on vegetation changes in the forest is probably unavoidable. Although this study highlighted the farmers' qualitative assessment of deforestation, some similar findings cited that living in the forest vicinity can make farmers aware of both qualitative and quantitative degradation of the forest (Yiran et al., 2012).

Washing off the soil as the most cited indicator of soil erosion is possibly due to the characteristic of the soil available in the study site. The most abundant soil group in the study site is known as Reddish-Brown Earth which is dark brown to dark reddish-brown in colour, highly erodible due to weak aggregation and having a typical subsurface gravel (quartz) layer (Moorman & Panabokke, 1961). During a rainstorm, it is highly probable for this soil to be eroded while producing the reddish muddy runoff which can be easily detectable at the time when it is happening (Jayasekara et al., 2018). This indicator was contrary to the most perceived soil erosion indicators (i.e. broken soil water conservation structures and coarser soil) of previous studies (Moges & Holden, 2007; Okoba & Sterk, 2006). This contrary, perhaps due to the different focal attention is given by different land users in a different locality. For example, people in hilly areas might give more concern on broken soil and water conservation structures to detect soil erosion, whereas people live coastal areas might give how much land area that lost to the sea.

Crop performance as the most cited indicator of soil fertility decline seems to be due to its suitability as a bio-indicator. Bio-indicators are found to be reliable indicators which can provide immediate feedback on the existing soil fertility (Kuria et al., 2019). Despite being in different localities, farmers in other communities also found crop performance as their popular indicator to detect soil fertility decline (Moges & Holden, 2007; Odendo et al., 2010). When farms are mostly occupied with crops than other vegetations, crops possibly become a suitable candidate for farmers to understand the soil fertility level.

The most perceived causes of LD are anthropogenic causes. The forest encroachment for cultivations is the most perceived cause for deforestation whereas the absence of soil conservations can be identified as the most perceived cause for both soil erosion and soil fertility decline as soil erosion is the most perceived cause for soil fertility decline. These causes are already identified in previous studies (Dharmasena, 1994; Fernando et al., 2015; Ministry of Environment and Renewable Energy, Sri Lanka, 2014). Consistent with this study, some farmers in other communities in other localities have perceived that anthropogenic causes as the main reasons behind deforestation, soil erosion and soil fertility decline (Moges & Holden, 2007; Twongyirwe et al., 2018). However, there are also contrary findings in other communities who have perceived natural causes as the main reasons behind abovementioned issues (Bewket, 2011; Okoba & Sterk, 2006). This perhaps due to the influenceability of anthropogenic or natural factors with relevant to the LD in that particular area. For example, even though soil in the dry zone is highly susceptible to erosion due to low aggregability of the soil and rainfall (Jayasekara et al., 2018; Moorman & Panabokke, 1961), a study by Dharmasena(1994) has emphasized that low vegetation cover and the absence of soil conservation can result in severe soil erosion. In this respect, it could assume that many farmers perceive the causes that have high influenceability on the LD in a particular landscape.

Farmers' moral responsibility for causing and halting land degradation

One of the specific objectives of this study was to understand the farmers' perceived responsibility for LD. Farmers' perceived responsibility for the causes of LD suggests that they willingly accept that their actions are responsible for LD. Findings in the previous section also support this fact that as farmers perceived many causes of LD are associated with farming practices. However, their perceived responsibility towards actions to halt LD indicates that they are not willing to take full responsibility for it but would like to share it with the government.

With regard to moral responsibility that people ascribe to themselves, particularly in environmental behaviors (Kaiser & Shimoda, 1999), it can assume that the farmers believe they possess the necessary powers and capacities for causing LD while they believe the power and capacities for halting LD is associated with them and the government in an equal manner (Talbert, 2019).

Even some previous studies suggested that people who ascribe responsibility for environmental issues to them are likely to sacrifice for the environment than those who ascribe it to others (E.g., the government) (Chen & Zheng, 2016), findings of this study could not justify this link as it could not observe suitable actions to halt degradations. Perhaps farmers may have not perceived those issues as severe due to their myopic understanding of potential future consequences of LD (OECD, 2012, p. 12). Or else they may not have suitable resources and competences for voluntary actions, thus expect supports from other parties like government.

3.7 Conclusion

Rain-fed farming in CTVS is popular in *Maha* season than in *Yala* possibly due to water shortage. Maize is abundantly cultivated in *Maha* season, possibly due to the increased market demand and use of hybrid seeds and machineries. Land preparation by deep ploughing possibly have a high risk of soil erosion unless suitable soil conservations are not placed. Regarding farmers' awareness of LD, study concludes that the farmers are aware of LD i.e. deforestation, soil erosion and soil fertility decline in their way. Farmers' awareness on LD is mainly based on physically examining and qualitatively assessing the relevant indicators of LD (E.g., onsite and offsite, and present and past consequences of LD) and recognizing both relevant natural and anthropogenic causes of LD. Moreover, it is blended with the understanding of interlinkages behind different LD processes thus, reflects farmers' awareness embraces the holistic nature of their land resource. Considering these aspects policymakers should avoid stereotyping land users as ignorant of LD in future land management interventions. Particularly policymakers should be more specific on what aspects that the targeted land users are unaware of LD prior designing implementing awareness improvement programs with significant budgets.

Meanwhile regarding farmers responsibility towards LD, study concludes that farmers feel high moral responsibility for the causes of LD. However, they feel low or partial moral responsibility to take actions to halt LD, possibly due to difficulties for voluntary solutions. In this regard, study recommends future studies to closer look into other possible factors and mechanisms that might affect land users' decision making and behaviour for neutralizing LD.

CHAPTER 04

Understanding the Drivers of Farmers' Intention to Conserve Soil: Integrating the Theory of Planned Behaviour and the Norm Activation Model

4.1 Introduction

Soil degradation has threatened the sustainability of global food security and terrestrial ecosystems (Jie et al., 2002). Some have referred to it as a global pandemic due to its global presence (DeLong, Cruse, & Wiener, 2015). Like many other environmental issues, soil degradation is also often coupled with the aspects of human behaviour. As estimated, the human-induced soil degradation occupies 15% of the terrestrial ecosystems and results mainly from erosion, nutrient decline, salinization, and physical compaction (Oldeman, 1991). Soil erosion causes an average of 24 billion tons of soil loss annually (UNCCD, 2017). The United Nations environmental agency has indicated that such degradations must be stopped to save our future (United Nations, 2019).

In Sri Lanka, the prominent type of soil degradation is water erosion, which alone could cost about 0.74 to 1.02% of the national GDP (Ministry of Mahaweli Development and Environment, Sri Lanka, 2017). Formerly, soil degradation was only an issue in the wet zone; however, according to the Global Mechanism and expert opinions, it is now a severe issue also in the dry zone (Ministry of Mahaweli Development and Environment, Sri Lanka, 2017). Soil erosion in this area is more pronounced due to low aggregate stability of the soil (mainly Reddish-Brown Earth soil), high intensity of rainfall, and undulating nature of the landscape that enhances rainwater runoff (Jayasekara et al., 2018; Moorman & Panabokke, 1961). Following the detection of significant soil degradation in the dry zone, a consensus has been reached to make amendments to the Soil

Conservation Act and include the dry zone as a "Conservation Area" where the regulations of the act would be applicable (Ministry of Mahaweli Development and Environment, Sri Lanka, 2017).

Having healthy soil improves the quality of ecosystem services, which have an inevitable effect on realizing SDGs (S. D. Keesstra et al., 2016). Hence, the understanding of the holistic nature of sustainable soil use and management including their socioeconomic and biophysical dimensions are becoming important (Gomiero, 2016; Hou, Bolan, Tsang, Kirkham, & O'Connor, 2020; S. Keesstra et al., 2018). Concerning the sustainable use and management of soil, the role of human behaviour is critical because most essential activities, like soil conservation, are ultimately reliant on the real-world behaviour of practitioners, mostly farmers. Many policies, regulations, and programs are expected to direct the dry zone land users toward soil conservation, yet a potential bottleneck that often come across is the lack of land users' commitment to adopt conservation activities (Ministry of Environment and Renewable Energy, Sri Lanka, 2014). If land users' behaviour is appropriately and sufficiently understood, it would be useful to reflect the drivers of land users' soil conservation behaviour for effectively tailoring policies, regulations, and programs and their effective and efficient administrations.

Pro-environmental behaviour (PEB) is the common term that defines the behaviour that consciously seeks to minimize the negative effect of one's actions on the natural and built world (Kollmuss & Agyeman, 2002). Soil conservation is also a PEB, as it protects soil from any type of deterioration to maintain its fertility and productivity. Finding the drivers of any PEB guides policymaking and administration of conservation efforts. Several studies have attempted to understand farmers' soil conservation behaviour using behavioural models (Bijani et al., 2017;

Hijbeek et al., 2018; Wauters, Bielders, Poesen, Govers, & Mathijs, 2010; Werner et al., 2017). In those studies, the Theory of Planned Behaviour (TPB) (Ajzen, 1991) and similar models with self-interest motives have been widely used. However, in general, PEB is recognized as a mixture of self-interest and pro-social motives (Bamberg & Möser, 2007). Self-interest motives explain a person's behaviour resulting from his/her expectancies and benefits, whereas pro-social motives explain a person's behaviour derived from altruistic and moral beliefs (what is right and wrong). "Moral norm" is a significant antecedent of PEB (Bamberg & Möser, 2007) and the most widely used additional variable added to the TPB in PEB studies (Yuriev, Dahmen, Paillé, Boiral, & Guillaumie, 2020). However, empirical studies that would incorporate both pro-social motives and self-interest motives to understand soil conservation behaviour are scant. Therefore, the current study attempted to understand the soil conservation intention of farmers in the dry zone of Sri Lanka using a model integrating the popular self-interest model, the TPB, and a pro-social model, the Norm Activation Model (NAM) (Schwartz, 1977).

4.2 The Theory of Planned Behaviour and the Norm Activation Model

The Theory of Planned Behaviour

The TPB is an extended version of the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) of which behavioural intention found as the only reliable psychological determinant of actual behaviour (Figure 4.1). The TRA suggests that when a person possesses volitional control over behaviour, that person's attitude and subjective norms towards behaviour precede the intention towards the behaviour. However, human behaviour is not always under an individual's control; hence, TPB was introduced after incorporating perceived behavioural control into the TRA (Ajzen, 1991). The TPB proposes three significant psychological determinants of intention, i.e., Attitude (AT), Subjective Norms (SN), and Perceived Behavioural Control (PBC) over the behaviour (Ajzen, 1991). According to explanations, the intention represents an individual's aim to perform a specific behaviour, AT is the person's level of favorable and unfavorable evaluation of performing the behaviour, SN is the perceived social pressure to perform or not to perform a behaviour, and PBC is the perceived ease or difficulty of performing the behaviour (Ajzen, 1991). In general, the TPB explains that a person develops a firm intention to perform a behaviour if that person has more favorable AT and SN towards behaviour and higher the perceived control over the behaviour (Ajzen, 1991). However, relationships between constructs and relative importance of determinants vary across behaviours and contexts (Ajzen, 1991).

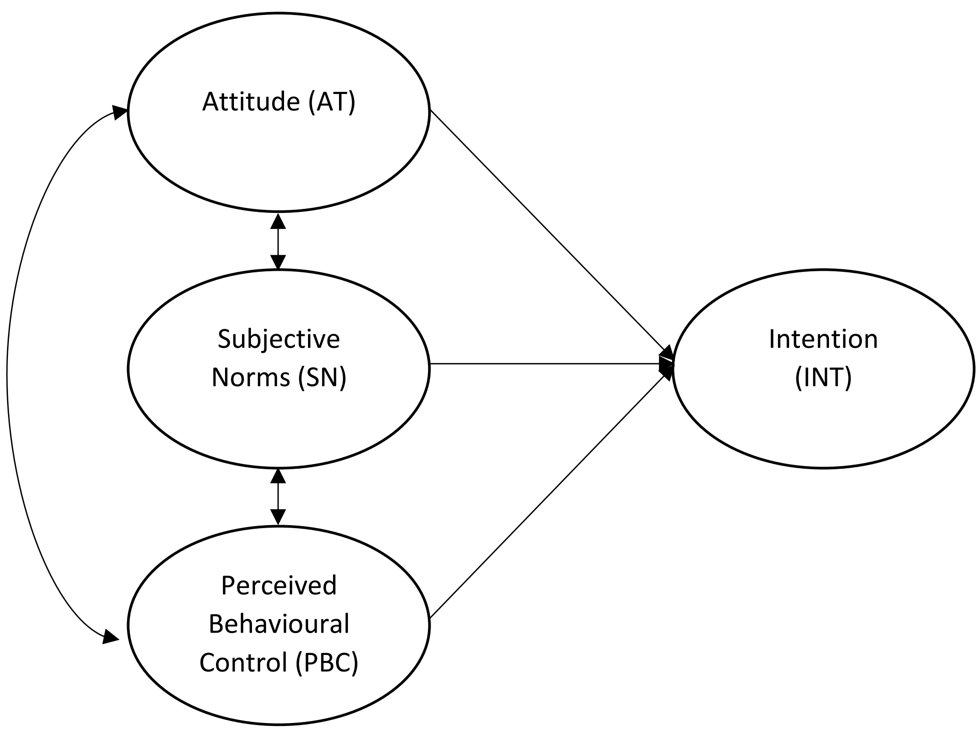


Figure 4.1: The Theory of Planned Behaviour (Ajzen, 1991)

The TPB has been successfully used since 1995 to understand many PEBs, including recycling, traveling, and energy savings (Yuriev et al., 2020). Additionally, it has been successfully used in understanding soil conservation behaviour. Using the TPB, Wauters and others (2010) found that attitude is a critical antecedent of soil conservation intention. Werner and others (2017) found that attitude and perceived difficulty of the behaviour precede intention when applied to cover cropping. Hijbeek and others (2018) understood that the attitude, subjective norms, and a perceived decrease in soil organic matter content are the critical antecedents of the intention to increase soil organic matter content. Using a similar approach, Bijani and others (2017) found that attitude, and social pressure towards the behaviour are critical precursors of soil conservation concern which identified as the antecedent of soil conservation behaviour..

The Norm Activation Model

The Norm Activation Model (NAM) (Schwartz & Howard, 1981) has been widely used to explain altruistic or pro-social and pro-environmental behaviours (De Groot & Steg, 2009; Song, Zhao, & Zhang, 2019; Steg & Groot, 2010). According to the NAM, three main factors, namely Personal Norms (PN), denoted as feeling a " moral obligation to perform or refrain from specific actions" (Schwartz & Howard, 1981, p. 191); Awareness of Consequences (AC), defined as "whether someone is aware of the negative consequences for others or for other things one values when not acting pro-socially" (De Groot & Steg, 2009, p. 426), and Ascription of Responsibility (AR), defined as "feelings of responsibility for the negative consequences of not acting pro-socially" (De Groot & Steg, 2009, p. 426), predict altruistic behaviours. PN is the main determinant of behaviour or behavioural intention. Depending on how AR and AC affect the PN, they have been used as either mediators or moderators in the model (Steg & Groot, 2010). However, the findings of a series of studies by De Groot and Steg (2009) highlighted their roles as mediators (Figure 4.2). They explained that PN is an antecedent of intention to perform a behaviour and mediates the relationship between AR and the intention. They further cited that AR mediates the relationship between AC and PN. Therefore, in the mediation model, people with higher awareness of the consequences of not acting pro-socially or pro-environmentally have a higher tendency to accept the responsibility for those consequences. Higher attribution of the responsibility generated greater feelings of moral obligation to engage in pro-social or pro-environmental activities.

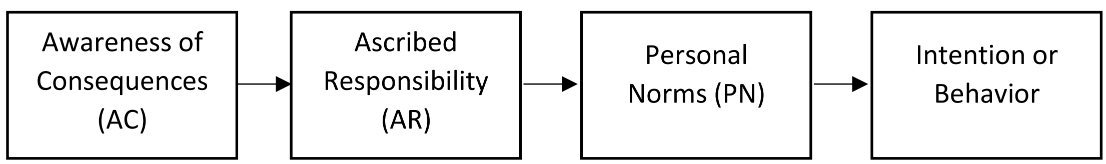


Figure 4.2: The Norm Activation Model (Schwartz and Howard, 1981)

Proposed integrated model and hypotheses

The proposed model (Figure 4.3) is expected to explain how the social and psychological constructs in both TPB and NAM determine the soil conservation intention of farmers. Lately, a similar approach has been used increasingly to explain intentions to perform different PEBs. Those PEBs include performing civilized manners at tourism destinations such as protecting seawater from pollution, keeping the beaches clean, maintaining seaside walks without damage, etc. (J. Liu, An, & Jang, 2020), ordering drone-delivered food (Kim & Hwang, 2020), using integrated pest management (Rezaei et al., 2019), choosing organic menu items (Shin, Im, Jung, & Severt, 2018), using sustainable transport (Y. Liu, Sheng, Mundorf, Redding, & Ye, 2017), participating in the environmental complaint (Zhang, Geng, & Sun, 2017), and recycling (J. Park & Ha, 2014). These combined models could explain more than 50% of the variance in behavioural intention, as opposed to using TPB or NAM as standalone models (Armitage & Conner, 2001; De Groot & Steg, 2009).

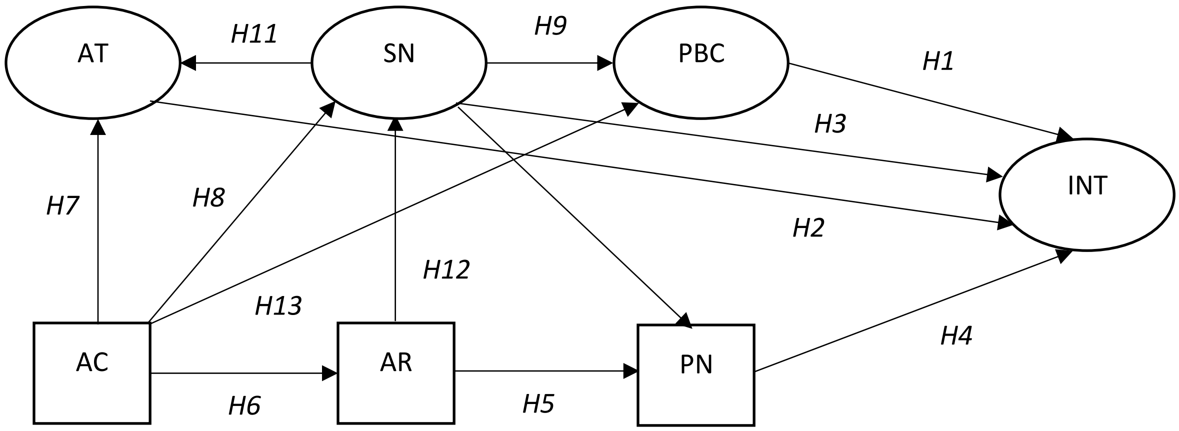


Figure 4.3: The integrated model

Following the original TPB and NAM models, the AT, SN, PBC, and PN are expected to be the antecedents of the intention to perform soil conservation in the hypothesized integrated model. The positive effect of SN on the intention is also hypothesized to be separately mediated by AT, PBC, PN (Bamberg & Möser, 2007). The AC for not performing the behaviour is hypothesized to be positively effecting AT, SN, and PBC (Bamberg & Möser, 2007; J. Liu et al., 2020; J. Park & Ha, 2014; Rezaei et al., 2019; Zhang et al., 2017). Meanwhile, as it is already understood, the PN is hypothesized to mediate the positive effect of AR on the intention, and AR is hypothesized to mediate the positive effect of AC on PN (De Groot & Steg, 2009). Besides the above relationships, this study hypothesized that AR has a positive effect on SN in that people who will accept responsibility for environmental consequences will be likely to increase their perceived social pressure to act environmentally. All of the hypotheses of this study (*H1*-*H13*) are listed as follows.

H1. *Perceived behavioural control will positively affect the intention*

H2. *Attitude will positively affect the intention*

H3. *Subjective norms will positively affect the intention*

H4. *Personal norms positively effect on the intention*

H5. *Ascription of responsibility will positively affect personal norms*

H6. *Awareness of consequences will positively affect ascription of responsibility*

H7. *Awareness of consequences will positively affect the attitude*

H8. *Awareness of consequences will positively affect subjective norms*

H9. *Subjective norms will positively affect the perceived behavioural control*

H10. *Subjective norms will positively affect personal norms*

H11. *Subjective norms will positively affect the attitude*

H12. *Ascription of responsibility will positively affect subjective norms*

H13. *Awareness of consequences will positively affect the perceived behavioural control*

4.3 Methodology

Participants and data collection

This study targeted farmers who conduct farming in the rain-fed uplands of the *Ranpathwila* CTVS in *Kahatagasdigiliya* divisional secretariat. A convenient sample of 219 farmers were selected from five *Grama Niladari* Divisions, i.e. *Thurukkaragama-40*, *Mahakiribbewa-40*, *Kokmaduwa-53*, *Bethkewa-77*, *Ranpathwila-81.*, where it had 1,377 farmers who possibly engaged in rain-fed upland farming according to the 2018 records of the divisional secretariate.

Formal permission was obtained from the responsible regional government officials to survey the villagers. The principal researcher and a group of 4th year agricultural undergraduates who were experienced in the dry zone ecosystems visited farmers' houses or the farms in March 2019 to collect data. Farmers were informed about the purpose of the study and requested for their voluntary participation before conducting face-to-face interviews. Each respondent was provided with a token of appreciation for their voluntary participation. Out of 291 responses, only 234 were used in the analysis after eliminating the missing values.

Questionnaire and measurements

A questionnaire (See Appendix 05) was designed to gather farmers’ background information and assess the constructs of the hypothesized model. The variables used to collect farmers’ background information are listed in Table 4.1. Questions (items) measuring the constructs were designed based on previous studies (Ajzen, 1991; De Groot & Steg, 2009; J. Park & Ha, 2014; Shin et al., 2018; Werner et al., 2017) and adjusted to fit the context. A Likert scale (1-5) was used to evaluate the responses to all the questions. The English questionnaire was translated into Sinhala (the common local language in the study area), and local experts were consulted to check the suitability and the clarity of the questions. Finally, Cronbach’s α value (>0.7) was calculated to establish the internal consistency of the questions used in each construct (Table 4.2).

Data analysis

The data and the hypothesized model were analyzed using structural equation modeling with the maximum likelihood estimation procedure in the Analysis of Moment Structures (AMOS) software version 26 and SPSS 18. Following the steps recommended by Hair and others (2014), a confirmatory factor analysis (CFA) was conducted first to assess the model fit of all the measurement models, i.e., the TPB, NAM and the integrated model, along with constructs' validity. The validity of the constructs was tested using both convergent and discriminant validity tests. Convergent validity assumes that the items that are indicators of a specific construct should be sufficiently related. It is established when factor loadings of items and average variance extracted (AVE) are greater than 0.5 (Fornell & Larcker, 1981; Hair et al., 2014), and construct reliability (CR) values of the constructs are greater than 0.7 (Hair et al., 2014). Discriminant validity refers to items that are meant to be indicators of only one construct unrelated to another construct. In other words, it is the extent to which a construct is distinct from other constructs (Hair et al., 2014). It is established when a construct's AVE is greater than its squared correlations with other constructs (Fornell & Larcker, 1981). Subsequently, the structural models were tested for their appropriateness and to answer the hypotheses. Following the previous studies, the model fit indices were assessed: Chi-square value (χ^2) (insignificant), degree of freedom (*df*), Relative Chi-square value ($\chi^2/df \leq 3$), Comparative Fit Index (CFI>0.90), and Root Mean Square Error of Approximation (RMSEA<0.08) due to their sufficient and unique information to evaluate a model (Hair et al., 2014; Han & Hyun, 2017; Schreiber, Nora, Stage, Barlow, & King, 2006; Schumacker & Lomax, 2016).

4.4 Results

Background of the current farmers

As Table 4.1 shows, these farmers were around 52 years old. Most of them were males, which is common in the dry zone agrarian communities. The maximum achieved education level of many farmers was up to the ordinary level. Farming was the primary employment for many farmers, while for others, it was their secondary employment. Farm households had nearly three family members and owned nearly one parcel of rain-fed upland, which was around two acreages. These respondents have engaged in farming for nearly 30 years in their lifetime. Therefore, they were well experienced in rain-fed upland farming in the dry zone.

Table 4.1: Background characteristics of farmers (N=234)

Variable		N	% / Mean (SD)
Age		231	52.2 (10.8)
Gender	Male	198	84.6
	Female	36	15.4
Maximum achieved education level	No	5	2.2
	Primary	39	17.2
	Ordinary level	148	65.2
	Advanced level	29	12.8
	Higher education	6	2.6
Engaged in farming as the	Primary employment	192	83.1
	Secondary employment	39	16.9
Number of family members		229	2.9 (1.2)
Number of upland parcels		214	1.2 (0.4)
The extent of upland farm in acreage		214	1.9 (3.2)
Farming experience in years		200	26.9 (13.4)

(Author's filed survey, 2019)

The measurement model

The results of the CFA showed that the standard factor loadings of all the items of constructs in measurement models (The TPB,NAM and the Integrated model) were greater than 0.5 (between 0.508 to 0.917) (Table 4.2), demonstrating that items loaded on their corresponding constructs. The Cronbach's alpha values of all the constructs (between 0.72 to 0.89) and composite/construct reliabilities of constructs in all measurement models (between 0.72 to 0.89) were greater than 0.7 (Table 4.2), suggesting sufficient construct reliability.

Except for the values of construct AC (0.468 in the NAM and 0.469 in the integrated model), the average variance extracted (AVE) values of all the constructs in the measurement models were greater than 0.5 (ranging from 0.504 to 0.673) (Table 4.3), showing satisfactory convergent validity. Furthermore, the AVE of each construct in the measurement models was greater than its squared correlation with other constructs, showing an acceptable discriminant validity (Table 4.3). Finally, different model fit indices indicated that all the measurement models were adequately fit (Table 4.4).

The structural equation model

Structural equation modeling was performed to examine the intention to perform the soil conservation behaviour using the original TPB (Figure 4.4), NAM (Figure 4.5) and the integrated model of TPB and NAM (Figure 4.6). All the model fit indices were in acceptable ranges, indicating their suitability to explain the intention (Table 4.5). The integrated model explained 51%, the TPB explained 41% and NAM explained 40% of the variance, indicating higher explanatory power of the integrated model than both TPB and NAM as standalone models. (Figures 4.4, 4.5 and 4.6)

Among the constructs of the original TPB, PBC was the only significant predictor of intention to perform soil conservation in the tested TPB and integrated models (Table 4.6). Therefore, the *H1* was supported, refuting the *H2* and *H3.* PN, the antecedent of the behaviour intention in the NAM, was found to be a significant predictor of the intention in the tested NAM and integrated models (Table 4.6); hence, *H4* was supported. Additionally, the sequential relationships between the constructs of the original NAM (AC→AR→PN) were validated in the NAM and integrated models; thus, *H5* and *H6* were supported (Table 4.6).

AR had a significant effect on the SN, and AC had a significant effect on AT, PBC and SN. Therefore *H7, H8, H12,* and *H13* were supported in the integrated model (Table 4.6). Meanwhile, the SN was a significant predictor of AT, PBC, and PN. Therefore, *H9, H10,* and *H11* were supported in the integrated model (Table 4.6). Despite the absence of a direct relationship with the intention, indirect relationships between SN (β=0.486, $p<0.01$), AR (β=0.266, $p<0.01$), and AC (β=0.304, $p<0.01$) and intention were significant in the integrated model (Table 4.6). Considering the influence of all constructs and their interrelationships, it was evident that except AT, all the constructs in the integrated model significantly influenced the intention either directly or indirectly. Finally, the result of the significant total effect on the intention shows that the effect of PN (β=0.477, $p<0.01$) was the highest, followed by PBC (β=0.464, $p<0.01$), SN (β=0.376, $p<0.01$), AC (β=0.304, $p<0.01$), and AR (β=0.266, $p<0.01$). Therefore, integrating constructs from self-interest and pro-social behaviour and accounting for their interrelationships enhanced the predictability of intention to perform the behaviour.

Table 4.2: Items, responses, and construct reliability

Construct	Items	Responses % 1	2	3	4	5	Std. factor loadings	t-value	α	CR
INT	*My plan to…* [(a)]	12.0	16.2	23.5	26.5	21.8	0.778 0.764 *0.771*	fixed	0.84	0.85 0.85 *0.85*
	My preference to... [(a)]	4.3	8.1	20.9	52.6	14.1	0.766 0.752 *0.768*	11.94 11.59 *11.81*		
	My motivation to... [(a)]	6.0	9.8	25.2	44.0	15.0	0.893 0.917 *0.897*	13.58 13.19 *13.08*		
PBC	*My confidence to…* [(a)]	3.4	7.7	25.2	47.0	16.7	0.876 0.884	fixed	0.79	0.80 0.79
	My ability to... [(a)]	1.3	13.2	27.4	45.7	12.4	0.814 0.805	13.76 13.66		
	Finding time to… [(b)]	3.8	22.6	29.5	29.9	14.1	0.577 0.572	9.07 9.01		
	Finding materials to... [(b)]	3.8	31.6	21.4	29.5	13.7	0.511 0.508	7.87 7.83		

SN	*People whose ideas I respect most think that I should…* [c]	4.7	10.7	23.1	49.6	12.0	0.830 0.847	fixed	0.84	0.85 0.85
	My family members think that I should... [c]	1.7	9.8	23.5	51.3	13.7	0.801 0.788	13.01 12.84		
	Agricultural instructors want me to... [c]	8.1	9.4	19.2	47.9	15.4	0.671 0.682	10.57 10.83		
	My fellow farmers think that I should… [c]	7.3	17.5	16.7	50.0	8.5	0.734 0.719	11.76 11.55		
AT	*Disadvantageous: Advantageous*	.9	3.0	5.1	29.1	62.0	0.728 0.734	fixed	0.83	0.83 0.83
	Bad: Good	.9	2.6	7.7	29.9	59.0	0.848 0.854	11.37 11.27		
	Foolish: Wise	.0	2.1	3.8	18.8	75.2	0.786 0.776	10.9 10.8		
PN	*I have a moral value to…* [c]	.4	5.1	15.8	53.4	25.2	0.783 *0.783*	fixed	0.89	0.89 *0.89*
	My feelings encourage me to... [c]	1.7	9.0	22.6	48.7	17.9	0.845 *0.831*	13.89 *13.05*		
	I feel honest to myself if I… [c]	.4	9.8	16.2	50.0	23.5	0.841 *0.853*	13.81 *13.92*		

	It matches with my principles if I... (c)	1.7	9.4	17.1	54.3	17.5	0.809 *0.813*	13.18 *13.17*		
AR	*All farmers responsible for all the negative outcomes if they not...* (c)	1.3	15.8	19.2	32.1	31.6	0.906 *0.900*	fixed		
	No farmer can avoid the responsibility of the issues of not... (c)	1.7	13.7	21.4	33.3	29.9	0.892 *0.897*	15.93 *15.84*	0.83	0.84 *0.84*
	We farmers, as the users of uplands, should be responsible for the negative outcomes of not... (c)	5.1	18.4	40.2	22.2	14.1	0.583 *0.583*	9.56 *9.54*		
AC	*High stoniness will result if not...* (c)	2.1	9.0	12.0	37.2	39.7	0.680 *0.657*	fixed		
	Difficult in land preparation will occur if not... (c)	.9	6.4	20.9	35.5	36.3	0.705 *0.728*	7.71 *7.22*	0.72	0.73 *0.72*
	Low yield will result if not...(c)	.9	4.7	12.4	40.2	41.9	0.668 *0.664*	7.55 *7.14*		

(Author's field survey, 2019)

Note1: INT= Intention, PBC= Perceived behavioural control, SN=Subjective norms, AT=Attitude, PN= Personal norms, AR= Ascription of responsibility, AC= Awareness of consequences, α = Cronbach's Alpha, CR= Construct/ Composite reliability

Note2: Items of all the constructs related to the behavioural statement of "*Conserve soil in rain-fed upland farms in the next main cultivation season.*"

Note3: Likert scales include a = (1= very low and 5=very high), b = (1=very easy and 5=very difficult), c = (1= highly disagree and 5= highly agree)

Note4: Underlined values are for the TPB and the italicized values are for the NAM

Table 4.3: Convergent and discriminant validities of the constructs

Constructs	AVE	Squared correlation of constructs						
		Int	PBC	SN	AT	PN	AR	AC
INT	0.663 0.663 *0.663*		0.404 0.394	0.187 0.181	0.187 0.184	0.396 *0.392*	0.153 *0.151*	0.018 *0.016*
PBC	0.506 0.504			0.323 0.326	0.291 0.291	0.260	0.128	0.110
SN	0.580 0.580				0.193 0.187	0.332	0.078	0.131
AT	0.622 0.623					0.303	0.100	0.162
PN	0.672 *0.673*						0.307 *0.306*	0.035 *0.036*
AR	0.652 *0.651*							0.159 *0.166*
AC	0.469 *0.468*							

(Author's field survey,2019)
Note1: AVE, Average variance extracted, INT= Intention, PBC= Perceived behavioural control, SN=Subjective norms, AT=Attitude, PN= Personal norms, AR= Ascription of responsibility, AC= Awareness of consequences
Note2: Underlined values are for the TPB and italicized values are for the NAM

Table 4.4: Model fit indices of measurement models

Measurement models	X^2	df	X^2/df	CFI	RMSEA
The Theory of Planned Behaviour	181.237	71	2.55	0.930	0.082
The Norm Activation Model	123.42	59	2.10	0.958	0.068
Integrated model	446.609	231	1.93	0.920	0.066

(Author's field survey,2019)
Note: X^2=Chi-square, df= Degree of freedom, X^2/df= Relative Chi-square, CFI=Comparative fit index, RMSEA=Root Mean Square Error of Approximation

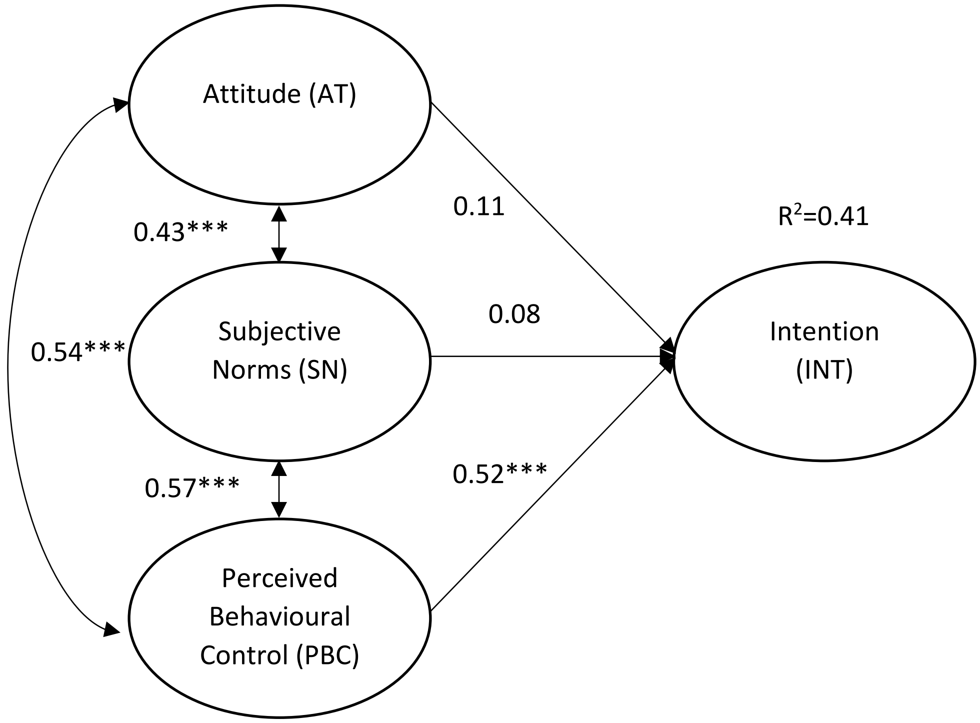


Figure 4.4: The structural equation model of the Theory of Planned Behaviour

(Author's field survey, 2019)
Note: *** $p < 0.01$

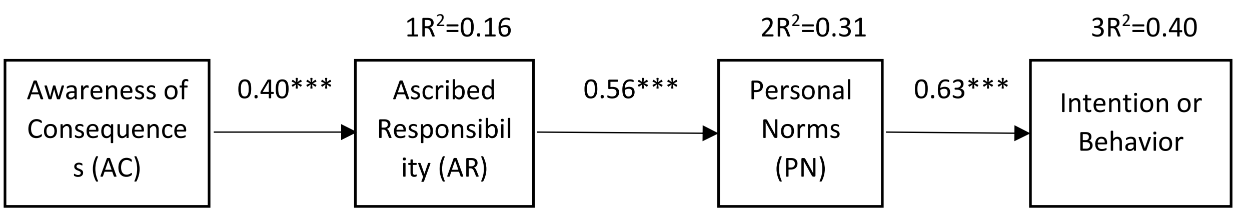


Figure 4.5: The structural equation model of the Norm Activation Model

(Author's field survey, 2019)
Note: *** $p < 0.01$

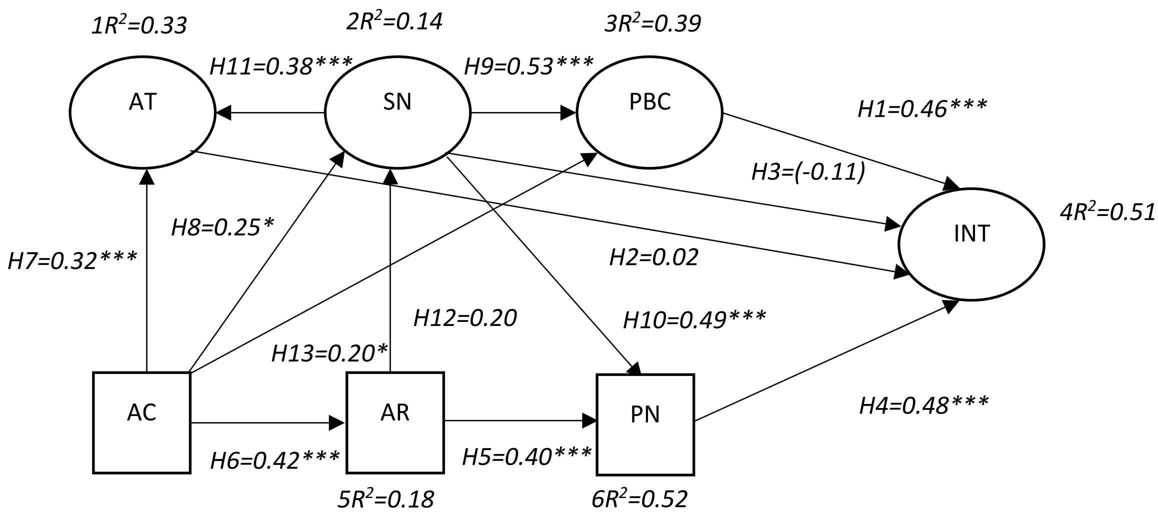


Figure 4.6: The structural equation model of the integrated model

(Author's field survey, 2019)
Note1: Shapes in dotted lines represent the NAM constructs, whereas shapes in straight lines represent the TPB constructs
Note2: *p< 0.1: ** p < 0.05; *** p < 0.01

Table 4.5: Model fit indices of structural models

Structural models	X^2	*df*	X^2/df	CFI	RMSEA
The Theory of Planned Behaviour	181.237	71	2.55	0.930	0.082
The Norm Activation Model	124.364	62	2.01	0.959	0.066
Integrated model	521.283	239	2.18	0.904	0.071

(Author's field survey, 2019)
Note1: X^2=Chi-square, *df*= Degree of freedom, X^2/df= Relative Chi-square, CFI=Comparative fit index, RMSEA=Root Mean Square Error of Approximation
Note2: Chi-square difference between the integrated model and TPB is 340.046, df=168, p<0.01

Table 4.6: Results of structural models

Hypothesis	Paths	Theory of Planned Behaviour			Norm Activation Model			Integrated Model		
		Coefficient	t-value	Result	Coefficient	t-value	Result	Coefficient	t-value	Result
H1	PBC →Int	0.523	5.351***	Supported				0.464	5.389***	Supported
H2	AT→Int	0.114	1.421	Not Supported				0.015	0.213	Not Supported
H3	SN→Int	0.077	0.941	Not Supported				-0.110	-1.067	Not Supported
H4	PN→Int				0.629	8.053	Supported	0.477	5.527***	Supported
H5	AR→PN				0.556	7.731	Supported	0.400	6.240***	Supported
H6	AC→AR				0.404	4.682	Supported	0.422	4.881***	Supported
H7	AC→AT							0.316	3.626***	Supported
H8	AC→SN							0.252	2.678*	Supported
H9	SN→PBC							0.528	6.846***	Supported
H10	SN→PN							0.492	7.074***	Supported
H11	SN→AT							0.384	4.805***	Supported

H12	AR→ SN	0.198	2.402*	Supported
H13	AC→ PBC	0.198	2.532*	Supported

Construct	The indirect effect on Intention	Total effect on Intention
PBC	NA	0.464***
AT	NA	0.015
SN	0.486***	0.376***
PN	NA	0.477***
AR	0.266***	0.266***
AC	0.304***	0.304***

(Author's field survey, 2019)
Note1: *p< 0.1: ** p < 0.05; *** p < 0.01
Note2: Bootstrapping method was performed with 500 bootstraps at 95% bias-corrected CI level

4.5 Determinants of farmers' soil conservation behaviour

The results showed that the integrated model is superior to the TPB and NAM model in the explanatory power of the intention variance. This result is consistent with the previous findings (Han & Hyun, 2017; Rezaei et al., 2019). Additionally, this study confirmed the effectiveness of integrating self-interest and pro-social constructs while considering their interrelationships in explaining pro-environmental intentions (Bamberg & Möser, 2007; Han & Hyun, 2017; Kim & Hwang, 2020; J. Liu et al., 2020; J. Park & Ha, 2014; Rezaei et al., 2019; Shin et al., 2018; Zhang et al., 2017). Instead of depending only on the direct effects of constructs on behavioural intention, like in the TPB model or the NAM, the integrated model has been advantageous in unfolding how constructs affect the intention both directly and indirectly. Although few constructs had significant direct relationships, many constructs had significant indirect relationships, supporting the conceptualized relationships among the constructs. Among the proposed hypotheses, most hypotheses, *H1 to H13* except for the *H2* (Attitude→Intention) and *H3* (Subjective norms→Intention), were validated.

The hypothesized antecedents of soil conservation intention were derived from both TPB and NAM. Among them, PN was the strongest predictor of the intention in the integrated model. This result was consistent with recent studies that investigated several other pro-environmental behaviours (Han & Hyun, 2017; Rezaei et al., 2019; Zhang et al., 2017). These studies emphasized how one's feeling of moral obligation motivates that person to engage in pro-environmental acts. According to Onwezen and others (2013), PN stimulates one's forecasted feeling, i.e., pride or guilt of performing or not-performing pro-environmental behaviour. Subsequently, these anticipated emotions result in actual behaviours or behavioural intentions. Therefore, it is evident that farmers who feel a higher moral obligation to conserve soil are likely to engage in soil conservation activities.

PBC was an antecedent of the intention in the TPB and the integrated models. Rezaei and others (2019) reported similar findings. Many other studies have used only an integrated model of TPB, and in some studies using NAM, PBC was an antecedent of pro-environmental behaviours (Han & Hyun, 2017; Kim & Hwang, 2020; J. Liu et al., 2020; Onwezen et al., 2013; J. Park & Ha, 2014;

Rezaei et al., 2019; Shin et al., 2018; Zhang et al., 2017). Ajzen (2002) explained that the PBC comprises two components, namely self-efficacy (mainly the associated with the ease or difficulty of performing a behaviour) and controllability (the extent to which performance is vested in the actor). Therefore, it can be presumed that stronger perceived self-efficacy (E.g., confidence and competence) and controllability (E.g., resourcefulness) of farmers over the soil conservation increases their intention to conserve soil.

In contrast with almost all previous similar studies (Han & Hyun, 2017; Kim & Hwang, 2020; J. Liu et al., 2020; Y. Liu et al., 2017; J. Park & Ha, 2014; Rezaei et al., 2019; Shin et al., 2018; Zhang et al., 2017), AT was insignificant in the integrated model as well as in the TPB model, which is perhaps due to the situatedness of the intended behaviour. As Marcinkowski and Reid (2019) explained, the valency of referents and the moderators (i.e., personal and situational) affect the relative strength of the attitude-behavioural relationship. For example, in this study, the soil conservation behaviour has been operationalized as the 'next main cultivation season,' which was six months away at the time of data collection. Indeed, many farmers have shown a favorable attitude towards the behaviour, as it is associated with many benefits to their farm and farming practices. However, not all farmers perceived performing conservation behaviour in the next main season as easy, probably due to lack of self-efficacy and/or controllability. Therefore, the authors assumed that PBC could moderate the relationship of the attitude with the intention (Marcinkowski & Reid, 2019), which this study did not attempt to investigate.

In this study, SN was not found to be a proximal predictor of the intention in both TPB and integrated models. Still, it was rather a significant distal predictor in the integrated model. AT, PN, and PBC mediated the indirect effect of SN on intention. This result was consistent with previous studies (J. Park & Ha, 2014; Rezaei et al., 2019; Zhang et al., 2017). Those studies explained that the effect of SN had been absorbed by other constructs, namely PN, PBC, and AT in the integrated models. In other words, SN positively and significantly affected farmers' judgment of the easiness and usefulness of and their moral obligation toward the soil conservation. Although the mechanisms underlying the effect of SN on the AT is less clear, significant overlaps between SN and AT has been found when the AT is social (H. S. Park, 2000).

Furthermore, individuals in a collectivistic culture can score high on SN and social attitudes (Park, 2000). Since Sri Lanka is a collectivistic culture (D. M. N. S. W. Dissanayake & Semasinghe, 2015), it can be assumed that the will of important others significantly affects the attitude of individual rural farmers. Concerning the effect of SN on the PBC, it is evident that important others affect farmers' perceived difficulty of soil conservation. According to Quintal et al. (2010), such a relationship, which can be viewed as a social pressure to act, affects people's understanding of the external barriers to acting. Regarding SN influence on PN, Bamberg and Möser (2007) found that SN stimulates people's anticipated guilt toward not performing and subsequently stimulates moral obligations. This is perhaps due to fear of social sanctions for not performing the act expected by the important people. Considering the findings described above, it is apparent that the value of SN should not be undermined only by considering its direct influence on soil conservations.

AC has a significant indirect influence on soil conservation intention. Its sequential relationship (AC→AR→PN) with the soil conservation intention is consistent with the initial conceptualization of altruistic behaviour in NAM (De Groot & Steg, 2009; Schwartz, 1977; Schwartz & Howard, 1981). According to them, the more people recognized the problems resulting from not acting altruistic, the more responsibility for those problems they attributed to themselves, subsequently leading to an increased feeling of moral obligation to perform altruistic behaviour. Similar findings were reported by other studies that used an integrated model of TPB and NAM (Han & Hyun, 2017; Kim & Hwang, 2020; J. Liu et al., 2020; Rezaei et al., 2019). Meanwhile, in this study, AC was also found to be positively affecting people's AT, SN, and PBC. These results are consistent with previous studies (Han & Hyun, 2017; J. Liu et al., 2020; J. Park & Ha, 2014; Rezaei et al., 2019; Zhang et al., 2017). According to their explanations, people who are more aware of the consequences of not performing environmental behaviour are more likely to feels favorable towards, socially pressured to engage in, and capable of performing the pro-environmental action. Therefore, it is evident that increased farmers' awareness of the negative outcomes of not conserving soil tends to lead to more favorable perceptions of soil conservation, perceptions that others expect farmers to engage in soil conservation, and perceptions of soil conservation as an easy task.

Lastly, consistent with previous studies (Bamberg & Möser, 2007), this study also found that AR has a significant effect on SN. This indicates that when people attribute the responsibility for the consequences of not performing environmentally, they are likely to perceive that important others expect them to act environmentally to reduce the negative consequences. Agricultural activities are highly associated with soil degradation and subsequent negative consequences. From the above results, farmers certainly feel that they are responsible for those issues, and they believe that important others, such as fellow farmers and agricultural instructors, expect them to engage in behaviours that halt soil degradation.

4.6 Conclusion

Investigation of the pro-environmental behaviour of people in different contexts is essential, as a lack of understanding often results in misinterpreting the underlined causes of behaviours. To the best of the authors' knowledge, this study provides the first insights into farmers' intention of soil conservation behaviour through empirically investigating an integrated model of TPB and NAM. The two merged theories combined self-interest and pro-social constructs into one theoretical model that is found to be superior to the widely used TPB. Five out of six constructs of the integrated model significantly influenced the farmers' soil conservation intention. PN from the NAM and PBC from the original TPB notably predicted the intention and correlated with SN, AC, and AR. Accordingly, farmers' internal value systems, self-efficacy, and controllability of soil conservation were found to be the most important underlying causes of soil conservation intention. Meanwhile, SN, AC, and AR had a significant indirect influence on the conservation intention, highlighting the important roles of farmers' awareness of negative consequences of not conserving soil, their feeling responsible for the negative consequences, and their exposure to increased social pressure in the soil conservation intention. Many other PEB studies that used comparable integrated models reported similar findings. However, in contrast to those studies, our study showed a non-significant relationship between AT and intention, probably due to moderated effects of other constructs, i.e., PBC. Several managerial implications were discussed to enhance the farmers' likelihood to conserve soil. In addition, several limitations that should be addressed to improve the comprehensibility and the validity of the empirical model to be used in future soil conservation interventions were noted.

Managerial implications

The study offers several useful insights to be considered when managing future soil conservation and various other pro-environmental behaviours (PEB). First, it should be mentioned that the farmers' decision about soil conservation is a complex process that involves many social and psychological constructs. Hence it is necessary to understand farmers' behaviour more broadly. The empirically verified tested theoretical framework is a valuable tool, as it facilitates the understanding of the formations of farmers' soil conservation decisions. Additionally, in a context where significant attention and investments are taking place to increase people's compliance with natural resource conservation efforts, this framework would be effective in understanding the proximal and distal causes of soil conservation and various other relevant PEBs. Moreover, this study expanded upon the TPB model and enriched the existing literature on PEB and soil conservation.

Considering PN as the most significant predictor of soil conservation behaviour, farmers' moral obligations to conserve soil should be raised by continuously informing them that soil conservation is one of the best practices for the sustainability of their rain-fed upland farms. As a useful initiative, soil conservation in the dry zone rain-fed uplands can be incorporated as a critical recommendation in related policies, acts, and regulations. In this way, many stakeholders, including administrators and the public, would be aware of the importance of soil conservation in the dry zone. Additionally, events like field level evaluations can be arranged to compliment active conservationists and to condemn those who are not because such compliments and condemnations will reinforce farmers' guilt or pride towards soil conservation.

SN and AR were the antecedents of PN, and the sequential relationship between AC and PN through AR was also validated along with other direct relationships of AC with other contracts (AT, SN, PBC). In such circumstances, informing farmers about the seriousness of the negative consequences of not conserving the soil is a critical responsibility of the government. However, this advising should highlight that farmers are responsible for those consequences or simply show that unsustainable agricultural activities have negative consequences for the soil. Moreover, farmers should be encouraged to be more responsible in their farming activities. Various methods, such as campaigns, workshops, and television programs, can be used to educate farmers. Meanwhile, considering the effect of SN, the perceptions of farmers can be modified through increased social pressures to engage in soil conservation. This can be done if all the relevant stakeholders are directed to conserve soil in the dry zone rain-fed uplands. To facilitate such orientations, activities like meetings, discussions, and participatory field observations can be arranged by the government with all relevant stakeholders, including farmers.

Concerning the influence of PBC on soil conservation intention, farmers need to be shown how to conserve soil conveniently. For that, researchers need to investigate the effectiveness, efficiency, and convenience of different soil conservation methods according to the characteristics of the local context, namely biophysical and socioeconomical. Otherwise, farmers might view soil conservation strategies as inconvenient. For example, a recent ecological restoration program in a nearby location (*Kapiriggama* CTVS) has used excavators to establish soil bunds to halt water erosion in rain-fed uplands (http://iucnsrilanka.org/Kapiriggama/soil-bunds-establishment/). However, if farmers want to engage in such activities themselves, it might be inconvenient for them because of their poor economic conditions.

Limitations

The findings of this study should be interpreted and applied to other contexts cautiously due to several limitations. First, the generalization of the findings to other contexts might be limited, as the sample included conveniently selected farmers from one CTVS in the Anuradhapura district. Thus, future studies should be conducted in different geographical locations with broader samples. Apart from that, this study focused on general soil conservation rather than on specific soil conservation activities, such as minimum tillage and mulching. Since farmers are likely to think differently about the various conservation activities, further studies on specific soil conservation strategies are recommended. In addition, longitudinal investigations could be designed to observe the consistency of the studied intention, as this study was a cross-sectional investigation of the soil conservation intention. Furthermore, depending on the self-reported intentions, further studies are necessary to understand the actual soil conservation and its correlation with intention. Finally, as the explanatory power of the integrated model of soil conservation intention was limited to 51%, incorporation of additional variables, such as socioeconomic factors, other social and psychological constructs (E.g., anticipated pride or guilt), and potential moderating variables is recommended to improve the explanatory power of the integrated model.

CHAPTER 05

Multi-stakeholder Perspective towards Sustainable Rain-fed Uplands in Cascaded Tank-Village Systems in the Dry Zone of Sri Lanka: A Study Using the Q methodology

5.1 Introduction

Sustainable land management (SLM) along with rehabilitation and restoration forms one of the main mechanisms to achieve land degradation neutrality (LDN) (Orr et al., 2017). It encompasses understanding and taking conservation measures for the ecology including soil, water and vegetation, and is based on the key principles of enhancing the productivity and protection of natural resources while being economically viable and socially acceptable (Motavalli, Nelson, Udawatta, Jose, & Bardhan, 2013). Collaboration among stakeholders including legislators, policymakers, decision-makers, scientists and land users is one of the key component as well as a precondition for successful SLM as strategies of SLM depend not only on the context of the entire system but also the related stakeholders and their perspectives (Gudrun Schwilch et al., 2012; Lange, Siebert, & Barkmann, 2015; Wang & Aenis, 2019).

However, it is highlighted that the stakeholders' collaboration, particularly in natural resource management might get weaker due to various reasons such as stakeholder fatigue, exclusion of key stakeholders, power imbalances, lack of understanding about others' perspectives and presence of non-negotiable expectations (Crawford, Katz, & Mckay, 2017; Durham, Baker, Smith, Moore, & Morgan, 2014; Grimble & Chan, 1995; Gudrun Schwilch et al., 2012; Schwilch, Bachmann, & de Graaff, 2012). Among them, lack of understanding about stakeholders' perspectives i.e. competing and complementary perspectives on a particular resource is essential fostering their collaboration (Grimble & Chan, 1995) as competing perspectives challenge creating a common platform to enable soft discussions among stakeholders and complementary interest lead to finding common grounds for better cooperation (Grimble & Chan, 1995; Reed et al., 2009).

Some studies have cited that the classical top-down approach of stakeholder analysis does not reflect stakeholders' real perspectives because the analysis is often taken place in the absence of direct stakeholder participation (Reed et al., 2009). In certain situations, this approach has resulted diverse perspectives (mainly due to subjectivity) among stakeholders within the groups that stakeholders are being differentiated (Cuppen, Breukers, Hisschemöller, & Bergsma, 2010; Lange et al., 2015). In addition, this approach often criticized as it marginalizes primary stakeholders, mostly less empowered stakeholders such as local land users, and their opinions (Grimble & Chan, 1995; Grimble & Wellard, 1997; Reed et al., 2009). Subsequently it seems to enable stakeholders who have a high interest and influence (This is probably through expertise, legitimacy and administrative power) over a particular phenomenon to dominate their views than other key stakeholders' views (Reed et al., 2009).

Embedded in various conservation and development programs, various approaches have been introduced to halt land degradation (LD) in rain-fed uplands in CTVS in the dry zone of Sri Lanka. They include both onsite activities such as conservation farming and agroforestry and offsite activities such as education, law enforcement, crop diversification in lowlands and perennial crop establishment in home gardens (Aheeyar, 2013; Dharmasena, 1994; Goonatilake, Ekanayake, Perera, Wijenayake, & Wadugodapitiya, 2015; Gunasena & Pushpakumara, 2015; IUCN, International Union for Conservation of Nature, 2016). However, obtaining a satisfactory level of stakeholders’ collaboration is recognized as a challenge not only for those programs but also for other similar interventions (Aheeyar, 2013; Ministry of Environment and Renewable Energy, Sri Lanka, 2014). Besides that, following top-down approach to identify and differentiate stakeholders, development of these programs have reportedly marginalized primary stakeholders and their opinions (IUCN, International Union for Conservation of Nature, 2015).

Considering the above facts, this study hypothesizes that the lack of collaboration among stakeholders might be associated with their competing interest over recommended solutions to halt LD. In addition, marginalizing primary stakeholders like farmers and their opinions in decision making might have widen the gap for stakeholders’ collaboration. To the date there has been no systematic investigations to understand stakeholders’ perspectives in the context of SLM in the dry zone of Sri Lanka. Therefore, this study has aimed at having an evidence-based understanding of stakeholders’ perspectives towards sustainability rain-fed uplands of CTVS in the dry zone in a participatory and reconstructive (bottom-up) manner while empowering marginal stakeholders’ perspectives in decision making.

This study has specifically adopted Q methodology as it is identified as a useful tool to differentiates stakeholders based on their subjective perspectives and empowers marginal stakeholders to include in the decision-making process (Reed et al., 2009).

5.2 The Q methodology

The Q methodology is developed by Stephenson in 1935 to systematically study people’s subjective viewpoints which are understood in operant terms (Brown, 1993; Watts & Stenner, 2012). It is often used in social (Rodl, Cruz, & Knollman, 2020), health (Rietveld, van Exel, Cohen de Lara, de Groot, & Teunissen, 2020) and environmental sciences (Moros, Corbera, Vélez, & Flechas, 2020; Moser & Baulcomb, 2020; Tuokuu, Idemudia, Gruber, & Kayira, 2019). It is useful to understand complex subjective viewpoints among stakeholders (Zabala, Sandbrook, & Mukherjee, 2018), and in situations where identifying shared values between participants is necessary but difficult, i.e. natural resources management (Lien, Ruyel, & Lopez-Hoffman, 2018).

Offering sample of statements (i.e. subjects) to participants (i.e., variables) to elicit their views on a specific topic, Q methodology assists comprehending the opinions including interlinkages in opinions between topics or patterns of perspectives (Moros et al., 2020; Mukherjee et al., 2018) and results in typologies of different perspectives (Brown, 1993). Hence, the Q methodology is also recognized as discourse analysis (Webler, Danielson, & Tuler, 2009).

Despite the subjectivity, the patterns and typologies expressed in the analysis become the compelling reasons for many policymakers in studying the viewpoints of different stakeholders (Tuokuu et al., 2019). Also, the integration of quantitative and qualitative data and their analytical techniques reinforce the suitability of the methodology in scientific platforms (Brown, 1993; Watts & Stenner, 2012; Zabala et al., 2018). In addition, free from biases such as group-think and dominance effect compared to some other group based methods (E.g., Focus group discussion) is an added advantage of this method (Mukherjee et al., 2018).

In a research, Q methodology follows four steps: (1) research design, (2) data collection, (3) analysis (4) interpretation (Zabala et al., 2018). Specific details relevant to these steps are discussed in the following sections.

5.3 Methodology

Research design

The research design begins by identifying the topic which defines the scope for the study and questions to ask respondents (Zabala et al., 2018), in this study it was set as *"Important activities for the sustainability of rain-fed uplands in cascaded tank-village systems (CTVS) in the dry zone of Sri Lanka"*. The subsequent process of the research design was conducted following the procedure cited by Zabala and others (2018) (Figure 5.1).

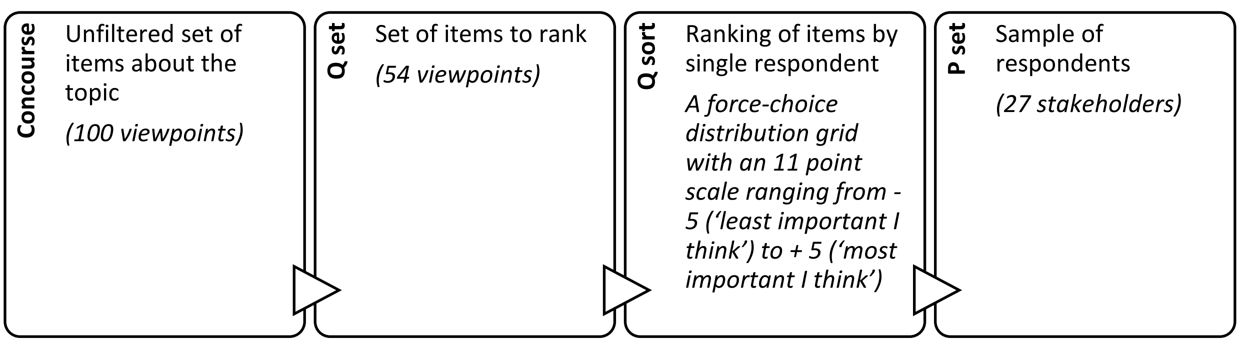


Figure 5.1: The process of Q methodology research design (Author's field survey, 2020)

A concourse is a full spectrum of perspectives about the topic, or in other words, it is the population to the sample of statements (Q set) which is to be offered to participants for ranking (Watts & Stenner, 2012; Zabala et al., 2018). The concourse of this study (100 viewpoints) was drawn from several sources, i.e. previous studies, government reports, technical bulletins, and informal interviews and discussions with groups interested in the topic. Considering the commonalities among the viewpoints the concourse broadly covers seven dimensions, i.e. 1) Preservation and use of traditional ecological knowledge, 2) Improving community engagement, 3) Enhancing the awareness of background information, 4) Conducting research and development, 5) Adopting conservation interventions, 6) Improving institutional mechanism and 7) Considering current and future trends.

A sample of 54 statements was extracted for the Q set from the concourse considering their ability to provide adequate coverage and diverse representation of the study topic (Watts & Stenner, 2012; Webler et al., 2009; Zabala et al., 2018). To facilitate participants understanding of statements, Q set was set to Sinhala language, and paraphrasing was performed if necessary. Finally, the face validity of statements was confirmed with the support from several academics experienced in the field of agricultural extension. The English version of the final Q set is provided in Appendix 06.

The answer sheet (Figure 5.2) was designed for participants to record their responses in three steps. The first step consisted of a table for participants to arrange the Q set in three batches (i.e. important, neutral and not important) based on their importance to the topic. This step facilitates the second step, which participants rank statements in Q sorts: reflections of participants' subjective viewpoints about the study topic on a ranking grid which use as variables in the Q analysis. A forced-choice distribution grid (FCDG) which confirmed as a quasi-normal distribution, consisted with an 11-point scale ranging from -5 ('least important I think') to + 5 ('most important I think') was used concerning its regularity in similar studies and to force participants to examine each statement thoughtfully (Watts & Stenner, 2012; Webler et al., 2009). Finally, two additional questions were included participants to explain the rationale of ranking items in most extreme columns.

Step 1

Important batch	Neutral batch	Not important batch

Step 2

Most important I think					Neutral	Least important I think				
+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5
2	3	4	5	6	9	6	5	4	3	2

Step 3

Reasons for ranking the two statements in +5 level
Reasons for ranking the two statements in -5 level

Figure 5.2: The answer sheet (Author's field survey, 2020)

The sample of participants or the P set is attributed to the people who are knowledgeable and have viewpoints that matter about the subject at hand (Watts & Stenner, 2012; Webler et al., 2009). This study used purposeful sampling method to recruited 27 participants representing eight different expertise groups (i.e. Academics (4), Government research officers (5), Government administrative officers (2), Consultants (2), Farmers (4), Undergraduates (3) and Government field officers (3) and officials from the private sector (4)) to capture the range of opinions in the concourse (Watts & Stenner, 2012). These stakeholders broadly related to the discipline of agriculture and natural resource management. Small sample sizes are often recommended concerning participants to statement ratio as 1: 2 or 1:3 (Watts & Stenner, 2012; Webler et al., 2009; Zabala et al., 2018), thus this study follows appropriate participants to statement ratio 27:54.

Data collection

In February 2020, each participant was met in person and provided two-page questionnaire consisted of a Q set, answer sheet, instructions for answering, contact details of the principal author, consent forms and few questions to collect some background information (i.e., current occupation, working experience, relationship to agriculture and agroecosystems of CTVS). Meeting participants in person helps to get a detailed understanding of participants and to elaborate the answering instructions if necessary. Participants requested sufficient time to read and rank the Q set in the grid. All the completed answer sheets were returned to the principal author within 2-8 weeks, either in person, through emails and messages.

Data analysis

Collected Q-sorts were analyzed using KADE (Ken-Q Analysis Desktop Edition) an open-source package with a graphical user interface developed by Banasick (2019). Principal Component Analysis was performed as it is widely used in conservation studies (Zabala et al., 2018). Considering the eigenvalues (1<), minimum two significant factor loadings per factor and Humphrey's rule explained by Brown (1980, pp. 222–223) and Watts (2012, p. 107), three factors were selected for varimax rotation. After the rotation, the three-factor solution was confirmed for its theoretical importance (Brown, 1978), by comparing with other possible factor solutions (two factors and four factors), particularly the inclusion of many defining Q sorts which can significantly affect in decision making. The third factor was a bipolar factor, including two negatively loaded and two positively loaded Q sorts; thus, it was split into two factors as 3a and 3b to separate their distinct but connected viewpoints.

Ideal Q sorts or factor arrays for each factor were obtained from the analytical software. For that, it has considered only distinctively and significantly loaded Q sorts to one factor without confounded Q sorts and calculated Z-scores (weighted score) for each statement (See Appendix

06). Since higher factor loadings are giving more weight on the Z-scores, they characterize the factor more than others. Factors were interpreted to understand their underlined viewpoints. Items that are both distinctive and with the highest or lowest scores tend to be most useful for interpretation (Zabala et al., 2018). After identifying these items and evaluating the reasons for their relative positions in the factor array, a holistic view of the factor was generated with supportive information including significant and relevant Q sorters' comments from the post-sort questionnaires and their background characteristics. A similar approach was applied to interpret the two perspectives of the bipolar factor. Meanwhile, the consensus items, which indicate the common ground among all factors, were separately identified and interpreted.

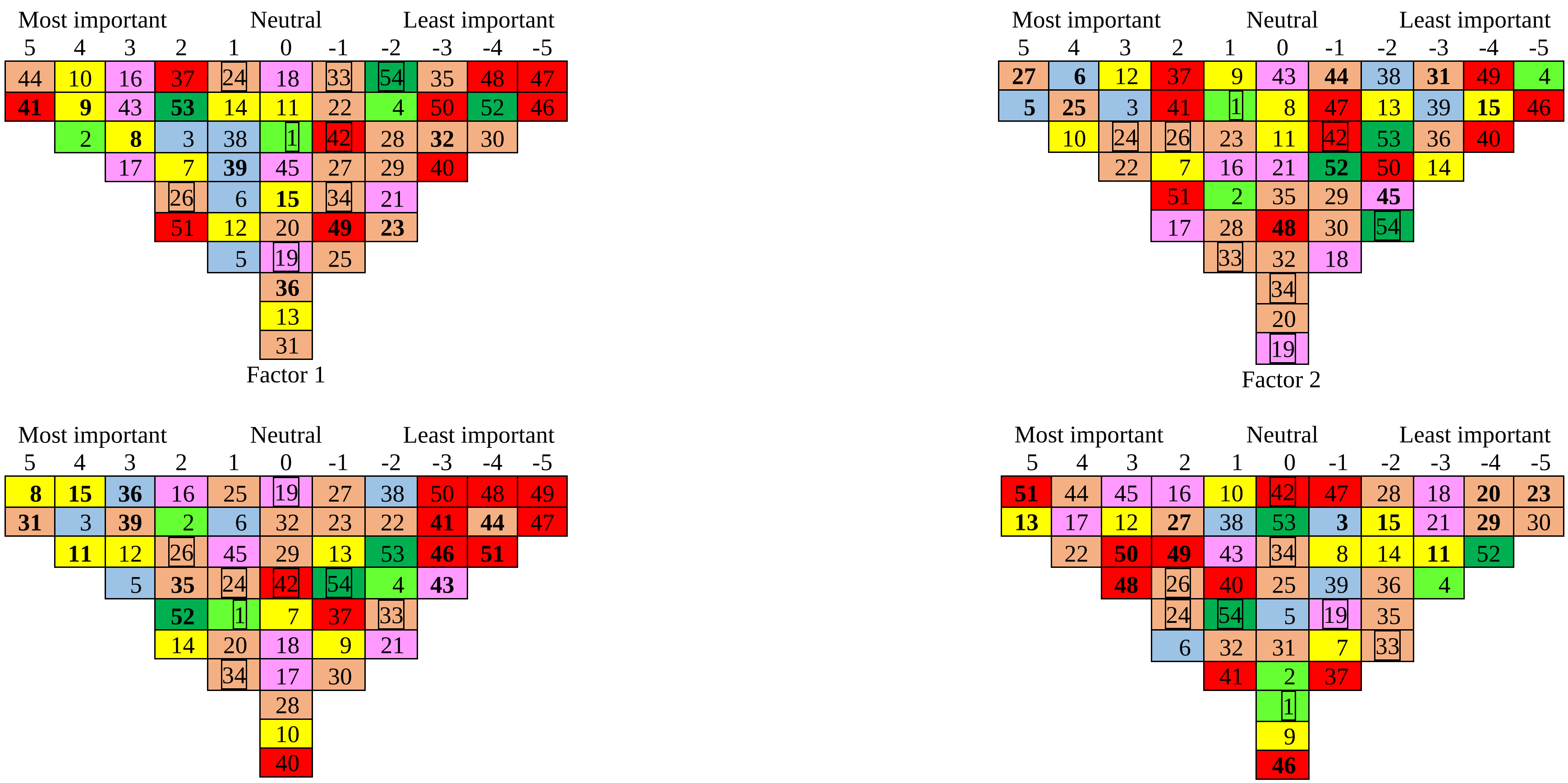
5.4 Results

The identified three-factor solution explained 42% of the study variance. Out of 27 Q sorts 25 were significantly loaded in one of the three factors and others were confounded. Table 5.1 shows the factor loadings of all Q sorts for three factors and factor loadings with distinct Q sorts are bolded. After splitting the third factor to separate viewpoints, all the distinct factor loadings were positively loaded in each factor. The correlation coefficients between each of the factors are also presented in Table 1. Factor 1 and Factor 2 were most highly correlated (r=0.43) while Factor 2 and Factor 3a were least positively correlated (r=0.13). Factor 3a and factor 3b were least negatively correlated (-0.29). Figure 5.3 shows the idealized Q-sorts of factors based on the associated factor Z-scores of the statements related to each factor. Numbers of distinguishing statements of each factor, which are significant at $p<0.05$ level are bolded while consensus statement among factors which are significant at $p<0.05$ level are shaded.

Table 5.1: Factor loadings and correlations of stakeholders' perspectives

No.	Q-sort	F 1	F 2	F3	
				a	b
1	Academic 2	**0.69**	0.22	0.17	-0.17
2	Consultant 1	**0.67**	-0.02	0.08	-0.08
3	Academic 3	**0.67**	0.30	-0.07	0.07
4	Consultant 2	**0.60**	0.19	-0.04	0.04
5	Government field officer 2	**0.60**	0.25	0.02	-0.02
6	Government field officer 1	**0.54**	-0.02	-0.23	0.23
7	Academic 4	**0.54**	0.40	0.03	-0.03
8	Academic 1	**0.53**	0.01	-0.06	0.06
9	Undergraduate 3	**0.53**	0.15	0.38	-0.38
10	Private sector officer 2	**0.50**	0.07	-0.05	0.05
11	Government research officer 1	**0.46**	0.18	0.19	-0.19
12	Undergraduate 2	**0.44**	0.13	-0.33	0.33
13	Private sector officer 4	**0.44**	0.24	0.04	-0.04
14	Private sector officer 1	**0.41**	0.07	0.09	-0.09
15	Private sector officer 3	0.39	0.37	0.33	-0.33
16	Government research officer 4	0.16	**0.75**	0.01	-0.01
17	Government research officer 2	-0.04	**0.74**	-0.13	0.13
18	Farmer 3	0.07	**0.72**	-0.05	0.05
19	Farmer 4	0.24	**0.71**	0.12	-0.12
20	Government research officer 3	0.09	**0.66**	0.10	-0.10
21	Government field officer 3	0.40	0.49	0.41	-0.41
22	Farmer 2	0.29	**0.49**	0.04	-0.04
23	Government administrative officer 1	0.35	**0.38**	0.01	-0.01
24	Undergraduate 1	0.40	0.00	**0.71**	-0.71
25	Farmer 1	-0.04	0.11	**0.71**	-0.71
26	Government administrative officer 2	0.40	0.04	-0.60	**0.60**
27	Government research officer 5	0.06	0.42	-0.44	**0.44**
Explained Variance%		19	15	8	8
Eigenvalue		5.13	4.05	2.16	2.16
No. of Defining Variables		14	7	2	2
Avg. Rel. Coef.		0.8	0.8	0.8	0.8
Composite Reliability		0.98	0.97	0.89	0.89
S.E. of Factor Z-scores		0.13	0.18	0.33	0.33
Correlation	F 1				
	F 2	0.43			
	F 3a	0.24	0.13		
	F 3b	0.33	0.24	-0.29	

(Author's field survey, 2020)
Note1: Bolded values indicate the defining sorts of factors at p<0.01 significant level
Note2: Factor 3 is a bipolar factor



Legend	
Color	Representing dimension in the Q set
(light green)	Preservation and use of Traditional Ecological Knowledge
(light blue)	Improving community engagement
(yellow)	Enhancing the awareness of background information
(pink)	Conducting Research and Development
(light orange)	Adopting conservation interventions
(red)	Improving institutional mechanism
(dark green)	Considering current and future trends

Figure 5.3. Idealized Q sorts for factors (Author's field survey,2020)
Note1: Distinguishing statements significant at $p<0.05$ of each factor are bolded, and consensus statements among factor significant at $p<0.05$ level are shaded.

5.5 Stakeholders' distinctive perspectives towards sustainable rain-fed uplands

Factor 1:(Cognizance)

This factor with an eigenvalue of 5.13 accounts 19% of the study variance, thus recognized as the dominant perspective. It anchored by significantly associated fourteen participants who are broadly engaged in agricultural education, research, development, extension and business activities. Supporters of this perspective believe enhancing farmers' awareness is important particularly on the impact of soil, water and forest degradations on the sustainability of whole CTVS and farm yield rather aspects like weather (S8: +3; S9: +4; S15: 0). As conservation interventions they believe it is critical to take swift actions to restore already degraded CTVS' ecosystems (S44: +5), probably capitalizing the recent international attention for CTVS' importance as a global agricultural heritage (S53: +2) and getting community involvement specifically by delegating the implementation of development and conservation programs to village communities (39: +1). However, they are ambiguous or undervalued many conservation interventions such as practicing minimum tillage, using simple and energy-efficient farm implements and farming diverse crops that perform well under environmental stressors (S23: -2; S32: -3; S36: 0). According to some respondents, such conservation attempts are perceived to "restrict cultivable land area, negatively affecting the country's economy" and "are less practicable for farmers" (P6 and P10). Also, they less value institutional mechanisms. For example, they perceive strong sanctions on agrochemical usage as less important (S49: -1) thus, suggest "educating farmers on the proper use of agrochemicals" in agricultural practices (P14). In addition, they criticize political interventions in conservation programs (S47: -5; S46: -5), as they perceive "instability of party politics influences the effectiveness and independence of conservation interventions and make them ill functional and unsustainable" (P1, P4, P5, P15). However, regarding many facts mentioned above, they value strengthening agricultural extension services to disseminate information about production and natural resource management (S41: +5).

Factor 2: (Pragmatism)

This factor has an eigenvalue of 4.05 and explains 15% of the study variance, thus recognized as the second main perspective of this study. Seven participants are significantly associated with this factor. Among them, four are government officers who are mainly experienced in research activities of natural resource management and, administrating regional resources. The rest is farmers who are experienced in dry zone farming. This perspective likely favours introducing conservation interventions and obtaining community involvement. Supporters of this perspective value conservation interventions distinctively including less time-consuming soil conservation methods (S27: +5) as they are "preferred by farmers" (P22) and low risk and short-term benefiting farming methods (S25: +4) as "farmers' economy is the basis of conservation" (P17). However, they consider it is less important to swiftly restore degraded agroecological systems (S44: -1) and attempting to plan weather-oriented resource use and cultivations (S31: -3). Provided the above facts, they believe improving community engagement is very useful for implementing conservation interventions (S5: +5; S6: +4). Regarding the farmers' awareness on aspects like weather (S15: -4) and collaborated multidisciplinary (E.g. agronomy, Economic, Social, Ecological) (S45: -2) research, supporters of this perspective think that they are unimportant for the study topic. Also, they think that continuing some aspects of traditional ecological knowledge like agricultural customs and rituals while getting the government support on them as unnecessary (S4: -5). Moreover, even if the trend of younger generations is to move away from farming causing less pressure on rain-fed uplands in future, supporters of this perspective think it as less important for the study topic (S52: -1). They are ambivalent about giving political supports for communities (S48:0) but condemn politically rewarding interventions (S46: -5) for conservation. Supporting this view some respondent cited that "politicians are linked to many soil degradation processors and make conservation programs ineffective" (P18), and the "politicized programs tend to change with the changing governments" (P19).

Factor 3

This factor is the last factor extracted in this study. It has an eigenvalue of 2.16 and explains 8% of the study variance. It is a bipolar factor which has both negative and positive factor loadings that highlight two distinct but connected perspectives (Table 1). Among the four participants who significantly associated with this factor, the farmer leader and an undergraduate student who has experience in dry zone farming are significantly associated with the first perspective (3a). The government administrative officer experienced in dry zone agricultural extension programs, and the government researcher experienced in dry zone agronomy is associated with the second perspective (3b).

Perspective one 3a (Ecological orientation)

This perspective highlights the importance of orienting people and rain-fed upland farming systems with nature. According to the supporters of this perspective, enhancing awareness of public including farming communities about the value of CTVS for the coexistence of human and other species and how soil, water and forest degradations affect their sustainability and weather knowledge are the paramount needs (S11: +4; S8: +5; S15: +4). As conservation measures, they believe adopting agriculture, planned and managed on weather knowledge while including a variety of crops that perform well under external stressors are important (S36: +3; S31: +5;). In the long term, they think replacing farms from annual cropping systems to perennial cropping systems would be useful (S35: +2). However, they undervalue mapping degraded agroecological systems (S43: -3) and rushing to restore them (S44: -4) at the moment, because they believe "intentionally or unintentionally people are engaged in environmental destructions" (P25). Under these circumstances, supporters of this perspective think that getting community involvement, particularly by delegating the implementation of conservation programs to the community is necessary (S39: +3). Meanwhile, they expect the trend of younger generations moving away from farming would facilitate the sustainability of future rain-fed farms (S52: +2). Considering the institutional mechanisms, they think strong regulations such as legalizing conservations to protect the environment, even from hazards like agrochemicals (S51: -4; S49: -5) are ineffective. Also, they have less faith in the usefulness of strengthening extension personnel for disseminating information about both production and natural resource management (S41: -3). Last but important, they believe political interventions, particularly direct political leaderships and rewarding political mechanisms for conservation interventions, are as irrelevant (S47: -5; S46: -3)

Perspective two 3b (Institutionalization)

This perspective highlights the importance of legal and political interventions. Supporters of this perspective expect political supports for the community would be useful (S48: +3) but are unsure about the usefulness of politically rewarding conservations mechanisms (S46:0). They believe legalizing soil conservation in the dry zone and punishing violators is vital (S51: +5) because "currently there is limited adoption of previously introduced conservations at the field" (P26) and "conservation through attitudinal changes is time-consuming" (P27). Also, they favour a robust controlling of agrochemical usage and industrial and domestic wastes like detergents, oils, bottles and bins (S49: +2; S50: +3). Facilitating those interventions, they value-enhancing farmers' awareness of relevant rules, acts and regulations (S13: +5), instead of the awareness of aspects like weather (S15: -2). Meanwhile, they believe informing people about the usefulness of CTVS ecosystems for mutual coexistence between humans and other species as unimportant (S11: -3), perceiving "protection of those systems depend on peoples' social or economic reasons" (P27). If conservation strategies are needed they distinctively value introducing farmers with less time-consuming soil conservation methods (S27:+2) relatively minimum tillage practices (S23:-5), mixed cropping system (S29:-4) or diversifying lowland farms (S30:-5) perceiving "difficult to alter the current land use" (P26). Also, they play down the importance of implementing development and conservation projects by improving the community's sense of ownership (S20: -4), plus they fairly undervalue the importance of community involvement particularly in forest management (S3: -1).

5.6 Stakeholders' consensual perspectives towards sustainable rain-fed uplands

Regarding the study topic, numbers that are shaded in figure 3 represent the eight consensus statements out of fifty-four statements. They are concepts of common agreement, thus can become the starting point for negotiation among stakeholders. Of these statements, figure 5.4 present how Z-scores were distributed among factors. According to figure 5.4 all stakeholders had a similar scoring for 26, and 24 statements reflecting their belief to have practicable soil conservation methods for small scale farmers and land uses and soil conservations align with the severity of soil erosion. Also, they showed a slight similar scoring pattern about the use of traditional ecological knowledge for future agriculture (S1), reflecting it has slight importance for the study topic.

Supporters of factor 1,2 and 3a,3b had a similar scoring pattern in pairs for statement 33, 34 and 42, reflecting that effective use of natural processors to reduce external farm inputs, agroforestry and private sector involvement as relatively less important or ambivalent (Figure 5.4). Stakeholders except for supporters of factor 3b, believe relative less importance to use new trends like social and mass media for future conservations (S54) and unsure about the importance of knowing reasons for less farmer cooperation in development and conservation programs (S19) (Figure 5.4).

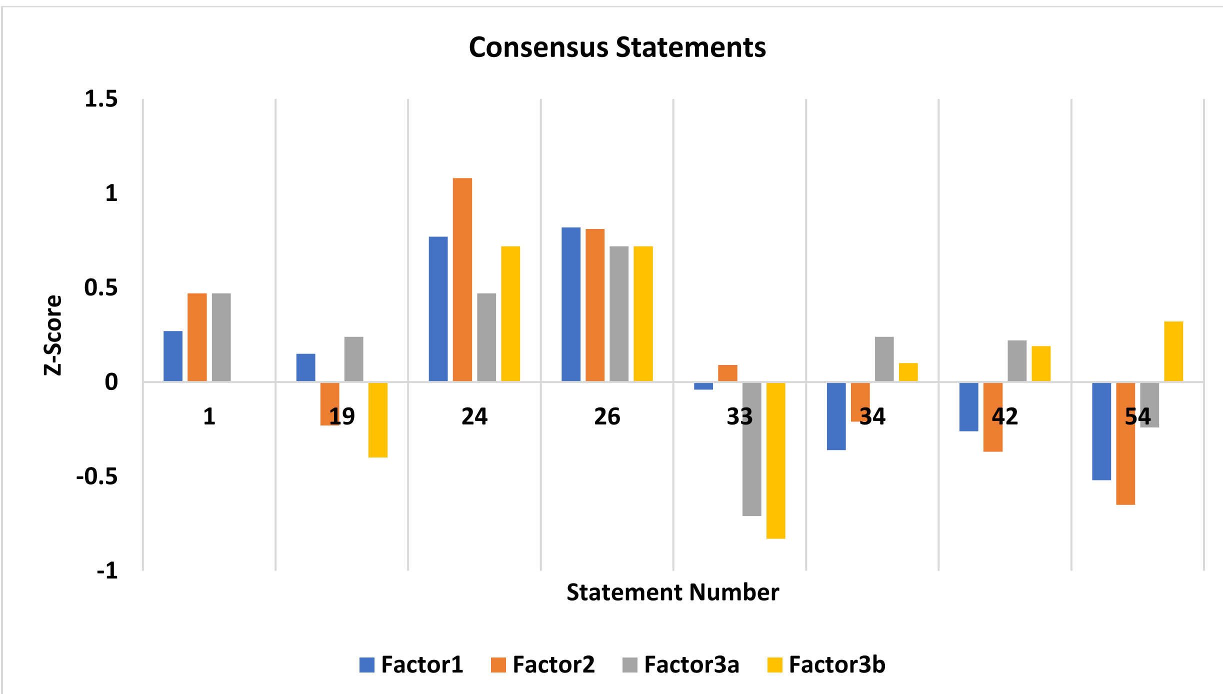


Figure 5.4. Z-score distribution of consensus statements among factors

5.7 Key stakeholder groups and challenges and opportunities for their collaborations

The Q methodology is potentially an important tool for understanding complex viewpoints among stakeholders and then to differentiate them in a structured way (Reed et al., 2009). It facilitates identifying areas of consensus and disagreements around key conservation topics, which can be used to resolve conflicts, assess management alternatives, appraise policies, or facilitate critical reflection (Zabala et al., 2018). This study, adopting the Q methodology is the first effort to systematically investigate stakeholders and their perspectives for sustainable rain-fed uplands in cascaded tank-village systems (CTVS) in the dry zone of Sri Lanka.

Results indicate that various opinions for sustainable rain-fed uplands are seen by stakeholders from four distinctive perspectives; cognizance, pragmatism, ecological orientation and institutionalization, which can also be recognized as reconstructive categories of stakeholders. Among these categories many stakeholders are identified in cognizance group followed by pragmatism, ecological orientation and institutionalization. Interestingly stakeholders such as academics, consultants, and many private sector officers and government field officers are scattered around the cognizance perspective. In contrast, many farmers and government research officers are scattered around the pragmatism perspective, while remained stakeholders are dispersed around several perspectives. This differentiation and stakeholders' distribution indicate that some stakeholders who hold similar expertise and can be identified in a common group mostly in a classical analytical (top-down) categorization have either homogenous perspectives or heterogeneous perspectives. Moreover, findings revealed that stakeholders who are often marginalized in decision making (i.e., farmers, field officers) to be identified with other stakeholders who are commonly known as critical or powerful stakeholders (i.e., government research officers and academics), due to their homogenous perspectives. This finding aligning with other studies indicates that stakeholders' expertise or a classification which based on analytical approach is not a good proxy of identifying and differentiating stakeholders' real perspectives (Cuppen et al., 2010).

Despite having distinctive perspectives it does not merely mean that competing interest inevitably leads to conflicts, but will indicate potential buffer zones for negotiations (Wang & Aenis, 2019).First, considering the main focal point of some distinctive perspectives, i.e. cognizance, pragmatism, institutionalization, farmers' awareness and behaviour towards LD seem to be targeted by many stakeholders for achieving sustainable rain-fed uplands. The perspectives of cognizance and pragmatism representing polarized options to improve farmers' awareness of consequences of LD (E.g., yield reduction) and feasible conservation interventions (E.g., low cost and low time consuming) indicate that the supporters of those perspectives perceive farmers are unaware of consequences of LD and suitable solutions for it. Meanwhile perceiving institutionalized approaches to control farmers' behaviour implies that supporters of institutionalization perspective believe farmers are unwilling to take voluntary conservation attempts. In another way, all these perspectives indicate that their supporters believe that making farmers aware of consequences of LD, low-cost and low time-consuming conservation methods, and using coercion can drive farmers to achieve sustainable rain-fed uplands while overcoming their difficulties. Previous studies including policy reports yet with limited evidence have reported such findings indicting farmers and highlighting that factors like farmers' ignorance of LD and poverty as some key reasons behind LD (Ministry of Environment and Renewable Energy, Sri Lanka, 2014; Samaratunga & Marawila, 2006). In that respect, aforementioned perspectives possibly due to those stakeholders' imprecision about the determinants of farmers' behaviour in SLM interventions in the respective landscape and thus relying on their intuition to understand farmers' behaviour towards LD.

Second, some distinctive perspectives in this study indicate that stakeholders have different expectations about other stakeholders' participation, i.e., just participation, being responsible and accountable, and not participation. For example, perceiving politician's involvement both as useful and problematic and valuing community delegation vs community participation for adopting conservation implements. These conflicting expectations about other stakeholder's participation imply that those stakeholders are either unclear or distrust other stakeholders' capabilities and involvement in SLM interventions. This perhaps due to unawareness of other stakeholders and historical experiences such as collaboration failures in previous conservation attempts (Crawford et al., 2017; Grimble & Chan, 1995; Reed, 2008). Stakeholders' effective participation throughout the decision-making process and the implementation of environmental management are well recognized in previous literature (Reed, 2008). If unable to define and disclose the role of all relevant stakeholders, it would challenge obtaining stakeholders' effective participation in SLM interventions and may lead to marginalize certain stakeholders in the decision making.

Finally, even though this study bordered the issue to rain-fed uplands in CTVS, some stakeholders' perspectives have either limited it to rain-fed uplands or have expanded its boundaries to the whole CTVS. This implies that the stakeholders' perspective on the scope of the problem is dissimilar. Problem definition and problem-solving are closely related, it needs a clear understanding of the issues and its boundaries for the solution to be effective and sustainable (Reed et al., 2009). Previous studies have also mentioned the importance of approaching conservation and development matters considering the whole CTVS because it is a social ecological system that its components are closely interrelated (IUCN, International Union for Conservation of Nature, 2015).

Perhaps the dissimilar scope of the problem among stakeholders is due to their unawareness of how different components of CTVS are interrelated.

This study delivered several consensus areas for the reconciliation of competing stakeholders and creating a common ground for their discussions (Grimble & Chan, 1995; Reed et al., 2009). Considering the importance indicated by stakeholders, the consensus to introduce practicable soil conservation methods and land uses with relevant to the severity of soil erosion implies all stakeholders' concern to the appropriateness and feasibility of land uses and soil conservation methods to fit the context and farmers' competence and resources such as money, time and materials. This is very essential in finding the best SLM solutions in a particular context (Gudrun Schwilch et al., 2012). Perhaps stakeholders possibly backed by their subjective or objective judgments, are either aware or assume that the proposed land uses (E.g. conservation agriculture) and soil conservation interventions (E.g., soil bunds and alley cropping) for dry zone rain-fed uplands are not context-oriented and difficult to adopt by farmers. (Gudrun Schwilch et al., 2012). Or else, they might be aware, or they might assume that the information of suitable and feasible land uses and soil conservation interventions has not reached to farmers' level through extension services. Besides these consensuses on needed aspects, stakeholders many other consensuses are for options which they perceived either less important or ambiguous for the sustainability of rain-fed uplands. This perhaps due to lack of information and trust on the contribution of those options for the sustainability of rain-fed uplands. For example, despite how traditional ecological knowledge (TEK) has contributed to the success of traditional farming systems, there is less evidence to show how it can contribute in modern farming.

5.8 Conclusion

This study has provided systematically investigated empirical evidence for the existing literature of stakeholder management in natural resource management. Findings of this study conclude that stakeholders' subjective perspectives for options to achieve sustainable rain-fed uplands in CTVS in the dry zone of Sri Lanka are both competing and complementary. The Q methodology has reinstated its usefulness particularly for policymakers in SLM to systematically understand these competing and complementary perspectives and to differentiate stakeholders into more meaningful categories irrespective of their expertise and in a reconstructive (bottom-up), participatory, power neutral and transparent manner. This study challenges the suitability of conventional analytical (top-down) categorization that identifies and differentiates stakeholders because individual stakeholders in those categories possibly express heterogeneous perspectives due to their subjective nature. Meanwhile, the reconstructive categorization enables the understanding of the real position of the commonly known marginalized stakeholders (E.g., farmers and field agricultural officers) and empowering them and their opinions in the decision-making process. In this regard, implementing an analytical approach to identify and differentiate stakeholders would possibly misperceive stakeholders' perspectives including the perspectives of marginal stakeholders and ignore their views in the decision-making process.

Competing interests create distinguishing perspectives, i.e., cognizance, pragmatism, ecological orientation and institutionalization which mainly emphasize the importance of improving farmers' awareness on LD; practical actions with community involvement; orienting farmers and farming systems with nature, and legal and political interventions to control farmers' behaviour respectively. Although distinguishing perspectives do not indicate non-negotiable opinions or inevitable conflicts among stakeholders, they indicate potential buffer zones such as lack of mutual understanding among stakeholders, and their participation in conservation attempts and unclear scope of the problem that may challenge the reconciliation among stakeholders. In this regard it is recommended to investigate possible reasons behind certain issues such as indicting farmers for LD by other stakeholders, marginalizing some stakeholders and neglecting some components in the landscape when managing lands. It further brings the attention for the validity of judgements such as stereotyping farmers as ignorant of LD and or unreceptive towards conservation efforts, which often based on some stakeholders' intuition. Meanwhile the complementary interests create consensus among stakeholders particularly to introduce feasible, appropriate soil conservation methods to fit with small-scale farmers and conditions of the landscape. Thus, it is recommended to consider such consensus in the initial reconciliation attempts as it would facilitate by creating the common platform for discussions with zero, or minimum conflicting ideas among stakeholders, and enable better cooperation among them. Organizers and moderators of stakeholder workshops would be benefited by the realized competing and complementary interests and their potential challenges, to efficiently structure the stakeholder workshops avoiding challenges such as overruling certain stakeholders' views by other stakeholders' views.

However, this study does not guarantee the identified perspectives as final because the study included a limited discourse and excluded some stakeholders such as highest government officials in the related discipline, political movements, and environmentalist. Moreover, findings do not assure solutions or ideas for perfect stakeholder engagement and collaboration as there can be various other reasons such as the nature of power and authority relationships and sociocultural relationships between groups (Grimble & Chan, 1995). In that respect, the focus of future studies is recommended not only to enrich the study with a broader discourse and other vital stakeholders but also to consider power, authority and sociocultural factors of stakeholders.

CHAPTER 06

Conclusion

Rain-fed uplands of the cascaded tank-village system (CTVS) in the low-country dry zone (LCDZ) of Sri Lanka, are experiencing deforestation, soil erosion and soil fertility decline. Although their biophysical aspects are discussed in many studies, their human dimension, particularly anthropological, psychological and sociological aspects, are often unseen or intuitively judged. In that respect, this thesis is the first to provide empirical evidence of the human dimension with respect to the LD in rain-fed uplands of the CTVS in the low-country dry zone using four different but interrelated studies.

First, it investigated how earlier rain-fed uplands were managed by traditional farmers, particularly when they were practicing shifting-cultivation (locally known as *Chena*), and what conservation insights were embedded in it. Then it attempted to empirically confirm whether farmers are ignorant of and irresponsible for LD, followed by an investigation to determine factors behind farmers' soil conservation behaviour. Finally realizing that achieving land degradation neutrality (LDN) needs multi-stakeholder partnership and collaboration, an investigation was performed to understand stakeholders and their perspectives for various opinions towards the sustainability of rain-fed uplands.

Based on the findings of the first study, it concludes that *Chena* including its' farming practices, cultural activities and farmers' awareness on certain aspects like weather, pest ecology and land quality have probably provided mutual benefits for farmers as well as environment by minimizing natural resource degradation, enhancing biodiversity conservation and controlling harmful anthropogenic activities such as competition for land resource. Traditional farming systems have been gradually changed from shifting types to fixed and organized farms, and followed a rapid expansion in recent decades possibly due to raised market demands. However findings of the second study conclude that it is unfitting to stereotype farmers as ignorant of LD, because farmers are aware of LD (i.e. deforestation, soil erosion and soil fertility decline) by perceiving both relevant indicators, causes and interlinkages of it. In addition, farmers feel a higher moral responsibility for causing LD yet articulate a partial moral obligation for actions to halt LD, perceiving that government possess part of the needed capacities and powers. Findings of the third study conclude that if farmers possess a higher moral obligation to conserve soil, self-efficacy (E.g., competence and confidence) along with controllability (E.g., resourcefulness) over the soil conservation behaviour, their likelihood for soil conservation is high. Moreover, if farmers are highly aware of consequences of soil degradation (E.g., yield reduction), feel responsible for the negative consequences of soil degradation and perceive social pressures to perform soil conservation, they indirectly increase farmers' likelihood for soil conservation. Finally, the last study concludes that stakeholders' have distinctive and complementary perspectives for sustainable rain-fed uplands, and distinctive perspectives differentiate stakeholders sometimes irrespective of their expertise. In addition, though, stakeholders' argument lies on various aspects (i.e. to improve farmers' awareness of consequences of LD, improve farmers' awareness on feasible solutions for LD, use coercion to make farmers conserve or orient people and farms with the ecology) findings conclude that stakeholders have a consent specifically to introduce farmers appropriate and feasible soil conservation methods and land uses that fit with the biophysical and socioeconomic context.

The aforementioned findings mainly contribute to the existing literature in human ecology, environmental conservation behaviour and land management. Particularly, it provides how traditional people in the rural dry zone of Sri Lanka perceived environment and interacted with it in harmony. Also, it provides how current people perceive their environment and what factors determine their interactions with it. Additionally, it provides how decision making can be complicated when different stakeholders' subjective perspectives are engaged in land management interventions.

This study also provides several useful insights for policy and managerial implications for achieving LDN, particularly to avoid or reduce further degradation by establishing sustainable land management (SLM) interventions. First, policymakers should better consider that human aspects in any time (past, present and future) are relevant for LD. For example, this study suggests that reviewing the human-environment relationship from anthropological perspectives enable opportunities to recognize long existed feasible and appropriate traditional land management practices and to partially or fully restate them either in their original forms or adapted versions. Since they are culturally accepted, they can be adopted in the current context with minimum restrictions from the community.

Second, based on the conclusions, policymakers and practitioners should give attention on both quantitative and qualitative assessments of LD in a particular landscape because they are equally important in understanding LD. In addition, when making decisions on farmers, it should be better to follow objectively assessed community-specific evidence instead relying on generalized intuitive judgements. Moreover, farmers' soil conservation behaviour should not be considered as a simple process that involves only direct determinants but instead as a complex process that involves both direct and indirect self-interest and pro-social motives. Due recognition of these aforementioned aspects paves the path to understand the real root causes for the way farmers behave and to suggest specific and effective solutions rather using pre-defined solutions or general solutions for achieving LDN.

Third, when searching stakeholders' compliance and collaboration for solutions for sustainable rain-fed uplands, policymakers should give attention to comprehend relevant stakeholders' subjective perspectives on those solutions without marginalizing any stakeholders or their views based on pre assumptions. Additionally, this comprehension should be conducted in a systematic, participatory and power-neutral way. As a result, policymakers and practitioners should be able to classify stakeholders according to their distinctive perspectives and to understand the perspectives which can challenge and facilitate their collaborative discussions in advance. In addition, it would be better to follow best practices (Reed, 2008) such as empowering, trust developing and skilled facilitation through the participatory process to avoid various other potential challenges (E.g., lack of mutual understanding and trust among stakeholders).

Finally, in order to achieve sustainable rain-fed uplands, this study recommends following process of activities. First, it recommends investigating and introducing conservation solutions (i.e. soil conservation methods and land uses that are appropriate and feasible for the biophysical and socioeconomic context) because they increase the suitability of those conservation solutions to the selected landscape as well as farmers' socioeconomic ability to implement them with minimum difficulty. Then, this study suggests understanding stakeholders' subjective perspectives for those conservation solutions in a systematic and reconstructive way because it would facilitate understanding the competing and complementary interests among stakeholders towards those solutions. If these perspectives challenge collaboration among stakeholders, this study suggest using skilled organizers and moderators to facilitate stakeholders' collaborations. Once there is an agreement among stakeholders and a satisfactory collaboration towards implementing the identified conservation solutions, this study suggests facilitating primary land users to improve their competence and resourcefulness for successful achievement of those conservation solutions. Finally, in order to achieve a better moral obligation from land users for recommended solutions, this study suggests including solutions as best practices for the particular landscape by including them in land management policies, acts and regulation followed by complimenting adopted solutions and condemnations otherwise.

Although the above implications are useful for understanding and managing some of the human aspects for achieving LDN in rain-fed uplands, particularly by establishing effective SLM interventions, the human dimension of LD in rain-fed uplands is much wider covering different disciplines including various other actors, land characteristics and degradation process in different localities. Since many of those aspects are practically impossible to cover in a single study, this study recommends future studies to focus on those aspects considering findings of this study as a reference.

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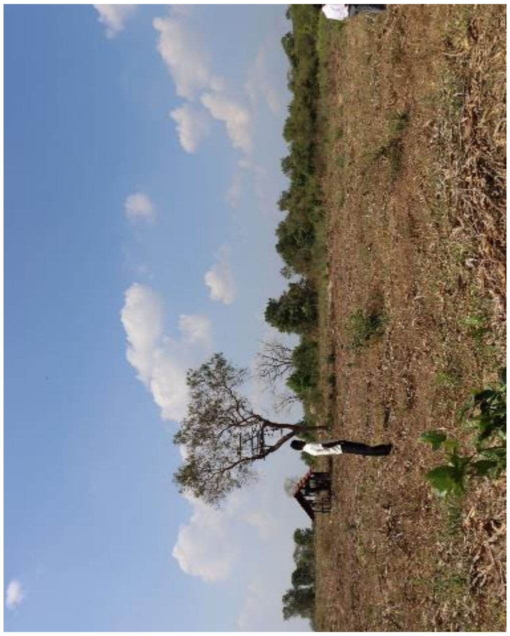
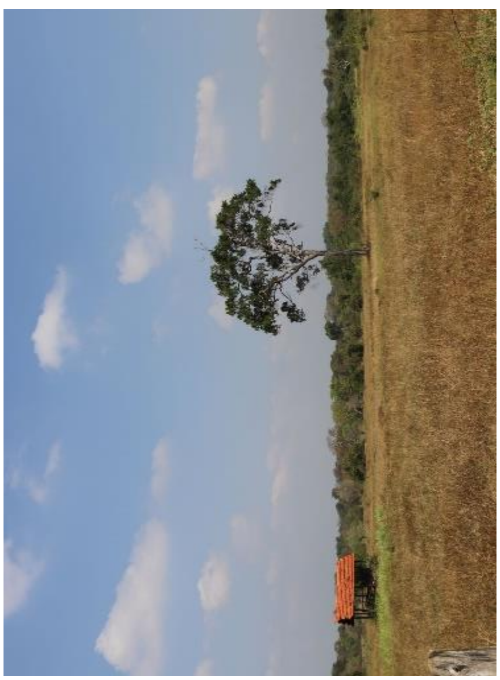
Appendix 01: Some photos of rain-fed upland farms in the study site



1

3

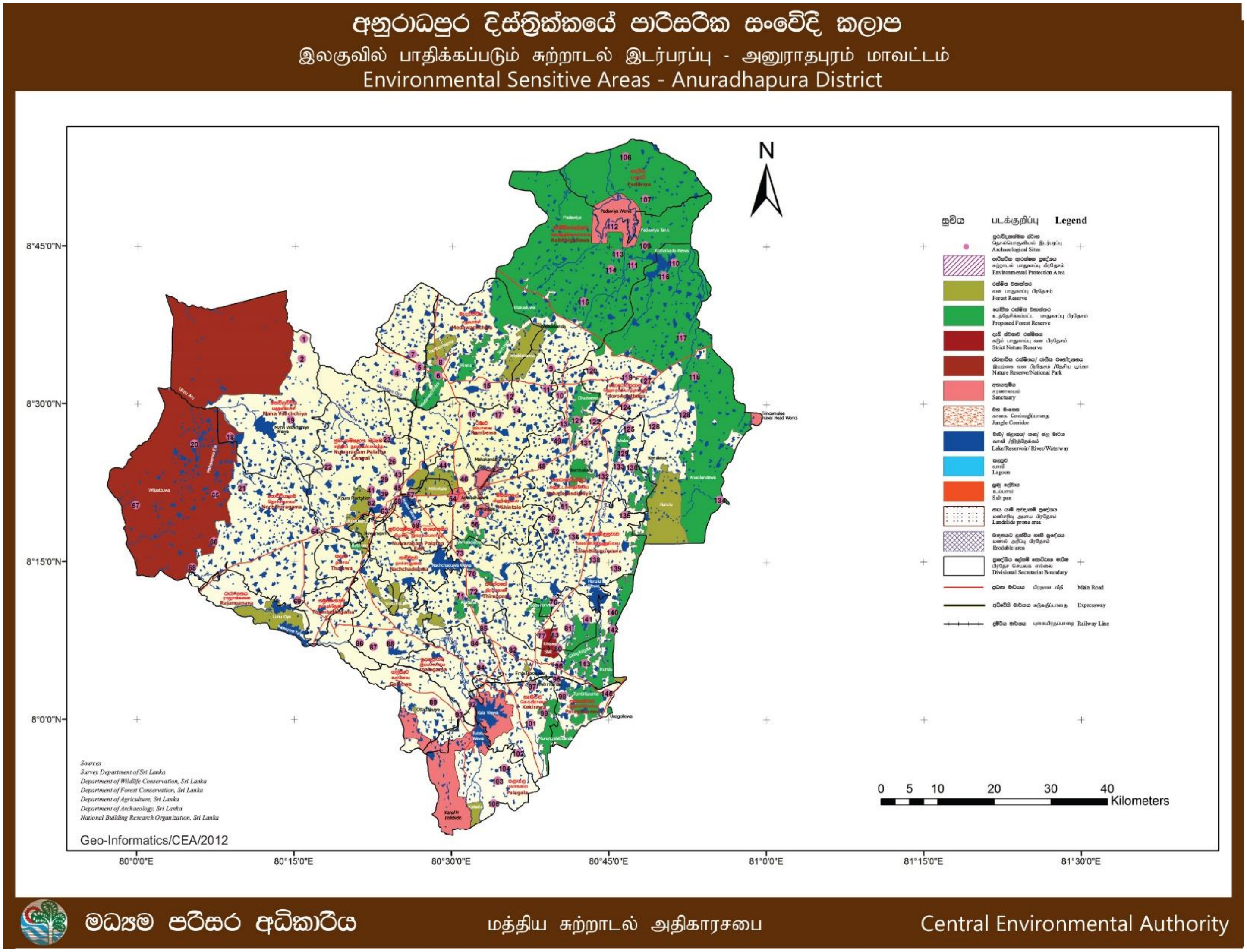


2

4

1. Recently fallowed rain-fed upland farm (maize) close by the forest
2. One-year fallowed rain-fed upland farm (maize) close by the forest
3. Deeply ploughed rain-fed upland farm
4. A farmland exposed to high water erosion

Appendix 02: Anuradhapura district map including environmental sensitive areas



Appendix 03: Guiding questions of focus group discussions

1) Background of participants
    a. Age
    b. Gender
    c. Education level
    d. Current presence in agriculture
    e. Family members and their occupations
    f. Age when managing a traditional type *Chena* farm for the first time

2) Discussion topics on *Chena* farming
    a. Categories of *Chena*
    b. Time period of *Chena* farming
    c. Place selection for *Chena*
    d. Forest clearing/ Salshing
    e. Burning
    f. Land preparation
    g. Fencing
    h. Selection and establishment of seeds and plants
    i. Manuring
    j. Crop protection
    k. Harvesting
    l. Processing
    m. Fallowing or recultivating

3) Crop calendar preparation

4) Continuing and disconinuing activities and reasons for them

Appendix 04: Questions included in the data collection instrument (originally conducted in Sinhalese language) to measure the variables in study 2 and Study 3.

1. Background details

1.1. Socio-economic attributes (write or circle the suitable response in the coloured section)

a) Age	Years				
b) Gender	Male			Female	
c) The main livelihood	Agriculture		Other (specify)		
d) Farming experience	Years				
e) Highest education level achieved	No	Primary	Ordinary level	Advanced level	Higher Education
f) Family size	Number of Persons except the respondent				

1.2. Farm and farming attributes

a) Farm		Upland			Lowland		
b) No of parcels							
c) Land parcel		1	2	3	1	2	3
d) Main crop	*Yala*						
	Maha						
e) Main land preparation method (1=fourwheel tractor 2=two wheel tractor ,3=Hoe, 4=Buffaloes)							
f) Main purpose of cultivation (1=Consumption 2=Selling)							
g)							
h) Crops (write the crops mentioned above)		1	2	3	4	5	
	Urea						

i)	Manuring (Kg per acreage) in a cropping cycle	Tripple superphosepahte (T.S.P)					
		Muriate of Potash (M.O.P)					
		Others					

2. Farmers perceveid indicators and causes of land degradation in rainfed uplands

2.1. Perceived indicators of deforestation, soil erosion and soil fertility decline in rainfed upalnds (mark one or more suitable responses by using a ☑ sign in the shaded sections or specify the responses in "others" section)

a) Deforestation	Frequent droughts	
	Water Scarcity	
	Change of rainfall patterns	
	Increase extent of rainfed upland farms	
	Others (specify)	
b) Soil erosion	Reduction of top soil layer	
	Wash of soil due to rain	
	Sedimentaion in tanks	
	increase of soil graveliness	
	Expose of bottom soil layers	
	Soil harness	
	Frequent floods	
	Others (specify)	
c) Soil fertility decline	Reduction of Soil color	
	Low plant performance (yield/growth)	
	low plant response to added fertilizer	
	paling of leaf colors	
	low vious in plants around the farm	
	Others (specify)	

2.2. Perceived causes of deforestation, soil erosion, soil fertility decline in rainfed uplands (mark one or more suitable responses by using a ☑ sign in the shaded sections or specify the responses in “others” section)

a) Deforestation	Illeagal timber felling	
	Encroaching for cultivations	
	Others (specify)	
b) Soil erosion	Absence of soil conservations	
	Unplanned crop establishements	
	Climtae change /Change of rainfall pattern	
	Slope	
	Nature of the soil (Erodability)	
	Deforestation	
	Cattle trampling	
	Others (specify)	
c) Soil fertility decline	Soil erosion	
	Cultivating the same crop for long period	
	Burning of stublles	
	Absence of fallow period	
	Low application of inorganic fertilzer	
	Heavy application of inorganic fertilizer	
	Low or absence of organic fertilizer applications	
	Others (specify)	

2.3. Who should be responsible for causing above mentined issues in 2.1

....

2.4. Who should be responsible for acting to halt above mentioned issues in 2.1

....

3. Farmers' intention to adopt soil conservation

Circle the suitable number from 1-5 (1 lowest and 5 highest) in the shaded sections

3.1 Intention

a) My plan to conserve soil in rainfed upland farms in the next *Maha* season is

Very unlikely	*1*	*2*	*3*	*4*	*5*	*Very likely*

b) My preference to conserve soil in rainfed upland farms in the next *Maha* cultivation season is

Very unlikely	*1*	*2*	*3*	*4*	*5*	*Very likely*

c) My motivation to conserve soil in rainfed upland farms in the next *Maha* cultivation season is

Very unlikely	*1*	*2*	*3*	*4*	*5*	*Very likely*

3.2 Perceived behavioural control

a) My confidence to conserve soil in rainfed upland farms in the next *Maha* season is

Very low	*1*	*2*	*3*	*4*	*5*	*Very high*

b) My ability to conserve soil in rainfed upland farms in the next *Maha* season is

Very low	*1*	*2*	*3*	*4*	*5*	*Very high*

c) Finding time to conserve soil in rainfed upland farms in the next *Maha* season is

Highly impossible	*1*	*2*	*3*	*4*	*5*	*Highly possible*

d) Finding material to conserve soil in rainfed upland farms in the next *Maha* season is

Highly impossible	*1*	*2*	*3*	*4*	*5*	*Highly possible*

3.3 Subjective norm

a) People whose ideas I respect most think that I should conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

b) My family members think that I should conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

c) Agricultural instructors want me to conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

d) My fellow farmers think that I should conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

3.4 Attitude

a) Conserve soil in rainfed upland farms in the next *Maha* season is

Foolish	*1*	*2*	*3*	*4*	*5*	*Wise*

b) Conserve soil in rainfed upland farms in the next *Maha* season is

Bad	*1*	*2*	*3*	*4*	*5*	*Good*

c) Conserve soil in rainfed upland farms in the next *Maha* season

Disadvantageous	*1*	*2*	*3*	*4*	*5*	*Advantageous*

3.5 Personal norm

a) I have a moral value to conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

b) My feelings encourage me to conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

c) I feel honest to myself if I conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

d) It matches with my principles if I conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

3.6 Ascription of responsibility

a) All farmers responsible for all the negative outcomes if they do not conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

b) No farmer can avoid the responsibility of the issues of not conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

c) We farmers, as the users of uplands, should be responsible for the negative outcomes of not conserve soil in rainfed upland farms in the next *Maha* season

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

3.7 Awareness of consequence

Following issues can results if not conserve soil in rainfed upland farms in the next *Maha* season

a) High gravelliness in soil

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

b) Low yield

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

c) Difficult in land preparation

Highly disagree	*1*	*2*	*3*	*4*	*5*	*Highly agree*

Appendix 05: The Q set including Z-scores of statements within each factor

No	statement	Z-scores				Z-score variance
		Factor 1	Factor 2	Factor 3		
				3a	3b	
1	Use traditional ecological knowledge for future farming	0.27	0.47	0.47	0	0.037
2	Use traditional ecological knowledge for soil, water and forest management	1.08	0.25	0.73	0	0.175
3	Community driven forest management to stop illegal forest encroachments	0.87	1.18	1.43	-0.27	0.421
4	Continue agriculture related customs and rituals with the support from government	-0.6	-1.82	-0.7	-1.25	0.239
5	Community driven catchment reforestation and, reservation area (stream bank and reservoir) conservation	0.54	1.91	0.95	0.05	0.468
6	Community involvement for halting soil, water and forest degradations	0.58	1.87	0.48	0.69	0.316
7	Inform farmers about the causes and consequences of soil, water and forest degradations	0.85	0.8	0.01	-0.51	0.322
8	Inform the community how soil, water and forest degradations affect the sustainability of cascaded tank-village systems (CTVS)	0.93	0.08	1.91	-0.32	0.736
9	Inform farmers how soil erosion progressively reduces the crop yield	1.16	0.48	-0.48	-0.13	0.394
10	Inform farmers all the suitable soil conservation methods	1.3	1.64	-0.23	0.69	0.504
11	Inform the public that ecosystems of CTVS are not only for human needs but also for the coexistence with other animals	0.33	0.01	1.42	-1.25	0.908
12	Educate farmers about effective land management practices	0.57	1.56	0.97	1.06	0.125

13	Inform farming communities about rules acts and regulations about soil conservation	-0.02	-0.59	-0.24	1.97	0.993
14	Inform farmers about the irrigation layout of the CTVS	0.74	-1.21	0.5	-0.74	0.67
15	Provide accurate information about patterns and erratic condition of weather to farmers	0.23	-1.68	1.44	-0.74	1.345
16	Manage CTVS, considering the lessons learned from previously managed CTVSs	1.07	0.28	0.95	0.88	0.094
17	Develop a sound knowledge foundation for managing CTVS	0.91	0.55	0	1.28	0.224
18	Orient university researches and curricula to further study the related agroecological and human ecological systems of CTVS	0.46	-0.56	0.01	-0.96	0.291
19	Investigate reasons for less farmer cooperation in development and conservation programs	0.15	-0.23	0.24	-0.4	0.07
20	Implement development and conservation projects in a way to increase farmers' sense of ownership to those projects	0.19	-0.22	0.26	-1.33	0.404
21	Investigate farmers' environmental sensitivity	-0.85	-0.1	-0.73	-0.96	0.11
22	Establish soil bunds in tank catchments to conserve soil	-0.14	1.05	-0.49	1.2	0.536
23	Implement minimum tillage practices	-1.02	0.46	-0.24	-2.03	0.855
24	Design land use and soil conservation methods according to the severity of soil erosion	0.77	1.08	0.47	0.72	0.046
25	Introduce low risk and short-term benefiting farming methods to farmers	-0.49	1.69	0.49	0.08	0.64
26	Consider the practicability of soil conservation methods to adopt by small scale farmers	0.82	0.81	0.72	0.72	0.002

27	Introduce less time-consuming soil conservation methods	-0.27	1.92	-0.24	0.83	0.809
28	Establish multipurpose tree species on contours to reduce soil erosion and to get fodder and green fertilizer	-0.6	0.13	0	-0.72	0.136
29	Encourage farmers always to keep a mixed cropping system	-0.76	-0.4	0.23	-1.65	0.463
30	Diversify lowland farms to reduce the agricultural demand for rainfed uplands	-1.9	-0.49	-0.48	-2.16	0.605
31	Plan cultivations and resource use considering weather patterns	-0.03	-0.76	1.9	0	0.967
32	Use simple and high energy-efficient farm implements	-1.47	-0.13	0.23	0.27	0.501
33	Reduce external farm inputs by effective use of natural processors	-0.04	0.09	-0.71	-0.83	0.163
34	Establish agroforestry in rainfed uplands	-0.36	-0.21	0.24	0.1	0.057
35	Cultivate perennial crops in rainfed uplands as a long-term solution	-1.03	-0.1	0.7	-0.83	0.46
36	Cultivate diverse crops that yield even under any biotic and abiotic stresses	0.05	-1.13	1.42	-0.83	0.984
37	Close coordination among responsible institutes to identify issues and to provide solutions	0.88	0.98	-0.25	-0.64	0.492
38	Consider the views of all community-level stakeholders to formulate development and conservation programs	0.71	-0.58	-0.48	0.59	0.351
39	Implement development and conservation programs through village communities	0.63	-0.91	1.42	-0.32	0.793
40	Provide short term government supports to establish soil conservation structures and to use fertilizers to enhance soil fertility	-1.49	-1.81	-0.23	0.51	0.881
41	Strengthen extension personnel to advice farmers not only to increase production but also to manage natural resources	1.42	0.84	-1.19	0.19	0.941

42	Arrange private sector activities to benefit the sustainability of agroecological systems.	-0.26	-0.37	0.22	0.19	0.069
43	Map of all the degraded and vulnerable areas	0.96	0.09	-1.42	0.59	0.822
44	Accelerate restoring degraded agroecological systems	1.54	-0.25	-1.9	1.7	2.158
45	Collaborate relevant disciplines (E.g. Agronomy, Economic, Social, Ecological) when conducting researches	0.25	-0.65	0.48	1.15	0.411
46	Establish politically rewarding mechanisms when developing and conserving agroecological systems	-2.62	-2.51	-1.19	-0.19	1.007
47	Use direct political leadership for conservation efforts	-2.18	-0.3	-2.38	-0.19	1.046
48	Arrange political supports focusing the whole community	-1.7	-0.11	-1.67	0.93	1.231
49	Strong control over agrochemical usage	-0.38	-1.54	-2.15	0.83	1.295
50	Stronger control over wastes like detergent, oils, bottles and bins than agrochemicals	-1.37	-0.64	-0.73	1.01	0.773
51	Legalize soil conservation punish violators	0.78	0.74	-1.91	2.53	2.509
52	Low interest in agriculture from the younger generation will reduce pressure on uplands	-1.84	-0.38	0.7	-1.97	1.221
53	Get international attention for conserving CTVS	0.88	-0.62	-0.7	0.13	0.412
54	Use new trends like social and mass media as useful tools for future conservations	-0.52	-0.65	-0.24	0.32	0.138