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OPERATIONALISING 'SUSTAINABILITY'

DEVELOPING AN ANALYTICAL FRAMEWORK TO ASSESS THE SUSTAINABILITY OF ORGANIC PADDY FARMING AND TRADITIONAL VARIETIES FOR POOR FARMERS IN SRI LANKA

Author: Robina Ang
Supervisor: Axel Fredholm

Abstract

Sustainable development "which meets the needs of the present without compromising the ability of future generations to meet their own needs," (WCED 1987) is a global development objective of paramount importance. However, on the ground, 'sustainable development' is – in my experience – often little more than a buzzword for securing grants. From a strong sustainability standpoint, this thesis documents an attempt to operationalise strong sustainability in technological development projects using a purpose-designed, user-friendly analytical framework which marries international guidelines for sustainability with the principles of appropriate technology.

The framework was applied to compare the sustainability of organic paddy farming/traditional varieties, with conventional paddy farming/improved varieties in Sri Lanka. In a mixed methods approach, interviews with key actors in the paddy sector were combined with cultivation cost-benefit analysis, and analysis of preliminary field data and national paddy statistics. Despite political and private sector dismissals of organic paddy farming with traditional varieties, these methods (technology choices) were found to be more sustainable, profitable and appropriate for small-scale farmers with rain-fed (and/or marginal) land. Significant macroeconomic, social and environmental benefits also exist for organic farming, which could be conducted on all rain-fed land while maintaining national rice self-sufficiency. However, private sector influence limits farmers' technology choice. This study shows that despite mounting evidence of organic farming's potential to help feed the world, the narrow interests of the wealthy continue to take precedence over the livelihoods of poor paddy farmers in Sri Lanka.

Keywords: Agriculture, Strong Sustainability, Paddy Farming, Green Revolution, Appropriate Technology, Sri Lanka, Improved Varieties

Abbreviations

CIA	Central Intelligence Agency of the USA
CPF	Conventional paddy farming
CSD	Commission on Sustainable Development
CSO	Civil Society Organisation
EUROPA	Official website of the European Union
FAO	Food and Agriculture Organisation
GoSL	Government of Sri Lanka
IISD	International Institute for Sustainable Development
INGO	International Non-governmental Organisation
IPCC	Intergovernmental Panel on Climate Change
IRIN	Integrated Regional Information Network
IV	Improved (paddy) varieties
NGO	Non-governmental organization
OECD	Organisation for Economic Co-operation and Development
OPF	Organic paddy farming
REN	Rural Enterprise Network
SLA	Sustainable Livelihoods Approach
SRI	System of Rice Intensification
TV	Traditional (paddy) varieties
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations International Children's Emergency Fund/United Nations Children's Fund
WCED	World Commission on Environment and Development
WFP	World Food Program
WHO	World Health Organisation
WSSD	World Summit on Sustainable Development

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Foreword

Research is impossible without data. A heartfelt thank you to everyone who gave their time, assistance and information so willingly to my humble project, particularly Mr V. Rathnabharathie whose work inspired mine, Dileepa for getting me started, Mr L. Nanayakkara for his invaluable 'gatekeeping' (and Mrs Nanayakkara for taking in unexpected strangers!), Mr Pathmanathan and his family for their friendship and hospitality and Mr S. M. Gamage for getting me into the most prestigious Sri Lankan rice event in a decade.

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I hope all your efforts were not in vain, and that this work helps to make life better for current and future Sri Lankan farmers in some tiny way.

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Chapter 1: Introduction

1.1 The problem: reconciling a global aim with local solutions

Today, searching Google for 'sustainability' draws over 70 million results. The term is used by diverse actors: UN agencies, primary schools, environmental organisations, and even petroleum giants like BP and Exxon Mobil. Clearly, 'sustainable' means different things to different actors. Without a stricter definition, the term is meaningless. The 1987 report, "Our Common Future" gives us sustainability's most quoted definition: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs," (WCED 1987). This definition demands that at the very least, development does not degrade the natural resources on which we and future generations depend. I agree with this definition (with some refinement – see Chapter 2), and accept that this is an important goal. However, details on how to achieve the transition to a "new era of economic growth... that is forceful and at the same time socially and environmentally sustainable" were not elucidated in the report (WCED 1987).

Despite the Paris Declaration's emphasis on using partner country systems (OECD 2011), technological projects such as the installation of tube wells, solar panels, wind turbines, schools buildings, stoves, toilets, vaccination centres etc. remain a popular mode for development assistance, particularly for non-governmental organisations (NGO). A technology-based development project should align with global sustainable development goals, and must also function in practice, on the ground. Participants must take ownership of the project for it to have sustained benefits. In Sri Lanka, I learnt about numerous projects which had been implemented but whose effects dwindled after the money finished – they did not work. I also learnt of large scale infrastructure projects which worked but caused serious environmental degradation and biodiversity loss – they were unsustainable. My experience with development practitioners in Sri Lanka and elsewhere taught me that these individuals usually have a genuine commitment to sustainable poverty reduction. Development projects are often exceedingly expensive and practitioners have an ethical and professional responsibility to ensure that the money is used effectively. So why are there so many unmaintainable, unsustainable development projects? How can we create technology-based development projects that are at once environmentally sustainable and workable in practice?

Operationalising sustainability is complicated. Sustainability demands an ecologically sound approach, but this is just one of several factors to be considered at both macro and local lev-

els; there are also social, economic, and even political considerations. Although we have globally agreed-upon guidelines and methodologies for sustainable development (UNDESA 2007), and even a Plan of Implementation (WSSD 2005), these are formulated on an international or at best, national level, and are thus of little practical use at the project level. There are techniques for valuation of goods and services with no market value such as ecosystem services, but these are unwieldy and difficult to calculate accurately for anyone but a specialist. This is not merely an academic problem; it has practical implications in terms of how easily findings can be communicated to the public and to policy makers who do not have this expertise. Furthermore, even if one particular course of action proves to be more economical in such an analysis, highly localised social and political factors still remain unconsidered. At the project level, there are hundreds of ways of conceptualising sustainability (Mann 2009), none of which are targeted as a guide for technology-based development projects in a low-income context. The Sustainable Livelihoods Approach (SLA) has become a leading framework among donors and consultants, but it assumes an initial "broad and open-ended analysis [which] requires a highly flexible planning situation which rarely exists," particularly for a small, practically-oriented NGO in the field (Krantz 2001:4). The open-endedness which allows it to consider many different factors is also an impediment to its applicability in the field (*ibid*.).

Thus, there is a need for a comprehensive but simple and practical framework to guide the planning or assessment of a sustainable technology-based development project. It should marry global concepts of sustainability to local project practicalities, and be easily understandable and usable by donors, consultants, practitioners, communities and policy makers.

1.2 The mission: research aims and methods in brief

My first-hand experience of the lack of meaningful mainstreaming of sustainability in project planning led me to the following research aims:

(a) Develop a simple conceptual framework to evaluate the sustainability of any technological development project;
(b) Use this framework to analyse the ability of organic and conventional paddy farming, and improved and traditional paddy varieties, to sustainably reduce poverty among poor smallholder paddy farmers in Sri Lanka; and
(c) Critically reflect on the utility of the conceptual framework.

Step (a) was guided by literature review. Step (b) was carried out using a mixed methods approach involving semi-structured interviews with key stakeholders in the paddy sector all over the country, and detailed cost-benefit surveys of smallholder farmers in Galle. Step (c) was done after the data collection and analysis were complete.

1.3 The context: persistent rural poverty and malnutrition in Sri Lanka

Sri Lanka in statistics presents a conflicting picture. It recently ended a protracted civil war and achieved lower-middle income country status (World Bank 2011), yet in 2009, 15.2% of the population was still calculated to be living under the Government of Sri Lanka's (GoSL's) own official poverty line (GoSL 2009:8). While the proportion of people in poverty reportedly declined by an impressive 42% in the fifteen years leading up to the latest poverty survey, this has not been uniform across the urban, rural and estate sectors (*ibid*.:11). While rural poverty declined by 47% during this period, the vast bulk of people in poverty is still overwhelmingly from the rural sector, which reflects the sector's enormous share of the population. 82% of those in poverty in 2006-2007 – 2 303 000 people - were from the rural sector (*ibid*.:8).

Poverty does not simply denote a deficiency of money. The GoSL (2009) describes poverty as a 'lack of access to basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education etc.' In Sri Lanka, poverty contributes to disturbingly high malnutrition rates: around one third of all children under the age of five and one quarter of all women are malnourished, despite national rice self-sufficiency and extensive and free healthcare services for children and pregnant women (FAO 2010; UNICEF 2011). Malnutrition stunts both the physical and mental development and health of children, and since stunted women are more likely to bear underweight babies, the intergenerational effects and high prevalence of poor nutrition places a heavy burden on the country as a whole (*ibid*.).

Malnutrition cannot simply be attributed to a lack of food production. Severe famines have occurred even in times of peak food availability, as in Bangladesh in 1974 (Sen 1999:165). Indeed, Sri Lanka as a country has good food availability, thanks to the widespread employment of Green Revolution technologies. It has enjoyed a surplus of rice, its staple food, for five of the past six years (GoSL 2010). UNICEF in Sri Lanka describes the factors behind malnutrition as 'closely intertwined with household food security' – a more nuanced concept than that of food shortage – which is based upon three pillars:

- **Food availability**: sufficient quantities of food available on a consistent basis;
- **Food access**: having sufficient resources to obtain appropriate foods for a nutritious diet; and
- **Food use**: appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation.

(WHO 2011)

Thus, although there is sufficient food available, the high prevalence of poverty in rural areas in Sri Lanka is a major limitation to households' food access, making even poor farming families food insecure. Food use may also be problematic, with UNICEF reporting one third of Sri Lankan households as having no access to sanitation and one quarter without access to safe drinking water (UNICEF 2011).

The World Food Program (WFP) assessed food security in Sri Lanka in 2007. Only six out of twenty-five districts were classified as 'food secure' (WFP 2007). Twelve others were 'chronically food insecure' with 2.8 million people below the poverty line, five other districts were in 'acute food and livelihood crisis' with 900,000 people below the poverty line, and Jaffna and Batticaloa were classified as in a state of 'humanitarian emergency' with 800,000 people below the poverty line (*ibid*.). The war only ended recently, and it is probable that the situation was quite similar at the time of this study. Thus at the time of this study, poverty and food insecurity were still pressing concerns for an enormous number of people, particularly in rural areas, over a large part of the country.

1.4 A solution? Organic paddy farming with traditional varieties

1.4.1 Definitions

For the purpose of this thesis, organic paddy farming (OPF) denotes paddy cultivation methods that do not involve the application of chemically synthesised pesticides, weedicides or fertilisers such as urea. It may substitute these with alternative pest control methods such as intercropping, or the application of non-chemically-synthesised alternatives such as mulch, leaves, manure etc. There were multitudinous non-chemical, integrated pest management techniques developed during pre-Green Revolution cultivation, but currently, the younger generation of farmers has little experience or knowledge of these. Organic farming is commonly juxtaposed with conventional paddy farming (CPF) techniques: the agricultural pack-

age of mechanisation, synthetic fertilisers and pest control methods, and genetically modified crops, popularised during the Green Revolution.

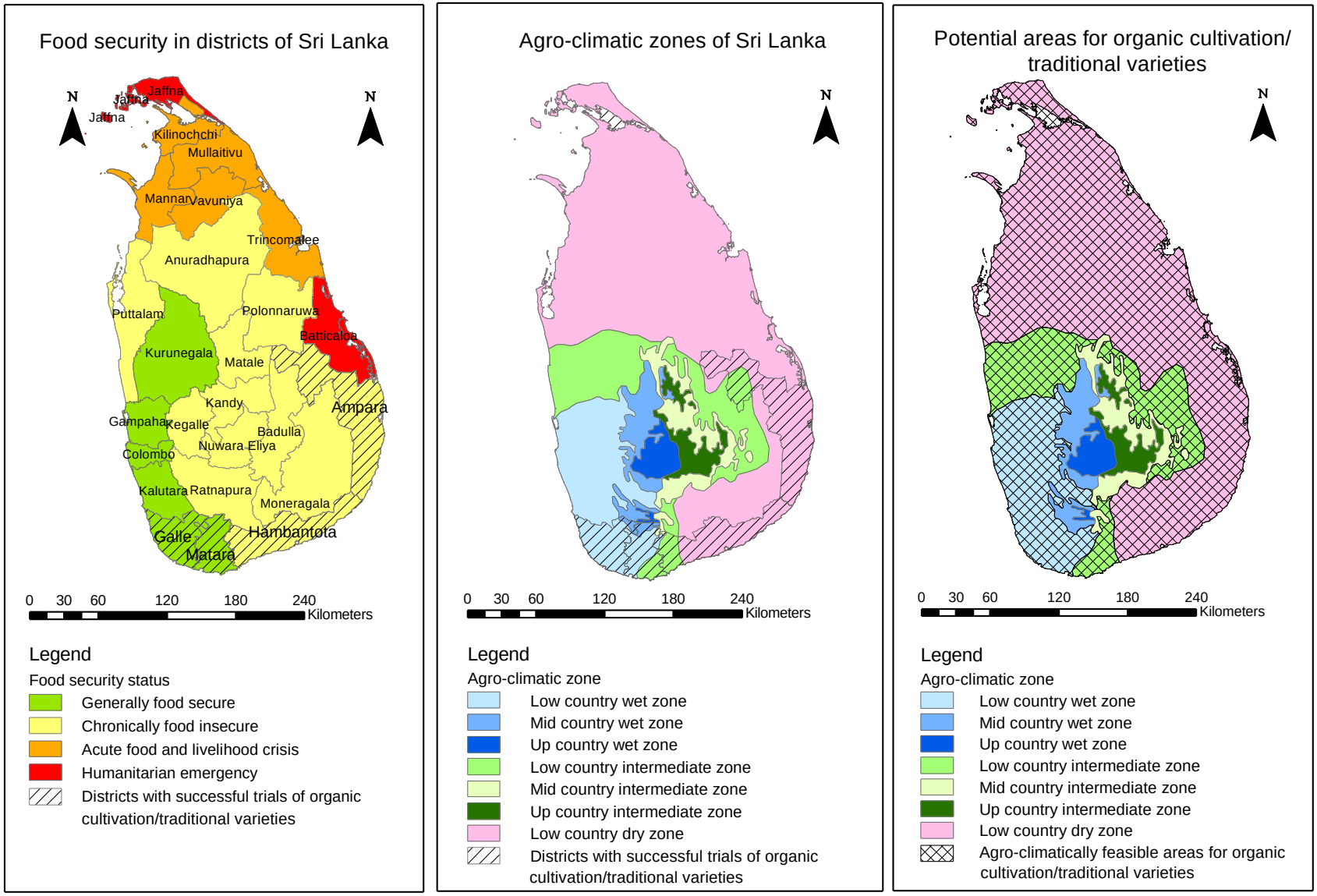
Traditional (paddy) varieties (TV) is the term for cultivars which have not been 'improved' by cross-breeding with cultivars from outside Sri Lanka, nor genetically modified to create specific characteristics such as dwarfism in local research institutes. As with organic rice farming, TV were once widely cultivated, but currently in Sri Lanka, virtually all cultivation is of improved varieties (IV) (Wijesingha & Pushpakumari 2009)[1].

1.4.2 A project as inspiration

In Sri Lanka, I interned with an international non-governmental organisation (INGO) which focuses on the use of appropriate technologies to challenge poverty. One of their projects involved action research with small-scale paddy farmers who cultivated marginal and sometimes tsunami affected land. Farmers, crop scientists working at the NGO and local academics worked together to compare OPF of TV with CPF of IV. Since CPF requires farmers to purchase consumable inputs such as fertiliser and pesticides, they hoped that organic, input-free cultivation would mean a considerably lower cost of cultivation, improving these poor paddy farmers' livelihoods, reducing their poverty and increasing their food security. IV are developed to be responsive to chemical fertiliser, so TV were used for this pilot study. TV also have culinary and cultural value, and are locally prized for their perceived nutritional benefits (REN 2008).

Between 2006 and 2008 they carried out field trials with farmers with rain-fed land in Galle, Matara, Hambantota and Ampara with extremely encouraging results. Their cost-benefit analysis showed OPF of TV to be more profitable than CPF of IV every year. Furthermore, the profit differential increased year on year (Appendix A).

[1] Improved varieties are not hybrid varieties; they still produce true to type, thus allowing farmers to save their own seeds from season to season.



Source: GIS files from Global Administrative Areas (2011); food security data from WFP (2007); agroclimatic zones digitized from Jayaneththi (2011)

Figure 1: Food security status, agro-climatic zones, and feasible areas for OPF of TV in Sri Lanka

The agro-climatic zones shown in Figure 1 are the agricultural classification system in Sri Lanka. They indicate what kind of cultivation is possible in which area. Therefore, as shown, if the success in these preliminary field trials in Galle, Matara, Hambantota and Ampara can be confirmed and scaled up, it is agro-climatically feasible for OPF of TV to be profitable for small-scale, rain-fed farmers in an enormous proportion of the country, including food insecure and impoverished areas.

Agro-climatically feasible it may be, but whether or not the idea is sustainable and workable is, as discussed, a different matter. Scaling up the combined technologies of OPF and TV could be a boon for poor small-holder paddy farmers in Sri Lanka, but the sustainability of this technological development project required further analysis – it is an ideal project to which to apply my analytical framework.

1.5 Structure of the thesis

Thus far, I have presented the general problem, my research aims and methods, the context and the inspiration for my study. Chapter 2 discusses the theoretical basis for my study. It shows how I have tried to combine the concept of sustainability as agreed to on a global level, with that of appropriate technology – an approach which advocates technology on a scale that users can influence and control to suit their needs. The analytical framework described in section 1.2 is introduced here, along with the key concept of technology choice. Chapter 3 describes my data collection methodology, with all its shortcomings. It describes my search for suitable methods to match the questions raised in my analytical framework, and how this ultimately led to my mixed methods approach. Chapter 4 comprises my findings. It shows how various stakeholders in the paddy sector perceive these technologies, and thus sheds light on the prospects for Sri Lankan farmers' technology choice. Finally, my conclusion in Chapter 5 attempts to answer the question of whether or not there is a place for OPF and TV in Sri Lanka, as a sustainable livelihood option for small, cash-poor farmers. I also reflect on the utility and further prospects of my work.

Chapter 2: Theoretical framework

2.1 Sustainable development

sustain (verb)…

5. *to keep up or keep going, as an action or process;*
6. *to supply with food, drink, and other necessities of life…*

(Dictionary.com n.d.)

In common usage sustainability describes a state or activity which takes into account environmental concerns, but a more specific definition is required to describe a theory of sustainability, and to justify why it is necessary in all development work

2.1.1 'Grand sustainability' – a central principle of contemporary development

The 1960's could be considered as the beginnings of sustainable development. Rachel Carson's ecology-focussed "Silent Spring" shed light on the catastrophic effects of agricultural pesticides in 1962, and decade culminated in the establishment of the first of the international commissions to focus on a new approach to development, the International Development Research Centre (IISD 2002). "The Limits to Growth", the landmark 1972 report from the Club of Rome, highlighted the impossibility of unending consumption growth on a finite planet and made sustainable resource management internationally discussed. Dire consequences were predicted if development patterns did not change (*ibid*.). This report took a rather macro-level point of view, and focussed on the consequences of population growth, pollution and resource availability, giving projections according to their model. The remainder of the 1970's saw the oil crisis fuel the debate on the limits to growth, while the global South began its own large scale efforts to ameliorate ecological degradation (*ibid*.). Sustainability further influenced development with the International Institute for Environment and Development's report on multilateral development agencies, including the World Bank, which paved the way for reforms (*ibid*.).

In the 1980's, understanding about links between poverty, population, trade, social inequity and environmental damage grew. In 1987, the World Commission on Environment and Development (WCED), also known as the Brundtland Commission, released a report entitled "Our Common Future", which became the first major international report to discuss environmental, economic and social issues as closely interrelated challenges (IISD 2002). This report popularised the term 'sustainable development' and was the source of its most quoted definition: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs," (WCED 1987:43). However, beyond recognising that technological change had "failed to reverse some of the most worrying environmental trends" (Commons & Stagl 2005:363), details on how to achieve the transition to a "new era of economic growth... that is forceful and at the same time socially and environmentally sustainable" were not elucidated (WCED 1987). Nevertheless, the concept of sustainable devel-

opment continued to reshape international development; guidelines were drawn up in the same year to make bilateral aid policies more environmentally friendly (IISD 2002).

Over subsequent decades, three general trends can be observed in the evolution of the concept of sustainable development. Firstly, global public consciousness of environmental degradation increased due to extreme weather and anthropogenic catastrophes such as oil spills and fires (*ibid*.). Secondly, international and national bodies, agreements and organisations dedicated to achieving sustainable development proliferated (*ibid*.). Finally, the recognition of the relationships between sustainability and other traditionally disparate considerations such as human rights, world trade and economics, health, energy sources and use, gender equity, climate change and international regulation increased (*ibid*.).

The key international conference on sustainable development was the United Nationals Conference on Environment and Development (UNCED) held in 1992 in Rio and the follow-up summit, Rio+10 or the World Summit on Sustainable Development in Johannesburg (WSSD) in 2002, which strongly emphasised the interdependence of poverty reduction and sustainable development (Commons & Stagl 2005:364). One outcome was Agenda 21 - a non-binding set of over 100 'programme areas' for countries to act upon to promote global sustainable development (*ibid*.) The summit in Johannesburg a decade later was intended to assess the progress of implementation of Agenda 21 and other initiatives which resulted from UNCED, and was unusual for a conference on sustainable development in that there was a large number of business sector representatives (*ibid*.:369). All nations were signatories to the Johannesburg Plan of Implementation, but once again, details were scarce – no clear goals, deadlines or funding commitments were agreed upon (*ibid*.). This is not surprising, given the torturous difficulties involved in securing an agreement between countries as diverse as the USA and Somalia across such issues as poverty eradication, changing unsustainable patterns of consumption and production, and protection and management of the natural resource base of economic and social development (WSSD 2005: 7-46). What *is* internationally accepted is that:

1. Further development is required to achieve the Millennium Development Goals;
2. Sustainability is a critical feature of this development; and
3. Sustainable development consists of three "interdependent and mutually reinforcing pillars" - economic development, social development, and environmental protection,

(UN General Assembly 2005:2; WSSD 2002:2).

I term this kind of sustainability 'grand sustainability' because of the international level at which it was formulated. International summits and conferences are indicative of large scale paradigm changes, and are important in setting normative standards for countries to aim towards (Vandemoortele 2011).

2.1.2 Weak versus strong sustainability

While I agree with the definition of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," (WCED 1987:43), and have described what I believe are the highest priority needs in section 1.1 of this paper, the nature of 'compromise' demands attention.

The concept of "weak sustainability' holds that "all forms of capital are more or less substitutes for one another; no regard has to be given to the composition of the stock of the capital," (OECD 2005). This means that degradation or depletion of natural resources is 'sustainable' as long as it is offset by increases in any other form of capital, including financial capital. One example of a weakly sustainable project could be the intensive logging and degradation of a forest area, with reinvestment of the profits into processing factories.

In contrast, 'strong sustainability' states that "all forms of capital must be maintained intact independent of one another. The implicit assumption is that different forms of capital are mainly complementary… all forms are generally necessary for any form to be of value," (OECD 2005). Unlike its weak cousin, strong sustainability recognises that man-made capital such as timber processing factories has no value if there is no natural capital – here, timber – to process. Since poor farmers' livelihoods are heavily dependent on natural resources such as uncontaminated water and fertile soil, it is strong sustainability that is implied in this study whenever the term 'sustainability' is used.

2.2 A strong case for agriculture-led development

Having established that grand sustainability is a crucial feature for all development which aims to improve the ability of people today and in the future to meet their basic needs, I now turn to the gargantuan question of how best to go about development. While traditionally, industrialisation *à la* high income countries was the preferred path to prosperity, demographics, recent research and history make a strong case for shunning years of urban bias and instead striving for agriculture-led development (Cypher & Dietz 2009:364-385).

Firstly, as described in section 1.1, the majority of impoverished people are in rural areas. Globally, there are around 3 billion people living and working in rural areas, but since agricultural production typically provides little value addition, rural poverty is widespread in low income countries. Despite having 70% of their populations in rural areas, only 21.5% of total GDP came from the agriculture sector in these countries (*ibid*.:342). Improving the security and profitability of livelihoods of poor rural producers is thus a logical goal.

Growing food insecurity is also a compelling reason to ensure that poor rural producers can sustainably increase food production. In the 1990's, the rate of agricultural output increase has not matched the rate of population increase in low and middle income countries (*ibid*.:343). Household food security in Sri Lanka is low enough that malnutrition is prevalent in rural areas (see Section 1.1).

Such development has also performed well; agriculture-led development focussed on the needs of small landowners has in the past played an important role in facilitating the dramatic reduction of poverty, particularly in East and South East Asia, and not just amongst those directly engaged in production (*ibid*.:354). In these cases, increasing the value of agricultural output by $100 also had 'multiplier effects', adding $80 of value to the remainder of the economy (*ibid*.:353).

Finally, the agricultural sector is a significant player in anthropogenic climate change. This suggests the sector should be researched and reformed to help mitigate the changing climate patterns which are already adversely affecting poor producers in Sri Lanka and elsewhere (IRIN 2011). Globally, agriculture is responsible for around 10-12% of anthropogenic greenhouse gas emissions (IPCC 2007:499), but it also offers great potential for mitigation, for example, through the sequestration of carbon in soils in the form of increased organic matter content (Muller 2009).

2.3 Technology choice

technology (noun)...

3. *the sum of the ways in which social groups provide themselves with the material objects of their civilization.*

(Dictionary.com n.d.)

As discussed, agriculture-focussed development is a feasible and logical strategy to reduce rural poverty. However, this is not specific enough for a development project. "Improving' agriculture in low income countries has been attempted in different ways by actors with dif-

ferent technologies - with correspondingly mixed results. Technology defines how agriculture is performed, and today, there are thousands of agricultural technology choices, some of which date back to the beginning of human civilisations. Over thousands of years, humanity has accumulated various cultivars, implements, machinery, irrigation methods, sowing techniques, pest management practices etc., all with the primary function of producing food, fodder and/or fibre. There exist many tested and viable technologies for more sustainable local-scale agricultural systems (Pretty in Desai & Potter 2008:165-170). Thus a range of technologies for food production exist, and a careful choice between them is necessary because although they share the same primary objective (food production), they have different secondary objectives (increasing national export revenue, subsistence, cultural value, increasing livelihood security...) (Willoughby 1990:8-9). Importantly, they also differ in terms of their unintended consequences, which are discussed below.

2.3.1 Unintentionally unsustainable: technology in agriculture

Technology has played an integral part in our history. Human creativity and ingenuity has dramatically altered the way we live and die, allowing the founding of complex societies with rich cultures, leading to some extraordinary advances in human health and longevity, and permitting science to explore previously unthinkable questions. We constantly innovate and create new ways of achieving our objectives (Willoughby 1990:8-9).

However, our technological prowess enables us to affect the biosphere within which we live to an extent unmatched by any other species, intentionally or unintentionally. That "human activities that are motivated by economic, cultural, aesthetic and spiritual goals are now causing environmental and ecological changes of global significance" is undeniable (Chapin 2000), and unfortunately, most of these environmental and ecological changes are unsustainable - they compromise future generations' ability to use the resources we have largely taken for granted. Our collective actions, including agricultural activities, are changing the biosphere too rapidly for ecosystems to adapt. We are causing biodiversity loss at a rate comparable to those of previous mass extinctions and the rate is accelerating (Aitken 1998), meaning the available genetic diversity for animal husbandry, plant breeding and medical research is rapidly dwindling. With the loss of species comes the disruption of complex ecosystem services. Natural resources and energy sources – capital – that were once easily accessible are rapidly becoming depleted and accordingly, expensive. Chemical technologies that promised a new, more bountiful age of agriculture are losing their potency and revealing their devastat-

ing long-term side effects as they persist in the environment and in human bodies; chemical insecticide use increased more than ten-fold between WWII and 1996, but the loss of food and fibre crops almost doubled over the same period (Harris 2000:2). Residues of pesticides are consistently found in breast milk in both high and low income countries (Landrigen et al. 2002:A313), showing the unforeseen persistence and ubiquity of chemicals whose effects and behaviour are incompletely understood.

This is not to say that agricultural technology is uniformly bad for people's wellbeing – on the contrary, it was the foundation for civilisation as we know it. Increased agricultural production allows the existence of non-food producing specialists, and today it can free people from backbreaking labour and provide food for millions. However, in accomplishing this, human technology has so far been exploiting natural resources unsustainably, and with unintended consequences which sometimes only become apparent years after the technology's use. Our technology use must evolve to a state of sustainability if we are to meet peoples' basic needs, because we depend on these resources for our most basic of needs, as well as our more elaborate wants. This is a truism which has been affirmed internationally as the "precautionary approach". At Rio in 1992, it was agreed that:

> *"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation,"*
>
> (WSSD 2005:50).

Basically, when it comes to resources which affect our and future generations' ability to secure our basic needs, it is better to be safe than sorry.

2.3.2 Power relations impact technology 'choice'

Unfortunately, this statement is non-binding. Technologies that are known to be seriously harmful to human health and the environment continue to be used and indeed promoted, particularly in low income countries. One example is the continued and in some cases, increasing export from the USA of thousands of tons of pesticides which are banned, discontinued, severely restricted, unregistered, or restricted in the USA to low income countries – often those known to have poor health and safety conditions for workers, unsafe application storage and application practices and inadequate user training (Harris 2000:5). Indiscriminate and wide-

spread misuse of pesticides cause serious public health problems in already poor countries, causing intergenerational effects through contaminated foods and breast milk (Cypher & Dietz 2009:364). This double standard in technology safety and quality is symptomatic of the inequitable power relations which dominate global trade, and which are often exploited to the financial advantage of powerful actors. These power imbalances probably originally arose due to differing environmental and geographical conditions which enabled some societies to develop technology earlier than others (Diamond 2005), and are still evident today in the dominance of the technology, modes of production and development of richer countries, which prioritise "rapid and efficient economic growth, privileges the industrial sector and urban areas, and tends to support the first foremost," (Parnwell in Desai & Potter 2008:111).

Clearly, technology is not neutral. Although all aimed at food production, different technologies align with the interests of different actors. More powerful actors can and do influence people's technology choice, and when these actors are not held accountable to the poor rural people who are the end users of the technology, producers can suffer. One example is the complete overhaul of colonized countries' agrarian structure to produce commodities for the financial benefit of the colonising nations (Cypher & Dietz 2009:347). The tea for which Sri Lanka is so renowned did not even exist in Sri Lanka before it was colonised, yet enormous tracts of land were appropriated, cleared and planted for the cultivation of these crops, at the cost of much loss of forest cover, soil erosion and pollution and sedimentation of waterways (Herath 2001).

2.3.3 Big is not necessarily better

Technology choices made by "experts' far removed from the problems faced by poor rural people are typical of the urban bias bemoaned by Chambers (1983:1-6), who argues that the rural poor should be at the heart of any project for sustainable rural development. Colonisation introduced technologies which were 'designed not to exploit the potential comparative advantage of the dominated economy and its people... but to supply the coloniser's needs," (Cypher & Dietz 2009:102). Unfortunately, similarly top-down development initiatives are still implemented today. Many past investments in public infrastructure such as irrigation channels in low income countries have proven unsustainable for economic, environmental and social reasons, because specific local time and place information was lacking (Ostrom et al. 1993:25-31). Consultation with local users from the very beginning of the project would have circumvented these extremely costly development failures (*ibid*.). Large, top-down initiatives

tend to disrupt existing local social institutions and technology use patterns, often without allowing much time for adaptation. Large agricultural programmes are poor vehicles for sustainable rural development:

> *Given urban bias, given the general lack of investment funds available to most poor nations, and given that the pay-off from investments in agriculture and in rural areas often require decades of concentrated efforts to show success, it is perhaps not too surprising that examples of successful agricultural programmes in less-developed nations are few and far between.*
>
> (Cypher & Dietz 2009:346).

The latest paradigm-changing, large-scale technological package in agriculture – the Green Revolution – dramatically increased production but was not optimally-adapted to the needs and constraints of the poorest producers. Initially, the technologies favoured already wealthy farmers over poorer ones, and while small farmers later adopted the technologies, the income gap had increased (*ibid*.:363). High-yielding varieties were designed for fertile, irrigated land, but those farmers on poor land could not benefit from this technology, and wages even in areas with increased production did not increase (*ibid*.).

2.3.4 Appropriate technology[2]: Small is beautiful and practical

If large-scale application of technology, infected by urban bias and designed by 'experts' outside the target rural area are expensive, high-risk, ill-suited to the needs of the poorest users and have widespread, long-term negative effects upon failure, the theoretical counterpoint to this mode of rural development is appropriate technology.

Developed most famously by respected economist E. F. Schumacher in the 1960's and 1970's, an appropriate technology has been defined as "any object, process, ideas, or practice that enhances human fulfilment through satisfaction of human needs," (Hazeltine 2003:4). Schumacher believed that one of these needs was satisfying, creative work involving technology which the user could shape and control, as opposed to 'dehumanising' work, which was a by-product of the single-minded focus of neo-classical economics on increasing output (Schumacher 1983; Kaplinsky 1990:36). Schumacher (1983) was concerned with enhancement of the quality of life, rather than merely increasing the consumption of goods.

[2]A closely related and often interchangeable term is "intermediate technology".

An appropriate technology is therefore one which functions on a human scale as opposed to the mega-projects described above – users should be empowered to shape and control the technology themselves. Many features of an ideal appropriate technology have been described. In general, an appropriate technology:

- Is compatible with local, cultural, and economic conditions (i.e., the human, material and cultural resources of the economy);
- Is consistent with the social and political institutions of the society in which it is used,
- Utilizes locally available materials and energy resources, with tools and processes maintained and operationally controlled by the local population,

(ibid.)

More specific characteristics are that an appropriate technology:

- Capitalises on local skills, ingenuity and needs in the innovation process,
- Is non-violent to natural environment and ecosystems,
- Is not an end in itself but is instead a part of development, owned and controlled by the community,

(Budgett-Meakin 1992:14)

- Is not capital intensive,
- Is relatively labour intensive but more than productive than many traditional technologies,
- Should decrease the dependency of a community on external economic, social and political forces.

(Darrow and Saxenian 1986:8)

Technological development initiatives with these characteristics should have a high acceptance rate by target communities, as they blend with, rather than disrupt traditional technologies. The emphasis on small scale technology, and local inputs and innovation should increase the possibility and effectiveness of social participation and control by even the poorest actors. Theoretically, appropriate technology is pro-poor and can help countries develop more equitably, bypassing the 'dual economy' conundrum whereby a small group of powerful urbanites benefit from advanced technology, while the rural poor remain in disadvantaged subsistence lifestyles, or are forced to migrate to urban areas where they remain marginalised and in poverty (Parnwell 2009:523).

Appropriate technology projects are by definition cheaper and smaller than large projects, while simultaneously being less likely to fail because of their incorporation of users' knowledge at the earliest stages. Effectively, this means more sustainable development for each unit of money spent. Appropriate technology also aligns with the precautionary principle, because its small scale precludes it from large-scale environmental devastation which results from poorly designed mega-projects.

2.4 Grand sustainability meets appropriate technology

Grand sustainability is required to help all humanity meet their basic needs, but operationalising this is difficult at the project level, where, in my experience, "sustainability' is often little more than a buzzword to be used to secure grants. Common indicators for grand sustainability are at a high level, far removed from the realities of rural projects (UNDESA CSD 2001). A technology which is environmentally and economically sustainable on a national level will not succeed if it is inappropriate for local users.

Development organisations and the communities they work with strive for livelihood-improving interventions which are accepted and maintainable by target communities. Small-scale, appropriate technology initiatives are purpose-designed for this, but they must also align with regional, national and international plans for grand sustainability – for sustainability's sake, but also to garner institutional support from donors and the government. A technology which increases local users' incomes but has downstream environmental effects which undermine the ability of others to meet their basic needs is also not sustainable.

Ultimately, a technological development project must both possess grand sustainability and be appropriate for the target community. Therefore, an analytical framework combining the concept of grand sustainability with the theory of appropriate technology should be useful in planning or assessing a truly sustainable technological development project, enabling those on the ground to devise and clearly present linkages between project outcomes and regional, national and international interests.

2.4.1 Politics

One factor which greatly affects a project's sustainability but which is not explicitly included in either appropriate technology or grand sustainability theories is compatibility with local political institutions. I decided to include this as a pillar in my analytical framework after some time in Sri Lanka with my host institution, whose work was reliant on the seemingly

arbitrary goodwill of local politicians. Grand sustainability is usually assessed at a country level, and thus does not reveal the role of local political institutions in promoting or hindering sustainable development. Appropriate technology, with its focus on increasing the self-reliance of communities, erroneously suggests that projects and communities function in a political vacuum. However appropriate a technology may be, if political institutions or even key individuals are against it, it will not be a sustainable intervention. Since I am focussing on how real projects can be designed to be truly sustainable, the irritating reality of political influence cannot be ignored, thus I included "suitability to local political institutions' as one of the pillars of my analytical framework.

2.4.2 My analytical framework

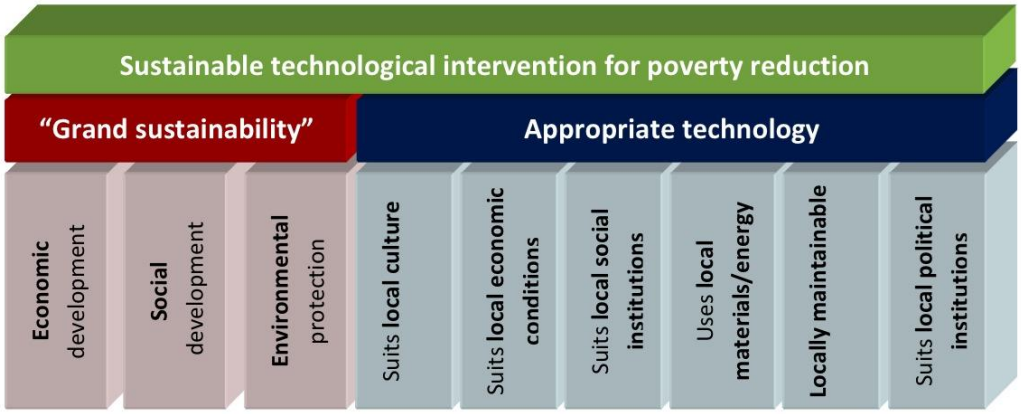


Figure 2: Analytical framework to assess a technological intervention's ability to sustainably reduce poverty among the targeted technology users. Each building block is integral to supporting the structures above. The intervention must display both grand sustainability and appropriateness to the target community.

Figure 2 shows the three pillars of grand sustainability and the six pillars I chose as essential to an appropriate technology. While a serious deficiency in any one of these nine pillars could be sufficient to scupper the sustainability of any technological intervention, a lack in one pillar may be compensated by another e.g. a technology which is culturally challenging may still be accepted by the community if they feel the technology improves local economic conditions sufficiently. The exception is the pillar of environmental protection, because this framework is based on strong sustainability. If a technology causes drastic loss in the natural capital's ability to supply basic needs to the community, this cannot be overcome by the technology being easily locally maintainable, for example.

2.5 Theoretical ambition

My theoretical framework was developed as "a basis for considering how what is unknown might be organised," (Silverman 2005:99). There are two parts to my theoretical ambition. First I take a simple deductive approach (Bryman 2008:9), using my analytical framework to explore the INGO's hypothesis that OPF with TV will be more sustainable and appropriate to farmers' needs than CPF with IV. The second part – an inductive analysis – uses my collected data and experiences to refine the theoretical framework, as described in Bryman (*ibid.*). Thus, I am attempting to create, apply and refine theory.

Chapter 3: Methodology

3.1 Meta-science

In the field, epistemology and ontology seemed extremely abstract. Nonetheless, questions about "what is (or should be) regarded as acceptable knowledge in a discipline" (Bryman 2008:13-21), or whether or not an external social reality even exists and can thus be described and analysed as such are fundamental. Indeed, my ontological and epistemological positions – interpretive and constructivist respectively - determine my methodology.

Prior experience had instilled in me a naive inductivism, which heavily influenced my initial research design (Silverman 2005:71). However, this was dismantled by acknowledging the inescapable theory dependence of observation (Chalmers 1988). Since different theories lead individuals to perceive the same object or social fact in completely different ways, one cannot do otherwise than presenting his or her *version* of social reality (Bryman 2008:19). Thus I was forced to accept that I could not eliminate the influence of my personal values (*ibid.*:34), and furthermore that I was constructing my own account of the social world through a lens as a student, an engineer, a woman, a New Zealander… (*ibid*:19).

I thereafter ceased to prioritise quantitative analysis and revised my research design to include semi-structured interviews of actors to provide me with data for my analytical framework. My study took on a mixed methods design, combining:

- Literature reviews on environmental sustainability;
- Quantitative cost-benefit interviews with farmers; and
- Qualitative interviews with key respondents in Sri Lanka's paddy sector.

Quantitative cost-benefit analysis was retained alongside my qualitative methods for ontological, educative, catalytic and tactical authenticity: concepts which are 'controversial' in social research circles because of their 'emphasis on practical outcomes' and actual utility to research subjects (*ibid*.:379). This controversy confuses me. Several texts discuss the ethics of social research, stating for example that it is "important to offer feedback to all parties that are under study," (Silverman 2005:263). I would argue that for ethical reasons, in the absence of any remuneration for research respondents' contributions, social research *should* be of value to them, and that practical, usable findings should be a research priority. Although quantitatively measuring an external reality and eliciting qualitative responses about the same phenomenon is epistemologically inconsistent (Bryman 2008:602-606), this research design improves my research's utility or 'authenticity', and is in fact necessary to evaluate all nine pillars of my theoretical framework.

3.2 Data collection

3.2.1 Initial sampling restrictions

The task assigned to me by the INGO was to conduct a macro-economic analysis to draw conclusions about the feasibility of scaling up OPF with TV nation-wide. Such generalisation requires a nationally representative sample of farmers, obtained through careful probability sampling (Bryman 2008:168), which requires some kind of database of farmers with information on location, holding size and irrigation for stratification purposes. Unfortunately, in Sri Lanka, such a database does not exist, and the organisation did not have a comprehensive database for the farmers involved in their trials.

3.2.2 Mixed methods: cost-benefit 'cases', in-depth interviews, observations

This methodological difficulty also motivated my mixed methods approach. My only option for examining macro-economic potential was to conduct in-depth cost-benefit interviews with as many farmers as I could access – not a statistically representative sample, but a group of economic 'case studies' – and complement this with the use of government import/export statistics. For the remaining pillars, I formulated guides to interview key respondents. I also visited traditional paddy trial sites in Batticaloa, and attended a decadal conference on the rice sector in Sri Lanka to make direct observations.

Interviewees were purposively selected according to their influence/roles in the Sri Lankan paddy sector (Bryman 2008:415). I aimed for a sample of respondents which varied in key

characteristics and interests to reflect the diversity of views of influential actors (*ibid*.). Based on pilot interviews, literature reviews, I chose seven categories of respondents.

Table 1: Key respondent categories

Category	**Role in market map**
Politicians/Civil servants in the agricultural sector	Business environment
Civil society organizations (CSO) with experience with local farmers and familiarity with the concepts of sustainable, alternative or organic agriculture and/or market issues relevant to organic rice production	Business environment (advocacy)/Business services (service provision)
Crop/Soil scientists from the public sector	Business environment
Crop/Soil scientists from the private sector	Business services
Representatives of large agribusiness companies which are extremely influential in Sri Lanka by virtue of their sizable and strategically distributed financial resources	Business services
Low income, small and medium scale paddy farmers who had experience of both conventional and organic methods, and traditional and improved varieties	Market chain actors
Representatives of marketing organisations for paddy	Market chain actors

These categories were inspired by Albu and Griffith's market map, which describes market systems involving small-scale producers (2006:12). As shown in Figure 3, actors/factors are identified as part of:

- **"The business environment**

  Infrastructure and policies, institutions and processes that shape the market system…;
- **The market chain actors**

  The chain of economic actors who own a product as it moves from primary producers to consumers…; [or]
- **The service providers**

  The business and extension services that support the market-chain's operation,"

(*ibid*.:13).

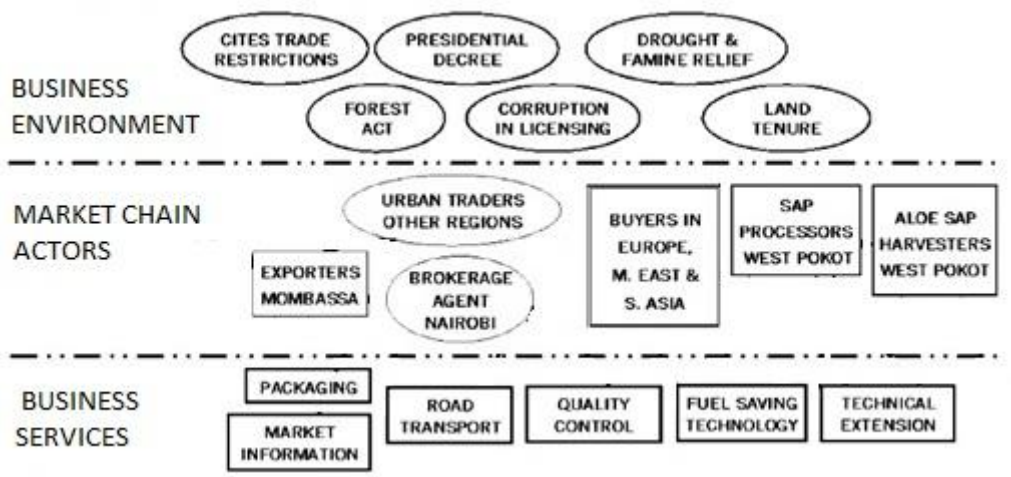


Figure 3: Example market map – aloe in Kenya (adapted from Albu and Griffith 2006:14)

I aimed for at least two respondents from each category. I hoped for more interviews with farmers, because the ultimate purpose of my research was to investigate if and how *their* livelihoods could be sustainably improved through OPF with TV. Ultimately, my interviewees were as follows.

Table 2: Interviewees and their roles in the market map

Interviewee/ Group[3]	**Market map role**	**Description**
BE1	Business environment	Head of a centre for sustainable agriculture research and development, which works closely with a local CSO advocating zero budget farming. Also on the board of the National Science Foundation.
BE2	Business environment	Policy analyst for the local CSO with which A works closely. Promotes alternative farming, works with farmer organizations around the country.
BE3	Business environment	Member of same CSO as BE2, paddy farmer.
BE4	Business environment	Labour activist, member of same CSO as BE2 and BE3, advocate of natural farming
BE5	Business environment	Lecturer at local university. Studied soil scientist (undergraduate), general agriculture and soil specialist (Masters), soil and environmental science (PhD, University of Reading). Experience in government agriculture bodies overseas.
BE6	Business environment	Retired professor in Agronomy, worked for 20 years at a local university. Specialist in plant breeding and seed technology.
BE7	Business environment	Agrarian Development officer of the Agrarian Development Department (extension officer) and rice farmer, organises training etc. for group MC4 of interviewees.

[3] For brevity, interviewees/interviewee groups will henceforth be referred to by their identifying codes. BE = business environment actor, MC = market chain actor, BS = business service providing actor, according to their roles in the market map.

MC1	Market chain	Commercial paddy farmer in the dry zone, also an activist and conserver of traditional seeds
MC2	Market chain	Manager of a social marketing organisation working with rural farmers and producers including traditional paddy farmers
MC3	Market chain	Manager of a large organic paddy and vegetable cooperative farm. Runs training programmes for farmers and works on market chain development. Also engages in advocacy and education work for organic/biodynamic farming.
MC4	Market chain	Association of medium scale paddy farmers who have received training in "natural farming'. In Batticaloa (dry zone).
MC5[4]	Market chain	Commercial paddy farmer (15 acres) and government worker in Batticaloa.
MC6	Market chain	Commercial paddy farmer (15 acres) and government worker in Batticaloa.
MC7	Market chain	Medium scale paddy farmer in low country wet zone, Galle. Cultivates 7 acres with conventional methods and varieties, and 0.5 acres organically with traditional varieties. Also cultivates cinnamon and other vegetables.
MC8	Market chain	Small scale paddy farmer in low country wet zone, Galle. Cultivates 0.5 acres with conventional methods and improved varieties, and 0.5 acres organically with traditional varieties.
MC9	Market chain	Small scale paddy farmer in low country wet zone, Galle. Cultivates 0.5 acres with conventional methods and improved varieties, and 0.5 acres organically with traditional varieties.
MC10	Market chain	Small scale paddy farmer in low country wet zone, Galle. Cultivates 1.5 acres with conventional methods and improved varieties, and 1 acre organically with traditional varieties.
BS1	Business services	Doctorate in economics, assistant programme director and programme manager in a government-funded foundation promoting organic home gardening for extremely poor farmers. Previously worked in a prominent international NGO.
BS2	Business services	Development worker in international NGO, focused on waste management and agriculture based on co-operative management. Also a journalist who writes on farming and development. Undergraduate degree in agriculture and crop science.
BS3	Business services	Well known rice breeder for an influential private sector company, which produces a large proportion of the national seed paddy, is the leading provider of agrichemicals in Sri Lanka and manages large government owned farms. The company represents many multinational agrichemical companies including Dow Agro Sciences, Syngenta, United Phosphorous Ltd. Studied at a local university for undergraduate level, then in Virginia Tech for their Masters and PhD. Worked 28 years as a rice breeder in the public sector before moving to private 5 years ago.
BS4	Business services	Director of an influential private sector company which supplies agri-inputs, particularly chemical spraying equipment. Has 25 years' experience in the field as an executive and in sales and marketing. Trained as an agriculture technician, has a diploma in agriculture.
BS5	Business	Managing director of the group of companies of which interviewee

[4] Interviewees MC5-MC10 were interviewed using a detailed cost-benefit spreadsheet (Appendix C), as opposed to all others whose interviews were based on the guide in Appendix D.

	services	BS2's company is a part.
BS6	Business services	National programme coordinator for a federation of farmers which works to conserve traditional paddy and vegetable varieties and methods of farming.
BS7	Business services	Advisor and board member of the same organization as interviewee MC5. Also a retired farmer.
BS8	Business services	Trainer and field coordinator for the same organization as interviewees BE7 and MC5. Trains farmers and farmer leaders to grow organic paddy using traditional systems.
BS9	Business services	Project manager for an international NGO in Sri Lanka, works on livelihood enhancing projects for poor farmers including one using traditional varieties of paddy in marginal, saline, and/or flooded land. Undergraduate degree in crop science from a local university. Worked with farmers MC7-MC10.

In theory, my sampling was purposive, and where possible I contacted interviewees directly. In practice however, I required help accessing my respondents both for initial contact and occasionally via translation. Therefore, snowball sampling – convenience sampling in which "the researcher makes initial contact with a small group of people who are relevant to the research topic and then uses these to establish contacts with others," (Bryman 2008:184-185) – was also used, notably for all my interviews with farmers. I was fortunate in having two non-judgemental gatekeepers with extensive contacts within civil society, academia and the public sector. Many respondents went to great lengths to connect me with other individuals or organisations.

3.2.3 Interviewing

"Interviewing is a craft [which] does not follow content- and context-free rules of method," (Kvale 1996:105). It is an art I have yet to perfect. My first interview guide was rigidly based upon my analytical framework. I was well-prepared with a camera, batteries and cue cards for the initial briefing (*ibid*.:128). However, although my questions were painstakingly worded and ordered to be neutral and open, and they performed well in a thematic dimension (Kvale 1996:129-130), they left much to be desired in terms of the dynamic dimension, which is responsible for "promoting positive interaction" between the interviewer and respondent (*ibid*.). I soon realised that inflexible adherence to the guide was inappropriate, because the open-ended questions elicited answers to more than one question at a time. With experience, I became more adept at being "[open] to changes of sequence and forms of questions in order to follow up the answers given and the stories told by the subjects," (*ibid.*) and my interview guide become a list of topics to ensure I covered.

The interviews were intended to be one-on-one to obtain the rich, detailed answers desired from qualitative interviews (Bryman 2008:437). However, occasionally spontaneous opportunities arose for small group interviews, for example with several members from an organisation. Although I had not planned for this, I was able to use the same interview guide to elicit the relevant information from the respondents. Despite having multiple respondents interacting, I still viewed these sessions as group interviews, not focus groups, because I was interested in their individual perceptions, not their interactions," (*ibid*.).

3.4 Ethical considerations

I am unfailingly grateful that all respondents were extremely willing to share their perceptions with me. I believe this is due in part to my status as an independent research student who is not funded by any organisation with local interests. However, as a foreigner I am inherently "urban based and urban biased," (Chambers 1983:9), which brings into question the ethics of my research, not to mention the legitimacy of my findings. However, I have sought to practice ethical conduct at each of the seven research stages (Kvale 1996:111), securing informed consent, offering confidentiality, retaining video recording, transcribing each interview verbatim, and in particular, keeping in mind that his maxim that "research with human participants must serve scientific *and* human purposes." With this in mind, I will send the final report to all respondents who requested it.

3.5 Quality considerations

This study would be improved with further data collection. Ideally, I would have continued interviewing until saturation point for each category, beyond which further interviews did not reveal any new relevant information (Ragin 1994:86). Logistical constraints unfortunately made this impossible. Also, the tight-knit community of actors in the paddy sector meant that many of my interviewees knew each other professionally, which was both beneficial for access, yet challenging because of the risk that antagonistic or collaborative individual actors might communicate with each other to intentionally or unintentionally affect the ecological validity of my investigation (Bryman 2008:32). This can be partially overcome through direct observations.

The need to critically assess the motivation and target audience of data from every source was emphasised by the differing quantitative information I obtained from actors – private sector actors gave different figures for paddy yields to those from civil society organisations. A simple review of the methodology of local crop scientists' papers shows that generalisations have

been made inappropriately, and external reliability is often very poor – methods used in the field experiments, even at prestigious local research institutes, are not recorded in adequate detail to allow reproductions of studies. For qualitative analysis, such disagreement between actors is itself a useful finding, and is acceptable within my constructivist epistemological position. It also adds to the authenticity and potential impact of the work, because understanding how different actors perceive the same situation can be used to facilitate communication and explore avenues for collaboration or conflict resolution. However, for quantitative data which supposedly represents hard facts about an external, measurable reality, such disagreement is a disappointing reminder of how misleading natural science and statistics can be, and subtracts greatly from the authenticity and practical use of the data. I use literature to triangulate such data.

My mixed methods approach, and range of interview subjects inherently offers a useful triangulation strategy. Information is on key issues in the paddy sector can be crosschecked between actors (Bryman 2008:380), and it has often been the case that small factual errors in responses are rectified in later discussions. The overarching message concerning the quality of my research is that it is incredibly difficult if not practically impossible to be a truly good scientist, who questions, crosschecks and critically analyses the motives behind every data source, while humbly acknowledging the limitations to their own research. It has been disheartening to see the misleading way in which 'objective research findings' are presented, and even more so to see how often such information is accepted – so I shall strive in my analysis to be explicit about the personal values inherent in my research, as well as the limitations of all the data I have collected.

Nevertheless, two major concerns are:

- The underrepresentation of female farmers/female household members. Only MC9 and a number of farmers in group MC4 were female, and they play significant roles in paddy production, in addition to their family duties and other work;

- The interviewing of only paddy farmers who had at some experience with OPF and TV. Through their contact with my CSO gatekeepers, they have (re-)learnt about these technologies and their benefits and disadvantages, and are therefore likely to express different opinions to those who have not had such contact, affecting the reliability of my data, and limiting the conclusions which can be drawn from my analysis.

Chapter 4: Results and analysis

In this chapter, analysis of the technologies is conducted pillar by pillar. Based on the layout of the market map with business environment actors on top, market chain actors in the middle and business service providers at the bottom, interviewees' key quotations are displayed. Quotations in support of OPF and/or TV are shown in green boxes. Those favouring CPF and/or IV are shown in red boxes. Neutral or contradictory comments are in yellow boxes. Thus, one can quickly grasp the level of support for organic/TV or CPF/IV amongst the three groups of actors. Analytical texts follow each diagram.

4.1 Assessing grand sustainability

4.1.1 Macroeconomic development

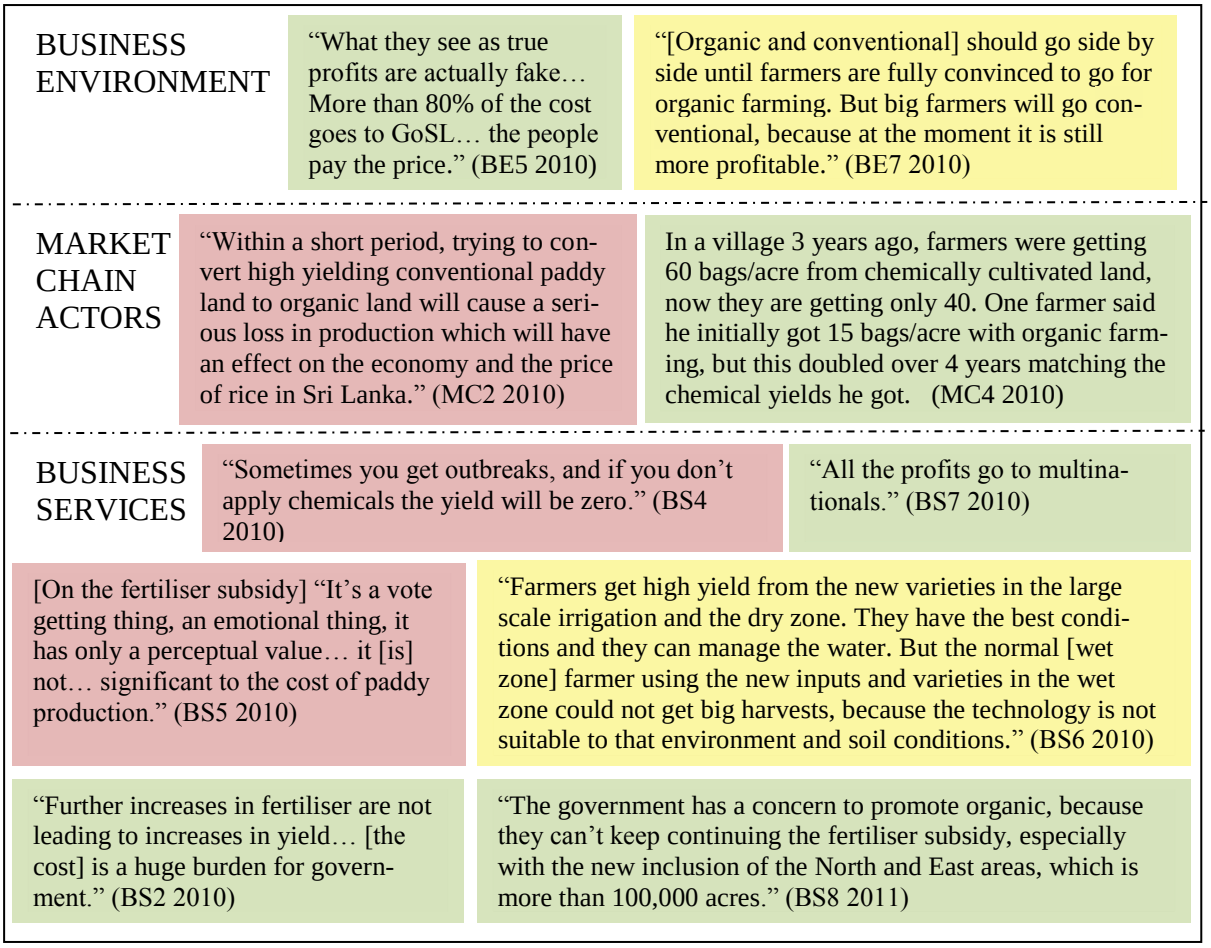


Figure 4: Responses on macroeconomic development

Respondents held strongly diverging views on OPF's and/or TV's potential to contribute to Sri Lanka's macroeconomic development. While national debt remains problematic (BE4 2010), Sri Lanka has been self-sufficient in rice for five of the past six years (GoSL 2010). Maintaining this is a fiscal and political priority.

All private sector representatives saw yields as the key concern. They maintained that OPF would threaten national rice self-sufficiency, referring to past Green Revolution successes, the 'inability' of OPF to produce yields comparable to those obtained by chemical methods because of perceived nutrient cycle deficiencies, and lack of disease-resistant breeding in TV. Their focus on yield is comparable to weak sustainability's focus on only one form of capital.

In contrast, almost all other interviewees considered a diversity of factors, including the heavy and accelerating cost of importing fertiliser and agrochemicals (Appendix B), lost labour and healthcare costs from chemical-related ill health, salaries for extension staff, and the increasing cost of fertiliser subsidies, especially with the North and East returning to cultivation (BE1, BE5, MC1, BS2, BS5 2010; BS9 2011). This breadth of analysis indicates that these actors, like this study, take a strong sustainability perspective. They saw CPF as profiting multinational agrichemical companies at great cost to the GoSL, and perceived OPF as part of the solution for genuine long term macroeconomic stability (*ibid*.).

All interviewees explained that 100% conversion to OPF would cause, at least initially, a serious drop in national paddy production. However, while private sector stakeholders rejected the possibility of organic to yield well under any circumstances, farmers and public sector scientists shared their experiences of increasing yields from organic paddy cultivation over time as the soil gains organic matter content and healthier communities of microorganisms, and the opposite for CPF land (BE4, BS2, BS3, BS4 2010). BE6 suggested 10 years as the period for organic yields to match CPF yields (2010). BE1 proposed a subsidy in the form of money for organic farmers to overcome the initial yield drop, claiming that after two to three seasons this subsidy could be dropped (2010). Empirical studies show CPF yields stagnating and/or declining in Green Revolution lead areas around the world (Rosset et al. 2011; Tilman et al. 2002:673).

BE5, BS1, BS2, BS6 (2010) and BS9 (2011) in particular emphasised that they were not advocating a complete shift to OPF in Sri Lanka, but that OPF with TV could yield as well as CPF *under certain conditions*, and that such practices should be pursued in these areas first. IV have been developed to give bumper yields under ideal conditions (dry zone with major or minor irrigation schemes, usually large scale commercial farmers), which they do. However, they perform worse in marginal lands with rain-fed irrigation systems, salinity, iron toxicity, water stress or flooding which are predominantly cultivated by very small scale farmers (MC3 2010; Rathnabharathie 2009). TV with special characteristics (such as the ultra-tall and there-

fore flood resistant *maha ma vee*) out-perform IV in these areas (*ibid*.). Since TV are not fertiliser responsive, fertiliser use here would be counterproductive, merely causing the plants to grow too tall and 'lodge'[5], so these varieties lend themselves to OPF or at least fertiliser-free cultivation.

Thus, given their characteristics, TV are better cultivated organically. Perhaps not surprisingly given the interviewee's profession, use of TV was not viewed positively by private sector rice breeder BS3, who explained in detail how IV are bred for disease resistance, unlike their allegedly weak and susceptible traditional cousins. However, another plant breeding specialist, BE6, explained that, "TV have general adaptations, they are resistant to pests and diseases in general and they do better under low levels of management compared to IV," (2010). Certainly, weedicides and pesticides act as strong selective pressures, and "any improvement in crop resistance to a pathogen is likely to be transitory," (Tilman et al. 2002:674). Interestingly, soil specialist BE5 whose research found strongly in favour of OPF, maintained that what was important in maintaining soil fertility was the cultivation method, not the variety. BE5 suggested that even the fertiliser needs of improved plants could be met with judicious application of organic inputs (2010), although optimal control of nutrient release from organic input requires more research (Tilman et al. 2002:673).

Currently, a statistically negligible area of paddy land in Sri Lanka is cultivated organically. Thus, I was interested to see if national rice self-sufficiency would actually be threatened by significant conversion of rain-fed paddy land to OPF with TV. As an estimate, I used data from my host INGO's field studies. The average yield of the OPF plots was used to estimate the national yield if all rain-fed[6] land Galle, Matara, Hambantota and Ampara were converted.

[5]Fall over

[6] I only extrapolated for rain-fed land, because this was the type of land on which the OPF and TV were trialled in Galle, Matara, Hambantota and Ampara.

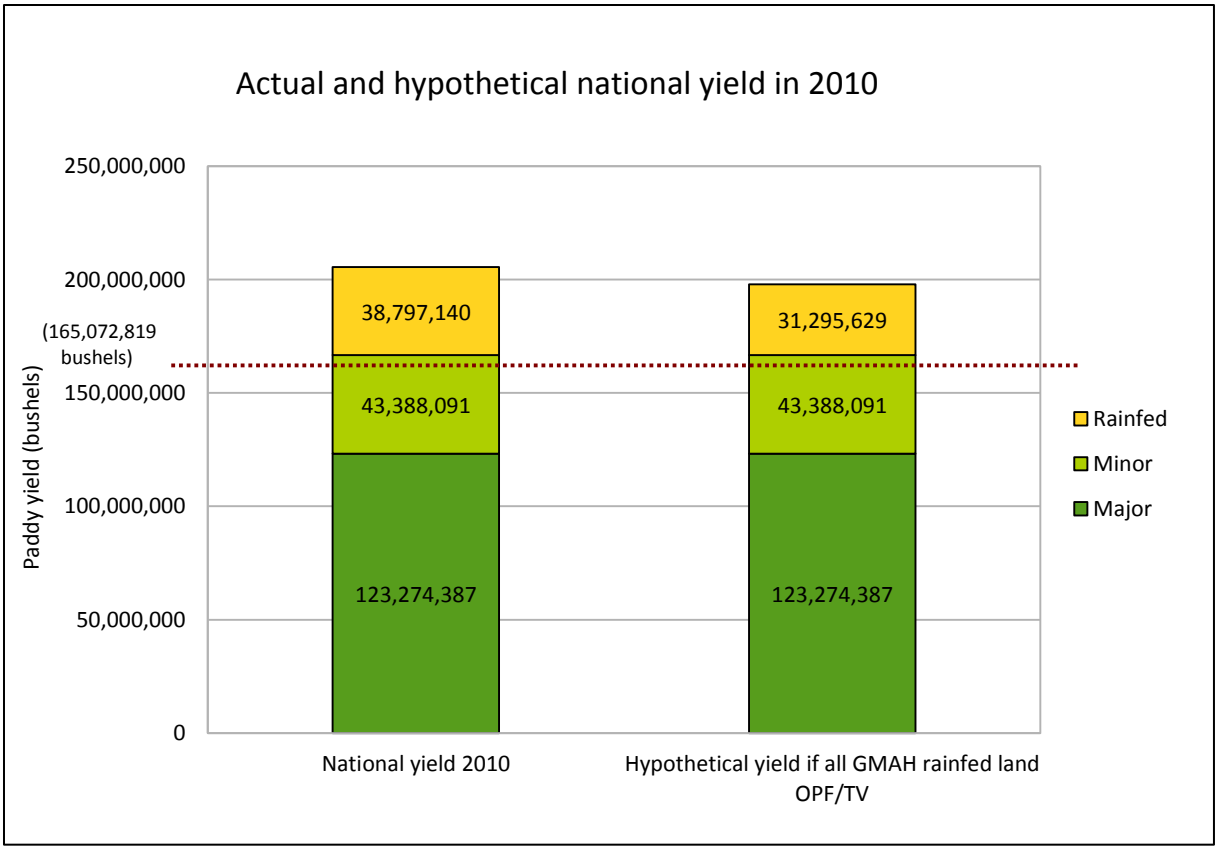


Figure 5: Hypothetical yield in Maha 2009/2010 + Yala 2010[7] if all rain-fed, prepared land in Galle, Matara, Ampara and Hambantota were cultivated using OPF and TV. The red dotted line indicates the national requirement for paddy in 2010 (GoSL 2010)

As Figure 5 shows, based on 2010 national yield data, national rice self-sufficiency would be maintained even if all rain-fed cultivation was lost, so the conversion seems macro-economically sound: foreign exchange would be saved on input imports without yield being overly compromised. While the population is still growing, yields from organic cultivation tend to increase over time, and large amounts of land are opening up for cultivation in the North and East, which would help to offset increasing demand.

[7] Maha and Yala are the two paddy cultivation seasons in Sri Lanka. Maha occurs during the north-east monsoon from September to March the next year, while Yala stretches from May until the end of August (GoSL 2010).

4.1.2 Social development

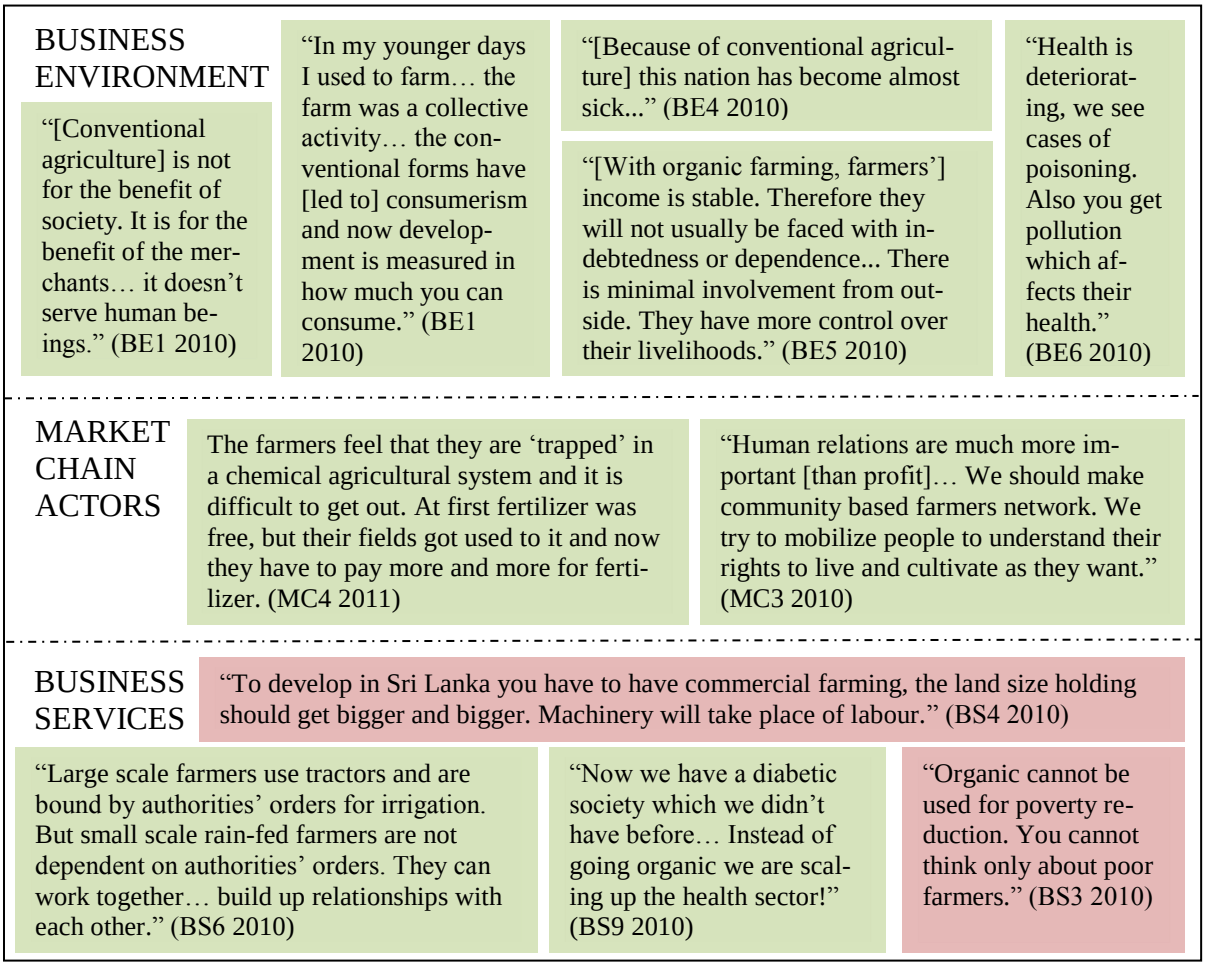


Figure 6: Responses on social development

Unlike for macroeconomic development, responses to questions about social development were almost uniformly positive or neutral on OPF/TV and negative or neutral on CPF/IV.

The most common concern was about perceived health damage caused by chemical farming. Health problems observed and mentioned by interviewees included breast milk contamination, pesticide bioaccumulation, early-onset puberty from exposure to oestrogenic pesticides, contamination of drinking water with nitrate leading to methaemoglobinemia (blue baby syndrome), and the rapid spread of kidney disease in Anuradhapura, a major rice-producing region in the dry zone (BE1, BE4, BE5, BE6, MC1, MC3, BS1, BS3, BS7 2010; BS9 2011). BS3 (2010) maintained that these problems were not directly related to agriculture and could even happen with organic inputs depending on the amount of nitrate released, but it is much easier to over-apply nitrate in the form of urea than manure, so this seems unreasonable.

BE5 said awareness of these health effects among society was low but increasing (2010). However, even full-time farmers with only secondary education preferred to eat their organically produced rice for health reasons, if they practised both kinds of cultivation. This may be because of their exposure to and education about OPF or personal experiences: a paddy farming family I visited informally had suffered multiple cases of accidental pesticide poisoning. The knowledge and accountability gap between producers/sellers and users of agrochemicals is an extension of power imbalances in the international agrochemical market (section 2.3.2).

Research supports the interviewees' misgivings. Misuse of pesticides "may damage water, air and soil and eventually endanger the health of pesticide users, bystanders, residents and consumers. They can cause acute, chronic or long-term health impairment, depending on the level and duration of exposure," (EUROPA 2006). Unfortunately, they are ubiquitous: "Unwanted amounts of certain pesticides are regularly found in environmental media (in particular water) and residues exceeding regulatory limits are sometimes found in agricultural food and feed," (*ibid*.). Despite regulations, the annual number of deaths due to pesticide poisoning in Sri Lanka was well over 1000 between 1986 and 1996, and in south India damaging pesticide residues in breast milk have been recorded for decades (Tanabe et al. 1990). Even synthetic fertilisers have been linked with human health problems. Nitrate-contaminated water has been linked with methaemoglobinemia (blue baby syndrome) on the Kalpitiya peninsula on Sri Lanka's west coast (UNDP 2010). OPF uses no pesticides, weedicides, fungicides or synthetic fertiliser. It therefore eliminates the risk of ill health from synthetic chemicals for everyone – from farmer to consumer. Interviewees BE1 (2010) and BS9 (2011) also described health benefits of TV, citing changing food habits and the complete dominance of less nutritious IV as a cause of the increase in non-communicable disease in Sri Lanka.

The second negative social effect of CPF described was the loss of social capital: a once communal activity became individualistic and profit-focussed. Explanations for this included ubiquitous 'propaganda' by the government and agricultural input companies promoting new tools, chemicals and seeds as ways for farmers to get rich and buy vehicles, and the centralised irrigation systems of major and minor schemes, which require all paddy fields to be ready for irrigation simultaneously (BE3, BE6, MC3, BS6 2010). The top-down involvement of non-local actors in paddy cultivation was viewed negatively by BE5, MC3 and MC4 as taking away farmers' control of their own livelihoods and forcing upon them inappropriate technologies which prioritise mass production and profit over self-sufficiency (2010). Their technology switch away from organic production is encouraged by companies and the government by

heavily subsidised or free inputs or equipment such as sprayers (BS4 2010), but as the price of these inputs climbs, farmers reportedly felt 'trapped' in the chemical system of farming (MC4 2010). Fortunately for farmers, hybrid paddy seed which does not breed true to type and must thus be bought from companies every season has not yet become widely established in Sri Lanka (BS3 2010). For biosecurity reasons, it is illegal to import rough rice. However, BS3's company is now developing such varieties with the support of the International Rice Research Institute (IRRI) (Overett 2005). The establishment of such varieties in Sri Lanka will only increase poor farmers' dependence on capital-intensive cultivation, and will increase the damaging social effects of uncertain livelihoods. The dependence of CPF farmers' incomes on outside factors reportedly led to indebtedness and livelihood instability (BE5 2010).

Thirdly, interviewees commented on the close link between the market-driven agricultural sector and social unrest (BE1, BE3, BE2, MC1 2010). Farmer MC1 was imprisoned for four years for his role in the youth uprising. Dissatisfied, educated rural youth, "have been… the main force behind social unrest and violent insurgencies in the country on several occasions," (Amarasuriya et al. 2009:18). Youths' increasing expectations of employment and income are undoubtedly encouraging youth to shun paddy farming (BS4, BS5 2010). However, the complete dominance of CPF refutes BS4's assertion that youth are turning away from paddy farming and preferring to sell their labour for precarious, irregular seasonal work because of the poor productivity of the 'traditional sector'. Furthermore, youth unemployment in Sri Lanka is high: around 40% of total unemployment (*ibid*.) A major obstacle to employment creation identified in 2006 by the National Action Plan for Youth Unemployment was …a lack of adequate community infrastructure, especially poor access to roads, electricity and markets, means that especially micro-, small- and medium-sized enterprises are prevented from growing and employing more people," (*ibid*.). With this in mind, BS4's assertion that, "To develop in Sri Lanka you have to have commercial farming, the land size holding should get bigger... Machinery will take place of labour," is anachronistic, and discourages social development.

Overall, private sector interviewees' understanding of the social effects of CPF on poor paddy farmers did not match those given by CSO and farmers themselves. BS4 grandly claimed, "We can't say we are selling inputs. We are contributing to developing Sri Lanka," but 'development' means different things to different actors. Company growth, high yields for national level food security and profits are the aims of the private sector (BS3, BS4, BS5 2010), but income stability, freedom from indebtedness, health, autonomy over one's livelihood and cultivation, and support for small producers are what farmers and CSO saw as social priorities

(BE1, BE2, BE3, BE4, MC1, MC3, MC4, BE7 2010, BS9 2011). Schumacher's advocacy of technology which users can shape and control is reflected in the opinions of farmers and CSO. CPF's dominance even amongst small, capital-poor farmers reveals the ongoing domination of technology focused solely on increasing output, as explained in section 2.3.3. The private sector actors use the language of development, but it fits poorly with their organizational objectives. BS3 maintained that, "Organic cannot be used for poverty reduction," but in the same breath continued: "You cannot only think about poor farmers."

4.1.3 Environmental protection

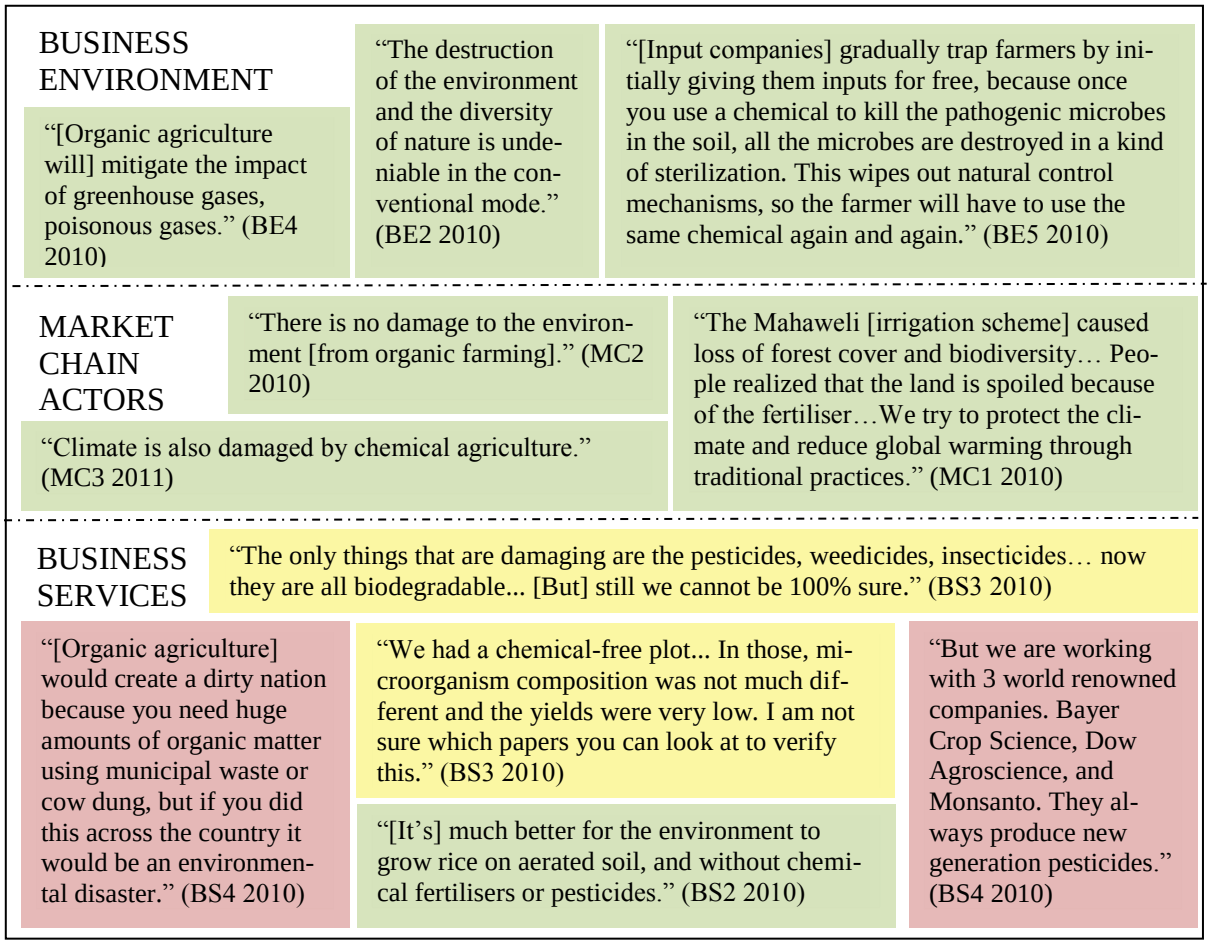


Figure 7: Responses on environmental protection

As with social development, OPF was perceived as better for the environment than CPF by all interviewees, except those who profited from input sales. Eutrophication from fertiliser runoff (BE1 2010), unintended side-effects of pesticides and weedicides (BE1, BS3, BS1 2010), loss of forest cover and biodiversity (BE1, MC1, BS5 2010), greenhouse gas emissions contributing to climate change (BE4, MC1 2010), and the decimation of balanced soil microbial communities (BE5, BS2 2010) were attributed to CPF. Plant breeder BS3 claimed that soil microorganism composition was not affected by the addition of fertiliser, pesticides and

weedicides but was unable to direct me to papers which supported his claim. In contrast, soil expert BE5 explained at length how soil microbes were crucial for soil fertility, enabling the greatest biodiversity (tropical rainforests) to exist on the poorest soils (humid tropical soils) (van der Heijden et al. 2008). He explained, "The addition of even minute quantities will dramatically change or harm these populations," effectively sterilizing the soil and forcing farmers to reapply fertiliser to obtain comparable yields. He also mentioned the important but incompletely understood role that balanced soil microbial communities play in regulating atmospheric CO_2 (Lou & Zhou 2006:3).

Soil is a vital natural resource for humans; it provides, directly or indirectly, almost all our food and fibre (Fitzpatrick 1998:1). Soil is composed of a balanced mixture of air, water, mineral material, organic matter and beneficial organisms, all of which are necessary for soil fertility (*ibid*.). Introduction of agro-chemicals and machinery can negatively affect soil productivity by making conditions uninhabitable for beneficial organisms, and compacting and disrupting the soil structure. Field trials comparing land which had either organic fertility amendments such as manure and compost, or chemical fertilisers added to it, show that organically farmed land had "enhanced beneficial soil microorganisms, reduced pathogen populations, increased soil organic matter, total carbon, and cation exchange capacity, and lowered bulk density thus improving soil quality," (Bulluck et al. 2002). Trace minerals in soil (and subsequently, crops) are also depleted when chemical fertilisers with imbalanced nutrient profiles are used intensively.

Poorly managed CPF not only degrades soil, it also promotes pest fitness. Monocultures – large, genetically uniform areas with only one species - do not exist in nature, yet are the basis for commercial agriculture, which requires uniformity for mechanisation to be efficient. Broad spectrum pesticides which quickly kill whole generations of pests seem to be convenient for dealing with unwanted species. However, large areas of genetically uniform crops are susceptible to devastation by one pest/pathogen, and pests/pathogens quickly develop pesticide resistance (Tilman 2002:673). It is now recognised that a more holistic or integrated approach to pest management which simulates or increases environmental heterogeneity is needed to protect crops (Roux et al. 2008, Banwo and Adamo 2003).

In contrast, OPF offers a more effective long term approach to pest management, because it promotes biodiversity and natural predator-prey relationships in the cultivated area through intercropping and by avoiding chemicals which wipe out many plants and animals. There is a

wealth of local knowledge in Sri Lanka of successful, alternative pest management strategies, such as planting sticks or trees in paddy fields as perches for predatory birds, intercropping, crop rotations, running resin-covered strings through the fields to catch insect pests, or concoctions of neem and other local plants (BS9 2011; MC3 2010; Tilman et al. 2002:673-674).

That chemical agriculture is often worse for the environment than organic agriculture is not seriously disputed (UNEP 2011:41). It is recognised internationally that "environmental pollution by pesticides may... provoke adverse effects on plants and wildlife, and more generally losses of biodiversity," but this acknowledgement is too little, too late. Agrochemicals' safety has only recently become the subject of legislation, even in the European Union (EUROPA 2006). A staggering "98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including non-target species, air, water, bottom sediments, and food," (Miller 2004). Fertiliser too causes problematic eutrophication of water bodies when excess fertiliser washes away.

OPF is much safer for us than chemical agriculture, because it does not involve wholesale release of poisonous chemicals into our environment and food system. Instead, it fosters natural predator-prey relationships. Mulch and manure support useful soil organisms (Werner 1990), and since they release their nutrients slowly, they are not as prone to the run-off problems associated with synthetic fertilisers. There may also be climatic benefits: some OPF methods such as *navakakkulum* or Uphoff's System of Rice Intensification (SRI) cultivate on aerated soil, thus circumventing the methane generation which results from flooded paddy.

It is short-sighted at best, and extremely perilous at worst, to damage systems that supply our basic needs of food, fibre, water and oxygen without understanding the long term effects. Chemical agriculture contravenes the precautionary approach agreed to in Rio.

4.2 Assessing appropriateness

4.2.1 Suits local culture

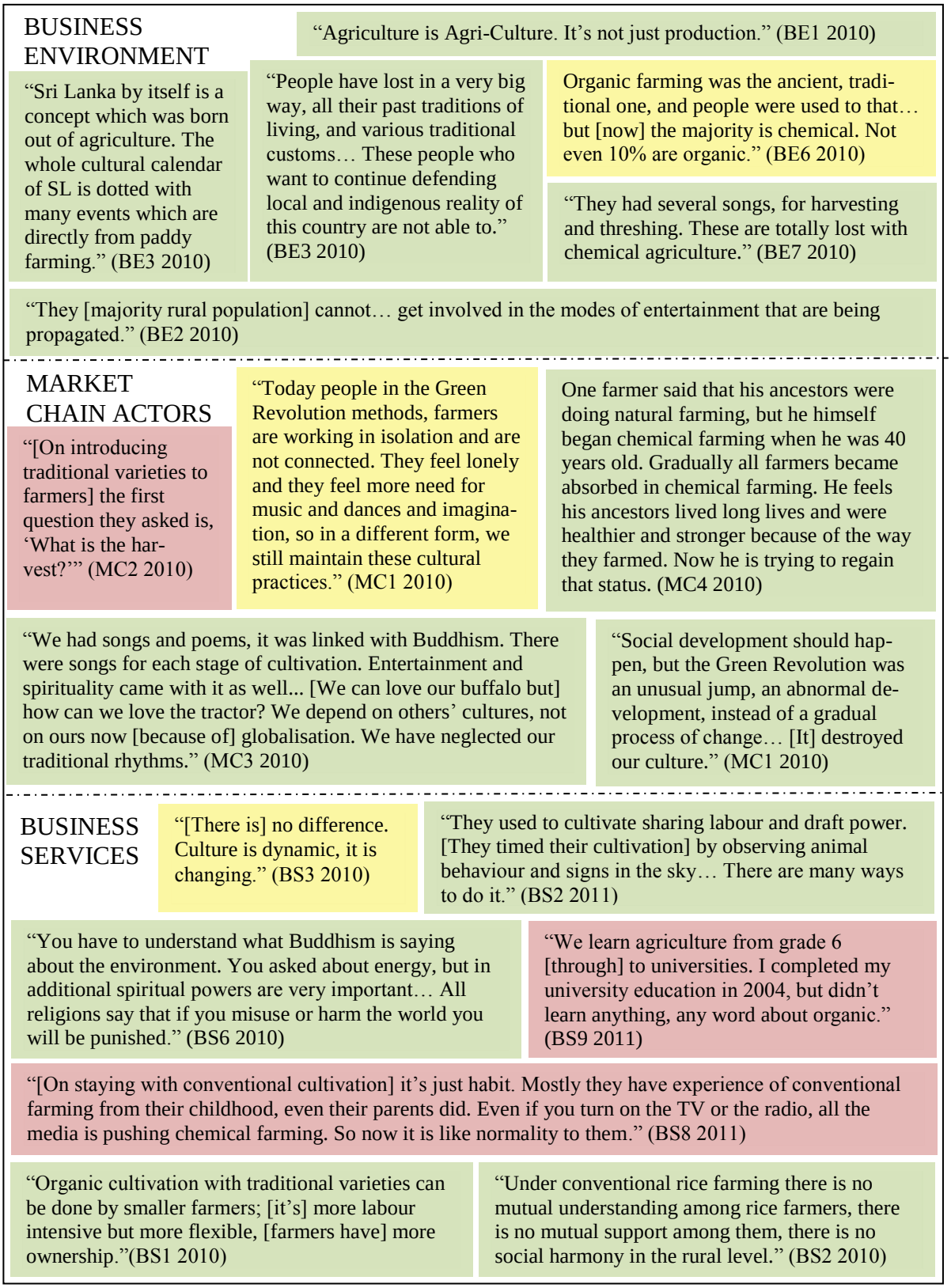


Figure 8: Responses on suitability to local culture

Two groups of responses to questions on cultural appropriateness can be discerned: firstly, those describing the link between traditional agriculture and Sri Lankan culture, and how this is undermined by CPF and mass media; and secondly, how farming culture/habits have changed since the Green Revolution.

Agriculture remains economically vital to Sri Lanka. With only 14% of its population living in urban areas (CIA 2010), agriculture has historically meant more than production – it is the basis of Sri Lankan culture (BE1 2010). Respondents described how the Sri Lankan cultural calendar is based around traditional cultivation patterns, e.g. the Sinhala and Hindu New Year in April is traditionally the harvest festival (BE3 2010). Interviewees mentioned how traditionally, agriculture extended beyond food production to traditional medicine and health care, Tamil and Buddhist religious practices, literature, instruments, music and dance (BE2, BE7, MC1, MC3, BS6, BS7 2010). BE4 described mutual influence between cultivation and Theravada Buddhism, Sri Lanka's dominant religion (CIA 2001), which he described as promoting respectful relationships between human beings and other living beings. These interviewees believed that traditional OPF therefore had cultural value and was appropriate for Sri Lankan farmers.

They maintained that this culture was degraded by the rise of CPF and mechanisation, which are insensitive to traditionally timed paddy cultivation, do not involve traditional methods of harvesting and pest control etc., and require less communal work (BE3, MC3, BS6 2010). They felt that the cultural change catalysed by Green Revolution cultivation was reinforced by the advent of globalised mass media, 'propaganda' by the government and private sector promoting a materialistic, consumerist lifestyle, and the complete take-over of chemical agriculture in agricultural education from primary through to tertiary level (BE1, BE4, MC3, BS7, BS6 2010, BS8, BS9 2011). Some felt unable to defend their local indigenous culture (BE4 2010). They saw contemporary Sri Lankans as consumers rather than generators of a culture which they could not shape themselves (BE2 2010) - an interesting parallel to the definition of inappropriate technology. Government and private sector use of mass media influences cultural as well as technology choice. Still, BS6 saw hope for the preservation of traditional culture, pointing to small-scale rain-fed paddy farmers' independence of authorities' management of irrigation, and the increased awareness of the GoSL, farmer organisations, CSO, researchers and students of the benefits of OPF.

Other interviewees acknowledged the move away from traditional agriculture-inspired culture, but insisted that culture is dynamic (MC1, MC3 2010). They saw culture as time- and context- specific, and did not think it was valid to opine that one form of cultivation was more culturally appropriate than the other. MC1 (2010) pointed to the continued influence of traditional songs in modern rap songs, and even suggested that since CPF farmers are more socially isolated, they feel more need for "music and dances and imagination." Private sector representatives BS4 and BS5 had nothing to say, reflecting their narrow focus on macro-level production.

Setting aside the debate on artistic influence and merits, the fact remains that for two generations almost all paddy farmers in Sri Lanka have been practicing CPF (BS8 2011). It is an ingrained habit, which, within a few decades, has overridden thousands of years of cultivation practices to become 'conventional'. Farmers today must re-learn basic organic techniques like compost production, mixed cropping and alternative pest control, and know of traditional methods only through stories from their grandparents (MC3, MC4 2010; BS8 2011). This makes it exceedingly difficult for them to convert to OPF. Since CPF is capital intensive, farmers need to make profits and have thus become more focussed on yield. Commercial farmers (as opposed to those who cultivate primarily for their own consumption) are therefore especially unlikely to change. Farmers themselves said that CPF was "good for lazy farmers" (MC4 2010), and organic extension workers and CSO identified habit as the greatest factor deterring farmers from converting to OPF (BS8, BS9 2011). Farmers' habit of poor cultivation record-keeping was another reason given for them not properly considering the economic benefits of OPF (BE6 2010), although this seems to have been the same regardless of the mode of production.

Consumer's cultural habits also currently favour CPF; the complete change in diet over the past twenty years has habituated consumers away from TV and traditional grains (MC4 2010). Low awareness of the health effects of either cultivation mode also affected consumers' willingness to support less cosmetically attractive TV or organic products (BS9 2011; MC1 2010).

It is difficult, particularly for an outsider, to judge what is more 'culturally appropriate'. While traditions have value, change is inevitable. I was intrigued by E's vociferous argument that he was not, as his detractors claimed, 'anti-development'. He spoke favourably of genetic technology but described it as a powerful and therefore dangerous tool, like a "knife which is

not for children to play with," (2010). He described CPF as "an unusual jump, an abnormal development instead of a gradual process of change… [which] destroyed our culture," (2010). The importance of flexibility, ownership and self-determination of cultivation for farmers and cultural continuity was emphasised by interviewees (BE1, BE4, BE5, MC1, BS6 2010; BS8, BS9 2011), suggesting that appropriate technology's emphasis on technology which users can control is still relevant in Sri Lanka.

4.2.2 Suits local economic conditions

Figure 9: Responses on suitability to local economic conditions

For this pillar I must return to my research aim (b) to refine my group of target farmers. While initially intending to focus on poverty reduction for "poor small-holder paddy farmers in Sri Lanka", interviews with those working with TV and OPF taught me that this is too general a target group. TV and OPF have been most extensively trialled and tailored for poor small-holder paddy farmers in Sri Lanka **with rain-fed land** (BS9 2011). Furthermore, practitioners were most confident about OPF's ability to compete with CPF **in the wet zone and on marginal land** (BS9 2010; BS6 2011). These farmers' land is marginal and prone to flooding (both human-induced and natural), salinity (in places exacerbated by the tsunami) and heavy metal toxicity, meaning IV perform poorly compared to cultivation under optimal conditions, and also compared to TV (MC2, BS6 2010; BS8, BS9 2011). Suitability to local economic conditions thus depends on the situation of the farmer in question. Since trial data is lacking for poor small-holder farmers cultivating fertile, irrigated fertile land[8], I can only draw conclusions for those poor small-holder farmers cultivating rain-fed and marginal land.

Figure 10 shows the national breakdown of paddy holdings by size. My target farmers typically cultivate less than two acres but are nevertheless significant paddy producers in Sri Lanka. They produce primarily for their own consumption, with around 5-10% of farmers selling up to half of their production (BE6, MC2, BS6 2010; MC7, MC8, MC9, MC10 BS8, BS9, 2011). They earn additional money through cultivating cash crops (MC7 2011), as wage labourers (BS9 2011), or by getting loans or selling jewellery when needed (MC1 2010).

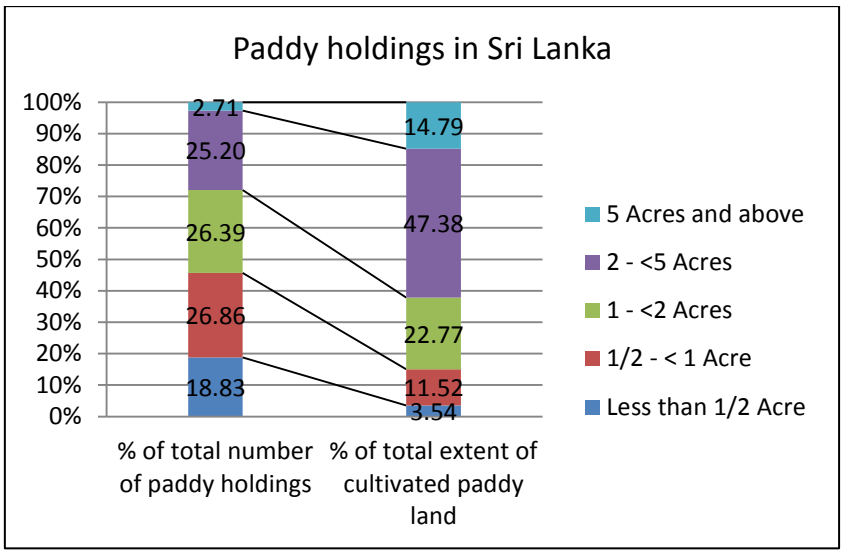


Figure 10: Size and number of paddy holdings in Sri Lanka. Data analysed from GoSL (2010).

[8] If any exist. Logically, it is more likely that farmers depending on poor quality, non-irrigated land will face more challenges in producing a profitable harvest.

Common among interviewees were descriptions of how the need to buy inputs – fertiliser, pesticides, and weedicides – each season made CPF fiscally unsuitable for poor farmers (BE1, BE6, BE7, MC3, BS1, BS2 2010). They explained how OPF or natural farming obviated this need by relying on local and freely available fertilisers like compost, G*liricidia sepium* (a green manure legume), rice straw, cow dung and cow urine, and how pests could be controlled through traditional methods (*ibid*.). Farmers in Batticaloa cited cow dung as a limiting factor (MC4 2010), which is related to the replacement of buffalo with two- and four-wheel tractors (BS2, MC3 2010).

Tractor use was common among both CPF and organic farmers, which, according to BE3, BE4 and MC1, made the labour of many rural people obsolete, encouraging migration to urban areas and subsequent rural labour shortages, and high labour prices in a cyclical manner (2010). Other economic challenges mentioned for both organic and CPF small farmers were transport costs (although OPF requires no inputs from outside and thus has lower transport costs) (MC1 2010; BS9 2011), and exploitative middle men and unregulated paddy prices (MC2 BS2 MC4 2010). There is a small niche market for TV both in Sri Lanka and internationally, so in Galle at least, TV can fetch higher prices than IV with similar characteristics (MC2, BS1, BS3 2010; MC7, MC8, MC9, MC10, BS9 2011), although this was not the experience of farmers MC4 in Batticaloa. Shortages of good quality traditional seed paddy, limited organic certification options and milling difficulties were recognised as barriers to OPF, traditional variety farmers getting premium prices (BS6 2010; BS9 2011).

Interviewees whose businesses sold inputs emphasised that consumable inputs were not such a large proportion of the cultivation cost, especially compared to expensive labour (BS4 BS5 2010). While this is true for commercial, CPF farmers, small farmers tend to do their own labour (MC3 2010; MC7 MC8 MC9 MC10 2011), meaning that for my target group of farmers, hired labour is not a dominant cultivation cost. BS2 (2011), MC7, MC8, MC9 and MC10 (2010) also explained that the maintenance and land preparation costs for *navakakkulum* (dry) cultivation and TV were lower, because they are able to thrive under less than ideal conditions. BS1 and MC3 explained that when moving from CPF to OPF, the labour cost would initially be higher, but that these would decrease as the soil fertility increased (2010).

Detailed cost-benefit interviews with MC7, MC8, MC9 and MC10 yielded the following (2011):

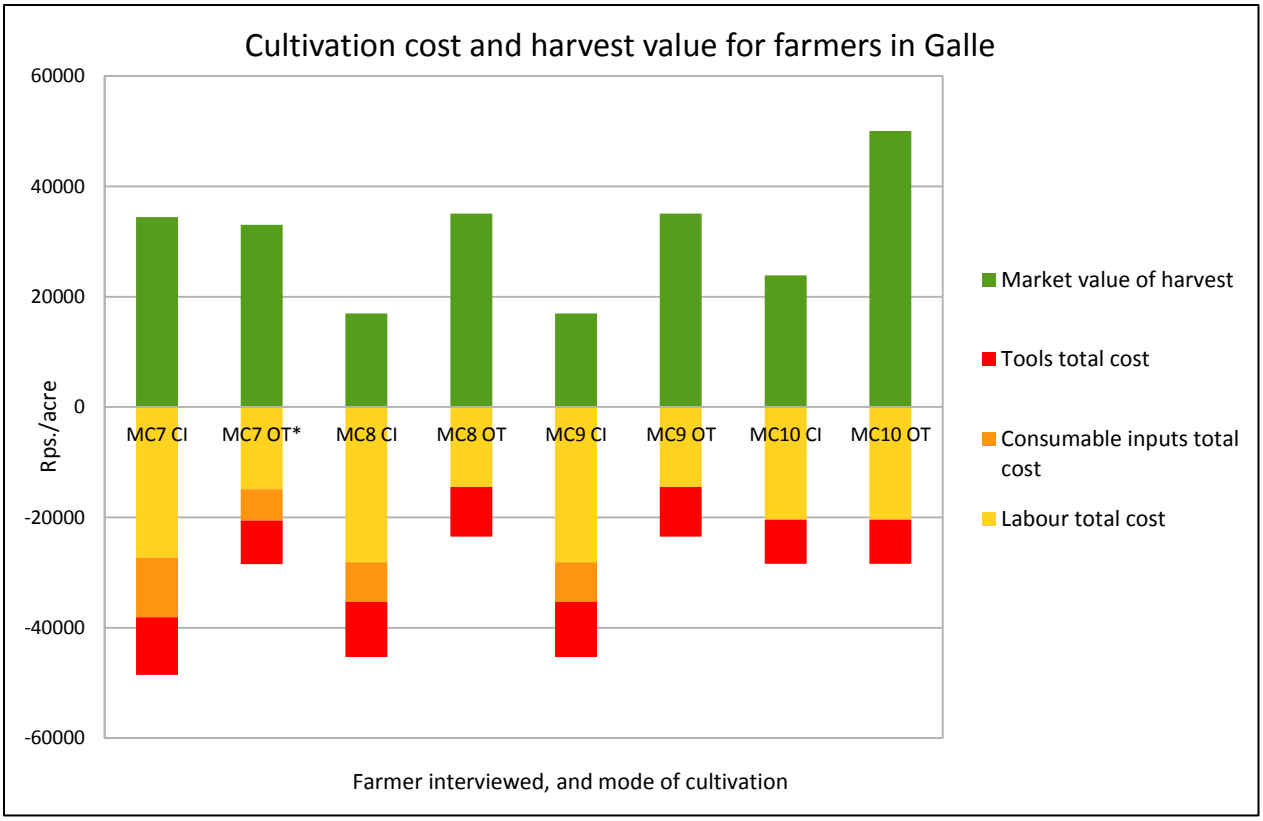


*Figure 11: Cultivation cost and harvest value for farmers in Galle comparing conventional cultivation with improved varieties (CI) with organic cultivation with traditional paddy varieties (OT).Data from farmers MC8 and MC9 are from Maha 2009/2010, data from farmers MC7 and MC10 are from Yala 2010. The labour component includes the actual cost of hired labour plus the hypothetical cost of family labour (hours done x market rate for labour). *This farmer's cultivation was not truly organic because some weedicide was applied, although no pesticide or synthetic fertilisers were used.*

The four cases in Figure 11 suggest that far from being less profitable than chemical agriculture, OPF with TV can, at least for small-holder farmers on rain-fed land, require less labour and no expensive inputs, while producing comparable yields with much greater market values (due to the higher price paid for TV). The reduced need for inputs means OPF farmers have fewer debts. Furthermore, because OPF encourages diversification of crops, farmers have diversified sources of income and are more secure, especially in the face of increasingly unpredictable seasons, which many farmers reported experiencing (MC5, MC6 2010; MC7, MC8, MC9, MC10, IRIN 2011).

4.2.3 Suits local social institutions

Figure 12: Responses on suitability to local social institutions

Few interviewees responded directly to questions on social institutions, apparently due to uncertainty about the definition of a social institution as compared to cultural appropriateness[9]. Most responses bemoaned the transformation from cultivation based on social capital and reciprocal labour to one based on financial capital (BE4, BE6, MC1, MC3, BS2 2010). The *attam* system of reciprocal labour exchange in irrigated paddy cultivation was, prior to the Green Revolution, the dominant form of labour mobilisation amongst small-holder subsistence paddy farmers in Sri Lanka (Karunanayake 1979). It made capital scarce-labour intensive technology socially sustainable by regulating labour exchange without the involvement of money, and also by pooling limited production capital such as ploughing equipment, buffa-

[9] This ambiguity is also recognised among academics (Miller 2011).

los etc. (*ibid*.:111). OPF amongst my financial-capital-poor target farmers is also capital scarce-labour intensive, and could benefit from this social institution.

Unfortunately, the advent of capital intensive-labour scarce CPF has promoted individualism among farmers who now work for wages and hire tractors for land preparation (BE4, MC1, MC3, MC5, MC6, BS2 2010; MC7, MC8, MC9, MC10 2011). The transition back to an *at-tam*-like system is problematic even for motivated farmers like MC1. Firstly, as discussed under the cultural appropriateness pillar, habits established over two generations are difficult to break. Secondly, the initial fiscal inappropriateness of CPF for my target farmers means that even small outlays of cash catalysed cycles of dependence on input companies and moneylenders, making "the local farmer… a slave of the companies," (BE3 2010).

Nevertheless, BE1 and BS6 described a new upsurge of hundreds of farmer organisations promoting OPF and/or TV (2010). It was my experience that many of the organisations who I interviewed were well acquainted with each other, either informally or professionally. Despite some personal and professional differences (particularly regarding BS3, who had moved from the public to private sector), there was significant willingness to collaborate to promote OPF. The relationships I observed amongst scientists, advocacy and service delivery CSO and civil servants suggest the emergence of a new social arrangement which could support my target farmers in OPF of TV. However, the different priorities and notable lack of engagement of powerful private sector representatives with others in the sector (apart from the civil servants – more discussion under the 'suits local political institutions' pillar) is a 'short-circuit' in sectoral communication which makes OPF difficult.

4.2.4 Uses local materials/energy / Locally maintainable

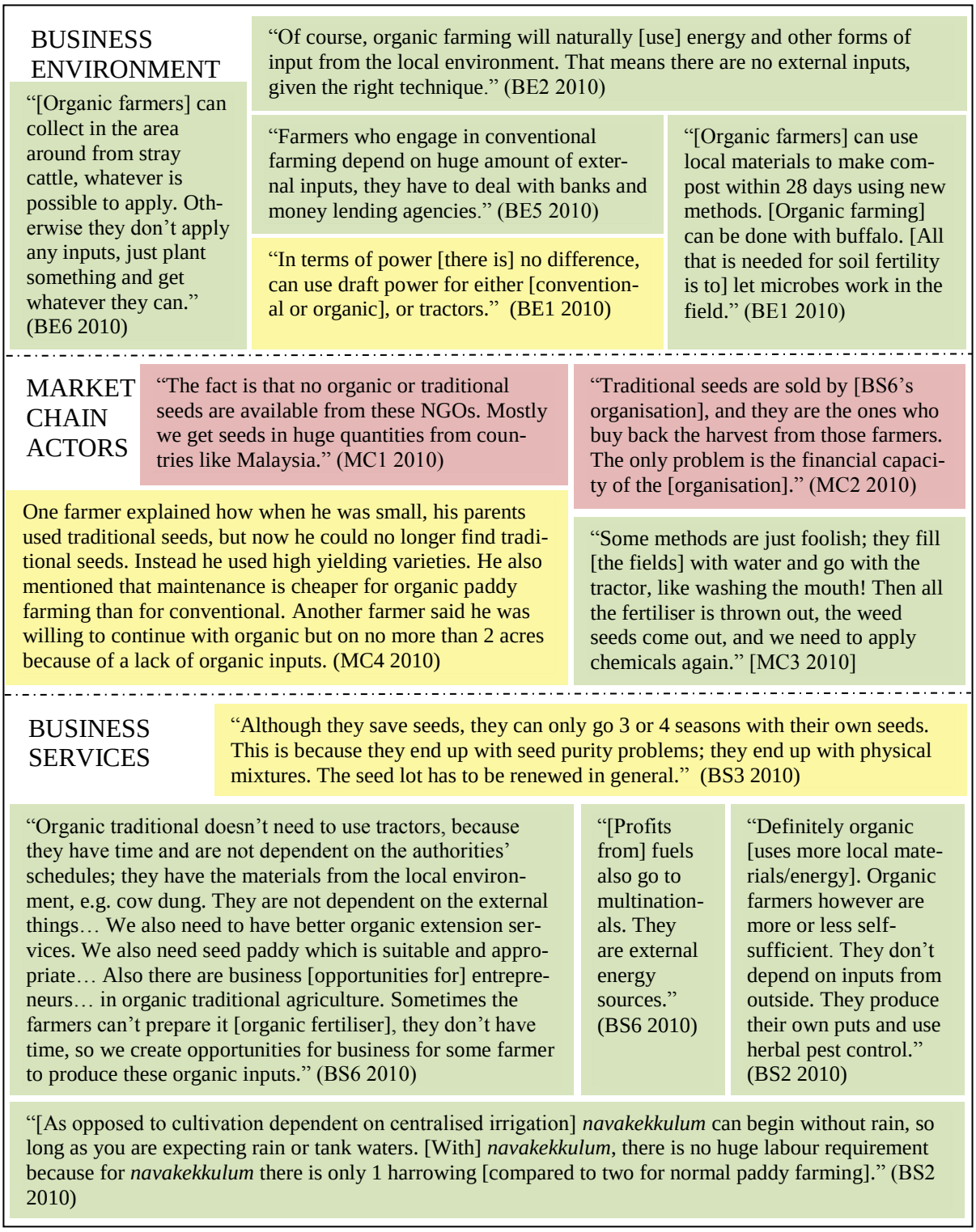


Figure 13: Responses on use of local materials/energy and local maintainability

These two pillars are discussed together because for these technologies, reliance on local materials/energy automatically translates to an ability to be locally maintained.

Again, few interviewees responded in-depth to these questions, but this time, because the answer is self-evident in the definitions of OPF and CPF. While the phasing out of buffalo ploughing means that small-scale organic and CPF both usually rely on two-wheel tractors and therefore externally bought fuel (BE7, MC4, MC5 2010); MC7, MC8, MC9, MC10 2011), the dependence of CPF on fertiliser, pesticides and weedicides makes it less dependent on local materials, and correspondingly, more vulnerable to external price shocks etc. The various organic, 'zero-budget', natural or dry methods that respondents described involved the application of varying levels of cow dung/urine, green manure and mulch, compost, bacterial cultures, and various local plant-based concoctions, which I was assured are freely and locally available for my target farmers (BE1, BE2, BE5, BE6, MC3, BS2, BS6, BS7 2010; BS8 BS9 2011).

Both IV and TV seed was bought extra-locally, at least every three or four seasons for purity reasons (BS3 2010). Poor technical capacity, quality control and marketing structures mean that high quality TV seed paddy is difficult to find, with only a small handful of producers in Sri Lanka (MC1, MC4, BS7 2010, BS9 2011). This is a serious limitation to increased TV cultivation. At a project site in Batticaloa, first-time cultivators of TV were discouraged by the poor germination rate of TV seed paddy they had received, which made them less willing to continue with the project in subsequent seasons. In contrast, the greater financial resources of the private sector enable them to produce consistently high quality seed paddy for the varieties which they promote – almost always IV (BS3 2010). Thus, while both TV and IV are dependent on external seed paddy producers, IV seed paddy is currently more reliable than TV. The impending introduction of hybrid varieties would increase farmers' dependence on external seed paddy sources, requiring them to purchase seed each season. There is an opportunity for small farmers, however. Seed paddy production requires skill in harvesting and processing, but since traditional seed paddy fetches a high price and is not yet produced *en masse* by the private sector, this could be a good livelihood option for small scale farmers (see the market value of farmer Z's organic produce)[10].

[10] However, the Seed Act requires all those who sell seed paddy on the open to be certified through the government, which is a barrier for small farmers (Grain 2008)

4.2.5 Suits local political institutions

Figure 14: Responses on suitability to local political institutions

Around Sri Lanka, the GoSL's agricultural extension services differ greatly in support for OPF and TV. Communication and direction within the Ministry of Agriculture seem bureaucratic and divided (BS1 2010; BS9 2011). Where local civil servants are enthusiastic as P, local farmers are offered support in OPF or natural farming. However, interviewees generally described government extension services as somewhat disorganised but strongly in favour of CPF, even showing false photographic comparisons of OPF and CPF (BE5, BS1, BS2, BS6 2010). Farmer MC1 and scientist BE5 described how organic farmers were actively discriminated against by extension officers who withheld advice and irrigation water. They explained that in the absence of strong extension services, farmers with no knowledge of organic pest management practices simply take pest samples to the local inputs dealer, and are sold chemicals (*ibid*.). More organised and motivated than government extension officers are input companies' private extension officers, who educate farmers in CPF. BS4, a representative of a leading inputs company, explained that his company's more than 240 university trained extension officers met directly with 300,000 farmers, ultimately reaching 2.2 million farming families (2010). BE1, BE5, BE7, BS1, and BS6 who had contact with the Ministry of Agriculture described individuals who were interested in OPF and TV, but who would do little in the face of private sector pressure and the public popularity of the fertiliser subsidy. Thus on the ground, CPF farmers receive greater support from Sri Lankan political (and private) institutions than their organic counterparts.

Agriculture is an important research field in Sri Lanka, and boasts the largest number of PhDs (BS9 2011). However, educational bias and financial support from input companies means that many students, academics and decision makers have specialised in CPF and are unfamiliar with OPF and TV. Attending the 2010 Rice Congress in Gannoruwa was an illuminating experience of this. The English-speaking event is hosted by the Rice Research and Development Institute of the Department of Agriculture, part of the Ministry of Agriculture, only once every ten years. It is an invitation-only forum for prominent researchers, decision makers and private sector leaders which reviews the past ten years of the Sri Lankan rice sector and develops new strategies for the coming decade. Although a public sector-hosted event, the influence of the private sector was obvious, from sponsors (pesticide companies Mackwoods and Innovative Pesticides Marketing Pvt. Ltd.) to discussion topics. Only one presentation, by Professor K M C Bandara, was dedicated to the development of a package for organic rice production, and TV were not discussed. The vast majority of speakers advocated use of fertilizer and pesticides, albeit in more targeted ways, and government officials claimed that a

reduction in the fertilizer subsidy was planned, but was unable to be implemented for various reasons.

Despite their significant contribution to paddy production, small farmers' needs were almost completely ignored, with speakers calling for greater consolidation of farm lands as in Japan to 'facilitate and promote mechanization and reduce the labour requirement' of paddy cultivation, despite the fact that rural under employment is known to be affecting around 25% of the work force and hindering food access, particularly in the south (WFP 2007). I was particularly shocked by comments I elicited during informal conversations. I met a representative of the International Rice Research Institute who was helping to develop hybrid varieties which require less fertiliser. When I opined that this technology was good for the environment but problematic for cash-poor farmers who would need to buy seed each season, he replied, "People who say that just want to cause problems," and maintained that the farmers were totally free to choose whether or not to adopt the technology.

Chapter 5: Conclusion

In the context of the dominance of CPF with IV in Sri Lanka, this last comment is extremely telling. The mix of responses for and against OPF with TV suggests that, at the very least, there are significant economic, social, environmental and cultural benefits to be gained from OPF of TV. CPF and IV have yielded spectacularly under ideal conditions for large-scale farmers in the dry zone, but have not done so for poor, rural paddy farmers on marginal land – arguably those who should benefit the most from rural-led development strategy. Yet within a few decades CPF and IV have almost completely displaced millennia-old methods and cultivars, even among poor small-scale farmers on rain-fed land for whom this technology is less profitable than their previous technologies. The dominance of these technologies in the face of significant cultural, social, economic and environmental inappropriateness for small-scale farmers on marginal, rain-fed land can be partially attributed to the overwhelming support and influence of those who profit financially from the increasing consumption of inputs – both private sector representatives and politicians (UNEP 2011:51). Unlike MC1, not all farmers interviewed had concrete experience of political opposition to their OPF or use of TV, but because of the influence of pro-CPF/improved variety actors in media, policy making, and in the village itself, farmers' technology choice is severely restricted by intra- and international power relations as described in section 2.3.2. It is certainly not the case that all available tech-

nologies were offered to farmers along with the information required to make an informed decision, and CPF and IV 'won' in a fair contest.

Thus, despite the contemporary dominance of CPF with IV, if one's aim is to empower poor, small-holder, non-commercial farmers to make stable, profitable livelihoods, the concept of appropriate technology remains relevant. While OPF could not immediately completely replace CPF on all types of paddy land while maintaining national rice self-sufficiency, there *is* a place for it amongst small-scale, rain-fed farmers. Indeed, conversion of all rain-fed land to organic with TV would maintain the national surplus. With continued population growth, it is important that yields increase. Long term experiments suggest that soils with more organic matter result in higher yields, but that this only become evident after decades, by which stage it is impossible to mimic the effect by simply adding fertilisers (Schjönning et al. 2004:194). In light of stagnating yields from Green Revolution areas, and the static yield potential of inbred rice varieties since 1966 (Tilman et al. 2002:673), nutrient-use efficient OPF with either IV or TV can be part of a sustainable solution to increased rice production and food security for Sri Lanka. The choice between intelligent OPF and national rice self-sufficiency is a false one. Nutrient-controlled 'precision agriculture', although typically been associated with large-scale, commercial agriculture, "is possible at any scale and under any conditions given the use of appropriate diagnostic tools," (*ibid.*). As I have applied it, the concept of appropriate technology does not preclude modern technology transfer and scientific progress, it merely demands that the users are able and equipped to choose and control the technologies which dominate their lives. My interviews show that scientists and farmers I interviewed have aims in common and are able to find solutions together[11]. Research on how small-scale farmers on marginal land can conduct precision agriculture should be prioritised, but attending the National Rice Congress 2010 emphatically demonstrated that private sector interests made this impossible.

Perhaps my most interesting finding is that the division between OPF of TV, and CPF of IV, is a false dichotomy – careful combination of OPF with IV may be part of the solution. Choice of varieties seems less contentious than choice of cultivation method. However, pat-

[11] Again, I refer to my sampling limitations with respect to farmers. I cannot claim that all small-holder farmers would agree with the farmers I interviewed, but the complete lack of small farmer representation at the National Rice Congress 2010 supports my observation that there is a problematic communication gap between decision makers and poor farmers.

terns of advocacy of certain technologies were clearly associated with interviewees' interests, and the political and social dominance of actors who profit from increased input consumption skews Sri Lanka's research agenda against small-scale farmers on marginal land. While interviewees who professionally promoted OPF through CSO acknowledged the possibility of combining technologies, representatives of input companies were dismissive of such combinations and seemed completely out of touch with the interests and economic/social realities of other actors, particularly farmers. Without rectifying this distortion of technology choice, CPF will continue to dominate, potentially at the economic and social cost of small-holder and farmers, and certainly at the cost of environmental degradation, health damage, and accelerating input import costs for Sri Lanka as a whole.

5.1 Meta-analysis of analytical framework

My framework did not result in a clear 'win' for any particular technology across all pillars. However, in combination with my purposive sampling, it succeeded in eliciting a diverse range of opinions from the various stakeholders, illustrating the conflicting interests and priorities of different actors in the market map. This is arguably more useful for a project manager, as it enables one to identify converging and diverging interests and strategise accordingly.

Nevertheless, there are issues. The low response rates for questions about appropriateness to local social institutions could merit a clearer definition of the concept for interviewees. Conversely, it could be considered illustrative to have pillars so open to interpretation, as interviewees are able to highlight what they feel are key issues which may not fit under other pillars. The overlapping of pillars regarding local materials and energy, and ability to be locally maintained suggests that these can be merged into one pillar, since it is unlikely that an input which is sourced locally cannot be maintained locally.

It would be very difficult to devise a technological intervention which scored well on all nine pillars, and different actors may feel that different pillars may compensate one another as described in 2.4.2. Clearly, in the case of paddy farming in Sri Lanka, the appropriateness of CPF to local political institutions has overridden other pillars. However, since we are aiming for sustainability and inter-generational equity as defined in section 2.1.2, there should be some limit set for each pillar, beyond which it is deemed that future generations would be unable to meet their basic needs. As discussed in section 2.3.1, due to temporal uncertainty, the precautionary principle provides the safest guide.

The model was instantly understandable for the interviewees to whom I showed it; its basic representation it is much easier to understand than the SLA or a similar alternative recently developed by the organisation I interned with. Although it simplifies the context by not showing relationships between pillars, if the project performs well on all nine pillars, these relationships are moot. Its explicit definitions of the characteristics of an appropriate and (grandly) sustainable technological project make it more user-friendly than the SLA, which shows only arrows of 'influence' and lists of factors.

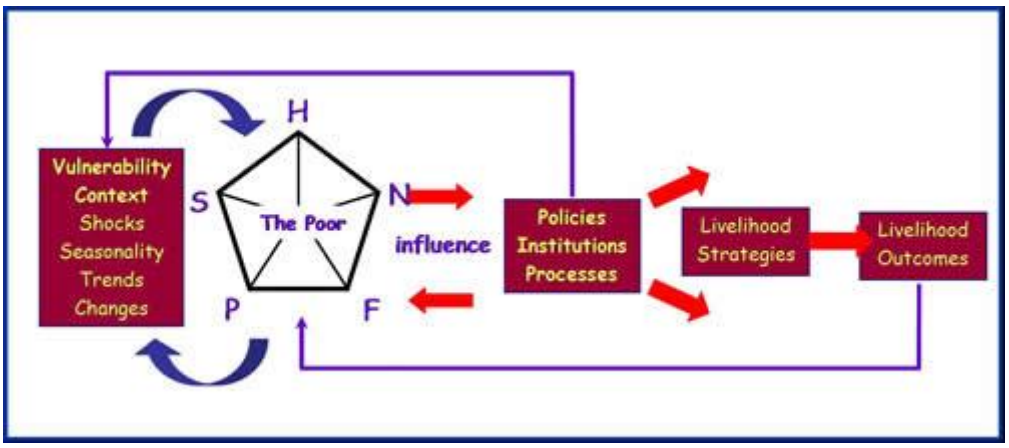


Figure 15: Sustainable Livelihoods Approach (Source: IFAD (2010))

Thus, although it lacks the complexity of models favoured by donors and consultants, my analytical framework has been successfully used to illuminate various interests and opinions in the sector. Thus far, it suggests that OPF with TV has good potential to sustainably reduce poverty and improve livelihoods among cash-poor small-holder farmers on rain-fed or marginal land in Sri Lanka[12]. With adjustment, it could serve as basic guide to help field workers in local NGO to craft or assess technological projects which are both appropriate to their target communities and aligned to international principles of sustainable development.

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[12] A greater diversity of opinions can and should be obtained by interviewing more farmers before this potential can be soundly confirmed. Further research on OPF with TV should be prioritised.

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Appendices

Appendix A: Field trial data from INGO

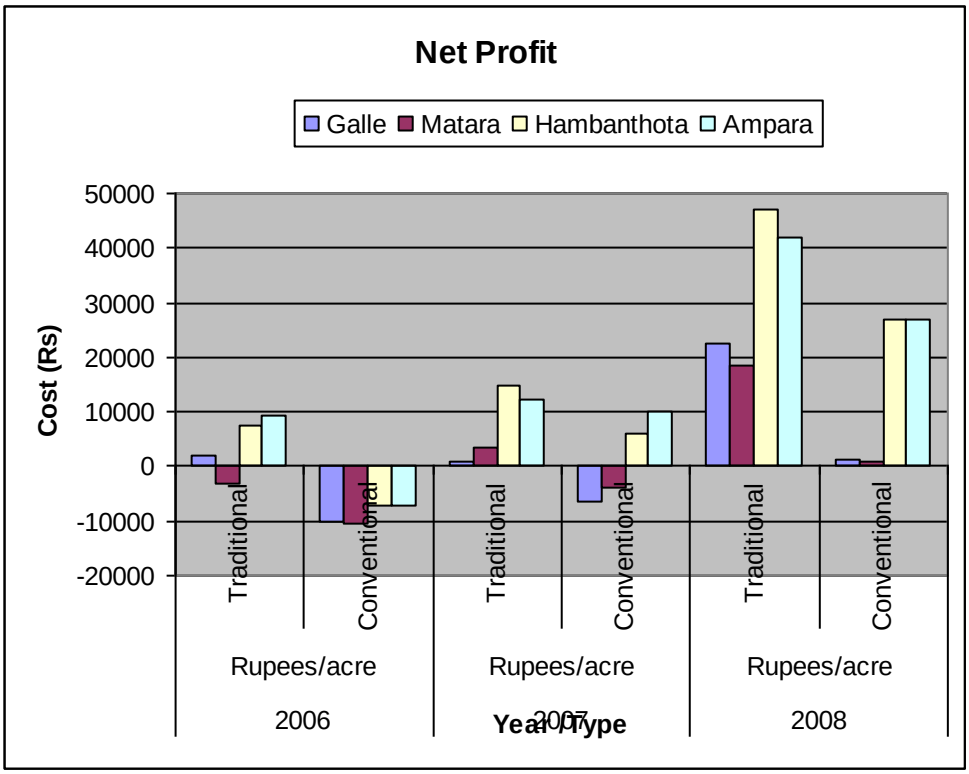
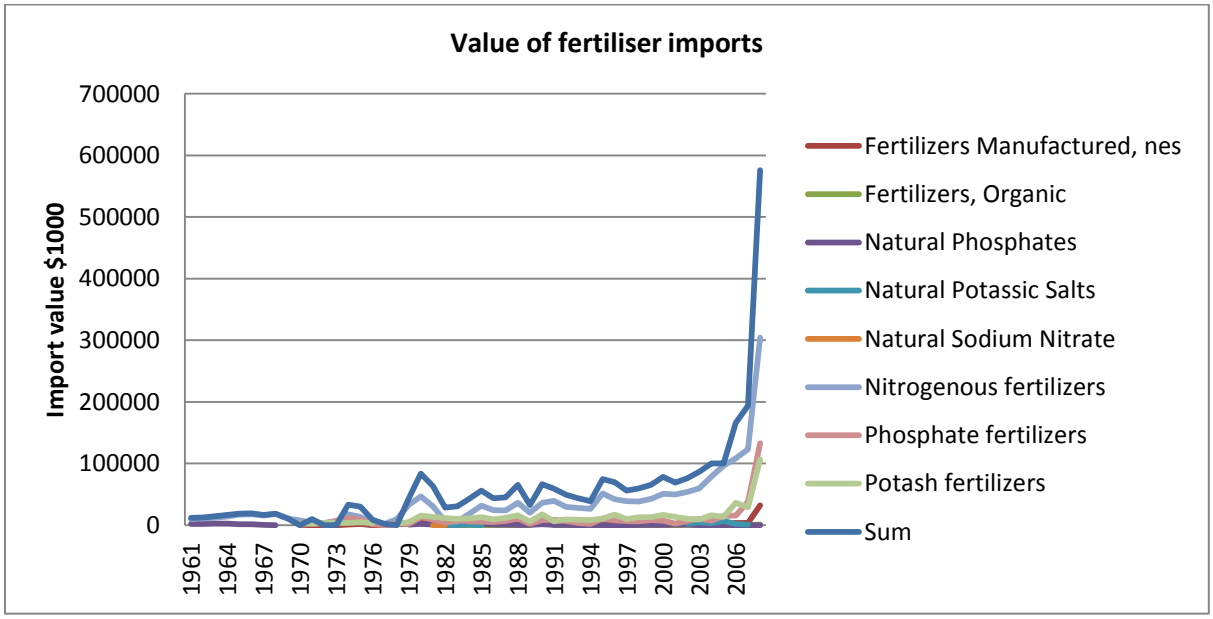


Image taken directly from Rathnabharathie's unpublished report (2008).

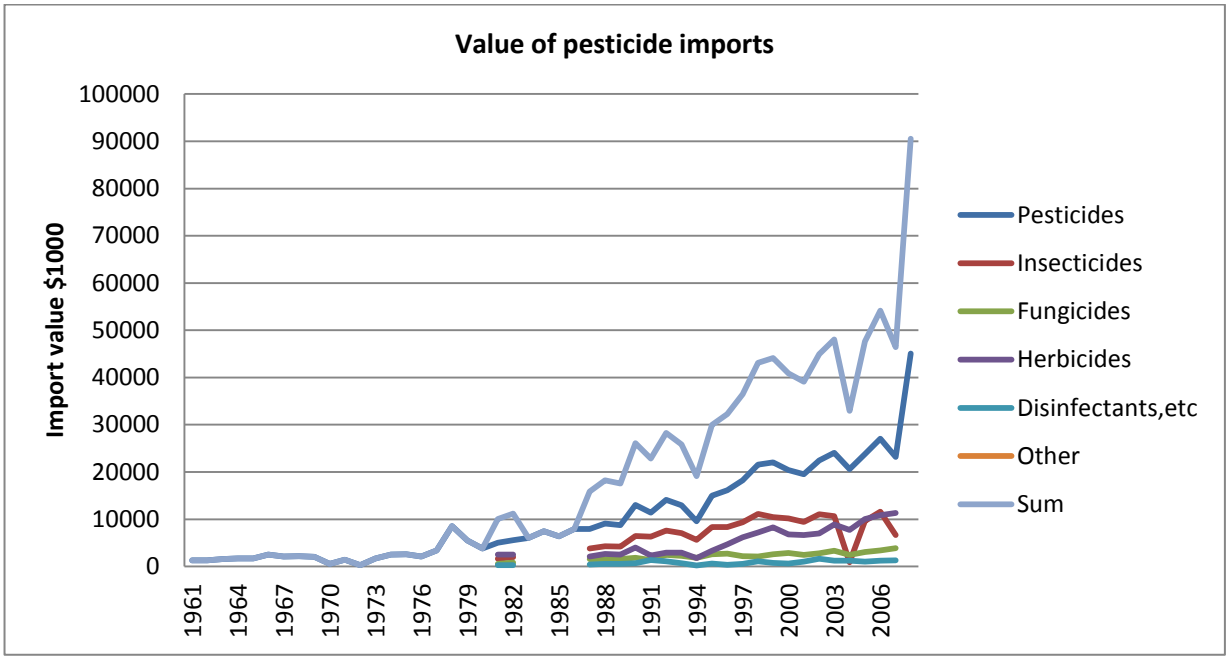
Appendix B: Cost of fertilizer and pesticide imports to Sri Lanka

Imports of fertilizer have grown hyperbolically over the past decade:



Import value of Sri Lanka's fertilisers from 1961-2008 (created from data from the FAO 2010)

The value of Sri Lanka's pesticide imports has also climbed sharply:



Value of Sri Lanka's pesticide imports from 1961-2008 (ibid.)

Appendix C: Interview spreadsheet for interviewees MC5-MC10

Detail	**Unit**
Farmer number	
Name	
Address	
District	
Season	
Year	
Area conventional / organic	acres
Land preparation tool (own/hired)	
Land preparation tool cost	Rps./acre
Irrigation method	
Irrigation cost	Rps./acre
Labour source	
Labour cost per manday	Rps./manday
Labour amount	mandays/acre
Land preparation cost (incl. labour)	**Rps./acre**
Variety 1	
Variety 1 area	acres
Variety 1 seed paddy source	
Variety 1 seed paddy amount	bshl/acre
Variety 1 seed paddy price	Rps./bshl
Variety 2	
Variety 2 area	acres
Variety 2 seed paddy source	
Variety 2 seed paddy amount	bshl/acre
Variety 2 seed paddy price	Rps./bshl
Variety 3	
Variety 3 area	acres
Variety 3 seed paddy source	
Variety 3 seed paddy amount	bshl/acre
Variety 3 seed paddy price	Rps./bshl
Total (average) seed paddy cost	**Rps./acre**
Weedicide 1 name	
Weedicide 1 unit cost	Rps./packet
Weedicide 1 amount	Packets/acre
Weedicide 2 name	
Weedicide 2 unit cost	Rps./packet
Weedicide 2 amount	Packets/acre
Weedicide 3 name	
Weedicide 3 unit cost	Rps./packet
Weedicide 3 amount	Packets/acre
Labour source	
Weedicide labour cost per application	Rps./acre
Total weedicide cost per application	Rps./acre
Number of weedicide applications	

Total weedicide cost	**Rps/acre**
Pesticide 1 name	
Pesticide 1 unit cost	Rps./packet
Pesticide 1 amount	Packets/acre
Pesticide 2 name	
Pesticide 2 unit cost	Rps./packet
Pesticide 2 amount	
Labour source	
Pesticide labour cost per application	Rps./acre
Total pesticide cost per application	Rps./acre
Number of pesticide applications	
Total pesticide cost	**Rps./acre**
Urea unit cost	Rps./kg
Urea units/application total	kg
Urea units/acre	kg/acre
TSP unit cost	Rps./kg
TSP units/application total	kg
TSP units/acre	kg/acre
MOP unit cost	Rps./kg
MOP units/application total	kg
MOP units/acre	kg/acre
Other fertilizer name	
Other fertilizer unit cost	Rps./packet
Other fertilizer units/application	Packets/acre
Labour source	
Fertilizer labour cost per application	Rps./acre
Total fertilizer cost per application	Rps./acre
Number of fertilizer applications	
Total fertilizer cost	**Rps./acre**
Harvesting tool	
Harvesting tool cost	Rps./acre
Labour source	
Harvesting labour cost per man-day	Rps./manday
Number of mandays/acre	mandays/acre
Total harvesting cost	**Rps./acre**
Total cost of cultivation	**Rps./acre**
Total cost of cultivation	**Rps./ha**
Average yield	bushels/acre
Total yield	bushels
Cultivation cost per bushel	Rps./bushel
Cultivation cost per kg	Rps./kg
Paddy kept for consumption	bshl/person/season
Variety 1	bshl
Variety 2	bshl
Variety 3	bshl

Number of household members	persons
Paddy paid to labourers	bshl/acre
Paddy available for sale	bshl
Variety 1 name	
Variety 1 proportion of total yield	bshl
Total amount variety 1 available for sale	bshl
Variety 1 sold to government	bshl
Price of variety 1 sold to govt.	Rps./bshl
Variety 1 sold to trader	bshl
Price of variety 1 sold to trader	Rps./bshl
Income from Variety 1	**Rps.**
Variety 2 name	
Variety 2 proportion of total yield	bshl
Total amount Variety 2 available for sale	bshl
Variety 2 sold to government	bshl
Price of Variety 2 sold to govt.	Rps./bshl
Variety 2 sold to trader	bshl
Price of Variety 2 sold to trader	Rps./bshl
Income from Variety 2	**Rps.**
Variety 3 name	
Variety 3 proportion of total yield	bshl
Total amount Variety 3 available for sale	bshl
Variety 3 sold to government	bshl
Price of Variety 3 sold to govt.	Rps./bshl
Variety 3 sold to trader	bshl
Price of Variety 3 sold to trader	Rps./bshl
Income from Variety 3	**Rps.**
Effective income from paddy	**Rps./acre**
Net profit from paddy	**Rps./acre**
Paddy main source of household income?	
Other jobs in family?	
Income from this?	

Appendix D: Interview guide for interviewees BE1-BE7 and BS1-BS9

Good morning/afternoon/evening, thank you very much for taking the time to talk to me. Would it be alright if I asked you nine questions? It need take no longer than 45 minutes, and you may stop the interview at any time.

(Yes – proceed, No – go away!)

Thank you. My name is Robina Ang and I'm conducting some independent research as part of my Masters in International Development and Management based in Lund University in Sweden. **My research task is to compare organic paddy farming with traditional paddy varieties with conventional paddy farming with hybrid paddy varieties.**

For this research, I have defined organic farming with traditional paddy varieties as farming with no chemical inputs – so no synthetic fertilisers, pesticides, or weedicides. Manure, straw or other non-synthetic fertilisers, and traditional methods of pest control such as spraying various herbal extracts or using natural predators are often used. Traditional paddy varieties are those non-hybridised, non-genetically modified varieties whose seeds have been saved by farmers and are not bought from or developed by large multinational seed companies or bodies such as the Rice Research and Development Institute in Sri Lanka. They have higher market prices than hybrid varieties, and can give better yields than hybrid varieties on marginal land, but they have a smaller market share.

In contrast, conventional farming is farming which is dependent on chemical fertilisers, pesticides and weedicides. Hybrid seeds are used, which are purchased from and developed by large multinational seed companies or institutions like the Rice Research and Development Institute, directly or indirectly. Most rice available in Sri Lanka is hybrid rice.

Do you have any questions about these definitions?

(Yes – explain, No – proceed)

Is it alright if I record the interview? It will make the interview faster because I won't need to take notes. The recording will only be used to transcribe the interview and will not be shown to anyone.

(Yes – go to test microphone, No – transcribe)

I'm going to test the microphone now. Can you please introduce yourself with your name and your position within the organization?

So now I will ask you the nine questions. To keep this short, it's important that you answer the questions as directly as possible, and **keep in mind the two specific types of farming under discussion**, shown here on the cards[13]. The research is not about organic farming with hybrid varieties, or crops other than paddy, for example. If you wish, we can have a more general discussion after we have gone through all the questions.

1) **<u>Economic development</u>**
   Which type of farming has greater potential to stimulate macro-economic development

[13] I brought two cards with me with my definitions of organic paddy farming with traditional varieties, and conventional paddy farming with hybrid varieties and place them on a table where the respondent can see them and refer to them. This is much easier than saying the full name of each mode of farming each time, and helps to keep the respondent focused on the two types of farming under discussion.

in Sri Lanka or is the difference unimportant? What experiences have led you to this conclusion?

2) **Suits local economic conditions**
   Which type of farming is most suited to Sri Lankan farmers' local economic conditions, or is there no difference? What experiences have led you to this conclusion?
3) **Uses local materials/energy**
   Which type of farming is more dependent on local materials and sources of energy, or is there no difference? What experiences have led you to this conclusion?
4) **Locally maintainable**
   Which type of farming do you consider to be easier for farmers to maintain locally, or is there no difference? What experiences have led you to this conclusion?
5) **Social development**
   Do you think there are any important social benefits or disadvantages to organic paddy farming with traditional paddy varieties? What are they? What about for conventional farming with hybrid paddy varieties?
6) **Environmental protection**
   Which type of paddy farming is better for the environment, or is there no difference? What experiences have led you to this conclusion?
7) **Suits local culture**
   Which type of farming is better suited to local paddy farming culture here in Sri Lanka, or is there no difference? Please explain what experiences have led you to this conclusion.
8) **Suits local social institutions**
   Are there any key social institutions which support farmers doing organic paddy farming with traditional paddy varieties? What are they and what do they do? What about for conventional farming with hybrid paddy varieties?
9) **Suits local political institutions**
   Do you think existing political structures, institutions and mechanisms in Sri Lanka provide more support to poor farmers for either of these types of paddy farming? If so, what are some key political structures, institutions and mechanisms, and which type of farming do they support? Why do you think [type of paddy farming] is favoured in this way?