Some Issues Related to Sustainability of Farming Systems in the Central Highland Region of Sri Lanka

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FOREWORD

Over the last five decades or so, Sri Lanka has recorded a significant achievement in food production, especially in the production of the staple food rice and a range of other subsidiary food crops. Consequently, the country has now reached near self-sufficiency in these commodities and has thereby reduced considerably the drain on our slender foreign exchange reserves. It is noteworthy that all this has been achieved by adopting two main strategies, the expansion of the cultivated extents by irrigating large tracts of land in relatively dry areas through the diversion of rivers that originate in the country's mountains regions, and the application of technologies of the green revolution to increase the productivity of cultivated lands.

The achievement, however, has not been without its disadvantages some of which could seriously undermine the very basis of this farming enterprise. Researchers and planners point out that the prevailing land use practices on steep lands would inevitably result in the rapid siltation of irrigation reservoirs. Although policies, social, economic and political are known to have led to destructive land management practices, a comprehensive study of the problem had been long in coming.

The author of this book, a senior researcher of the HARTI address some of these concerns by examining the factors that contribute to soil erosion in the ecologically fragile central highland region of Sri Lanka. This, no doubt, will add to our understanding as to why those who till the land in this region adopt the practices they do.

By examining his findings, the author provides us with an insight into the hazards associated with the two selected farming systems, why this is so, and the implications for agriculture in the region. The author does well to address a range of everyday problems faced by small holders which need to be resolved if the farming systems in the region to be made sustainable.

Professor M.O.A. de Zoysa
Director

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Dhanawardana Gamage.

EXECUTIVE SUMMARY

A survey of the factors affecting soil erosion in the ecologically fragile central highland region of Sri Lanka revealed that the two farming systems studied, the one growing cash crops and the other subsistence crops were experiencing severe pressures on the land that could affect their sustainability. The pressures could be attributed to the marginalization of the peasantry as a result of the plantations the British colonial government started in the mid nineteenth century and more recently the rapid growth of population in the hill country combined with the policies pursued by the Sri Lankan government after independence. All this, has resulted in the progressive dwindling of the land person-ratio in the region, both in quantitative and qualitative terms.

Measures taken by the Sri Lankan government to reduce landlessness and rural unemployment in the region by opening up of new lands on the elevated highland areas have resulted in further aggravation of the problem due to the erosion and leaching of soils because of the land use practices adopted on these newly opened up lands. In addition, a range of social, economic and political processes at the local level too appear to have a tremendous impact on the farming systems themselves and the ability of farmers to generate a desirable level of income from farming.

The two villages studied are located in the Kothmale Divisional Secretariat Division of the Nuwara-Eliya district. The villages are no more than 10 kilometers from each other on the mountainous landscape and are very similar in physical features and climate. However, the very agro-climatic elements of Saman-Eliya, which is located at a higher elevation than Rambodagama, is better suited for the cultivation of non-indigenous food crops on a cash crop basis. The natural ecological features of this locality enables the small holder land operators of the village to produce a range of vegetables like cabbages, leaks, carrots, beet root, knoh khol and potatoes for the market and enjoy a competitive edge over other food producing areas of the country. Potato cultivation is also protected as an import substitution food crop by the government. The state has extended its patronage to the villagers of Saman-Eliya for growing cash crops in the village by providing inputs, subsidies and import protection. Indeed, the very system of farming in Saman-Eliya has being established by the government to relieve landlessness, rural unemployment and to increase food production.

A very basic problem with the system of farming in Saman-Eliya is that it leads to high erosion and leaching of topsoil that arise from the clean weeding required by this system of farming, which is unsuitable for tropical mountain terrain. On the other hand this farming system by producing a range of vegetative and root crops for sale in rapid succession also exploits the available soil nutrients heavily. To compensate rapid deterioration and loss of soil quality and nutrients, farmers tend to apply farmyard manure like basal and heavy doses of chemical fertilizers. The exhaustion of the soil under cash crop cultivation is also aggravated by the heavy application of agrochemicals to protect the plants that are grown in a host environment.

Almost all the inputs used in this farming system except the labor and lands are not obtained locally while some, such as seeds, inorganic fertilizer and agrochemical are imported. Further to these dependency on inputs, the farming population also depends on the market for staple and subsidiary foods and fuel wood for cooking and thus their vulnerability, in addition to the deterioration of the natural resources base itself, is connected with the market supply and demand situation.

Farming in Rambodagama is different and is characterized by terraced paddy cultivation, a system of agro-forest gardening which produces perennial crops mainly for consumption while cattle and buffaloes are reared on a small scale for draught power. In regard to management of the physical quality of land, the Rambodagama farming system appear to be altogether sustainable as the soil erosion is well below the rates reported even for forested areas with less than 0.5 tons per hectare per annum. It is also

less dependent on inputs provided via the market system. The most intensive input used in the production of paddy is labour and is supplied by the family in combination with a system of exchange labour. Seeds are produced locally and shared, bartered or sold.

However, there are a number of problems faced by the farming system in Rambodagama. In the first place, the limitedly available land is inequitably distributed. To meet the demand for land in the face of a burgeoning population, the lands are fragmented into miniature holdings reducing their economic viability. Attempts at keeping the land holdings intact also have resulted in various forms of share tenancy while plot and operator rotations have become typical of the region's land tenure system. These tenurial forms act as a constraint on how the lands are cultivated such as restricting crop diversification. Complex tenure system would also disqualify sharecroppers from obtaining institutional loans for crop diversification. Ecological elements such as temperature and soils are relatively less suitable for vegetable and potato cultivation.

In addition to the difficulties of diversifying to achieve an economically more productive system of agriculture, it appears that there are problems in retaining even the existing production base. For instance lands under this farming system continue to decline by the process of modernization where the exiting agricultural lands are converted to roads, houses and townships yet with little direct benefits to the farming population. Also the lack of technological innovation suitable for increasing productivity of existing land has meant that agriculture has become much less rewarding as an occupation. While the system of farming is dependent on heavy labour inputs at peak times, traditional methods used for labour mobilization are under stress in the face of on-going social changes. Also, other traditional, social and institutional forms that have been helpful in the management of locally available resources are continuously under stress and these have a debilitating effect on the sustainability of the farming system.

The study reveals that, apart from the stresses brought about by localized factors like increasing population, reduction in carrying capacity of the available land, there are pressures executed through the changing social dynamics, external factors such as the impact of the policies of the government which are felt as the natural resource farming base is diminished through attempts at modernization which have had a profound effect on the farming system. Thus it would appear that in this particular context the human-environmental resource problem is a much more complicated one for which there is no simplistic explanation.

Page No.

CONTENTS

List of Tables

CHAPTER ONE

1.1 Introduction

Main issues addressed in the report: "The sustainability of two farming systems in Nuwara-Eliya district" surfaced in a study that attempted to examine in depth the socio-economic factors affecting land use practices in an ecologically vulnerable region of the country. The two farming systems that the study focuses on are;

(1) Subsistence oriented farming system based on lowland paddy and upland mixed crop gardening;

(2) The small holder-based market garden system producing non-indigenous vegetables mainly potato for the market.

The research on which the present study is based was undertaken between June and December 1994 in two villages viz. Rambodagama and Saman-Eliya. Both the villages are located in Kothmale Assistant Secretariat Division of the Nuwara Eliya district. Nuwara Eliya is one of the two major potato and non-indigenous vegetable producing districts in the country. Production is based on a small-holder, very often a micro- land holder, market gardening system, though the incidence of larger operational holdings with the scale of economies is on the increase. The village Saman-Eliya represented the small-holder-based market garden system of production in the district. Rambodagama represented a farming system oriented towards producing the staple food, rice on lowlands and mixed crop gardening on upland holding mainly for subsistence, common in Kandy, Matale and in certain parts of Badulla district.

Selection of the district: Kothmale Divisional Secretariat (KDS) Division and the two villages for the study were purposive. The two villages, Saman Eliya and Rambodagama represent two distinct systems of agricultural production, both in terms of the mode of production and the orientation prevalent in the district. The Rambodagama farming system symbolizes the low input-low output system, or a traditional approach to farming for subsistence. The problem with this system is its inability to produce enough to satisfy the basic needs of the population that depends on it. In contrast the Saman-Eliya farming system characterizes an input intensive financially remunerative small-holder-based market oriented crop production system.

Kothmale is one of the five local administrative divisions of the district, where all of these divisions, have similar geographical, social and economic characteristics. The Kothmale division is located in the wetter parts of the district with an average annual rainfall of 3800 m.m (150 inches). The highest rainfall is from May to September, which is the period of the Southwest monsoon. Both the study villages are located in this division, approximately 10 kilometers apart along the Kandy-Nuwara Eliya road. Modal red yellow Podzolic soils are the predominant soil type found in the KDS Division.

The most important factor among others, that influenced the selection of the KDS area is its characteristic land use which is symbolic of the land use pattern in this area. The area has large tea estates as well as tea small holdings, smallholder paddy farming, upland mixed crop gardening as well as small-holder-based cash crops. The Nuwara-Eliya district, where KDS is located, is also one of the most ecologically fragile areas in the country whose resource base has been mismanaged for a considerable

period of time. The district consists of a substantial area of the upper catchment of the country's river system, mainly the watershed area of the Kothmale Reservoir under the Mahaweli Development Project.

Data was collected mainly by interviewing a random sample of agricultural land operators on the basis of a schedule. In Rambodagama, out of a total of 113 households, 60 were interviewed selected exclusively from the traditional settlers. Twenty two households consisted of new settlers who had received small patches of lands for housing purposes from Land Reform Commission lands. In Saman-Eliya, out of 133 households, 70 were interviewed. In addition, the cost of production data relating to vegetables was obtained using a sub-sample of the main sample used in both the villages. In selecting the sample households, only those practised agriculture were chosen.

In-depth interviewing of the key informants like the village elderly and officials, non-participant observations, meetings to discuss issues in informal gatherings with village people were the other important methods of information gathering employed in the study. The study also draws from the existing literature related to the issues discussed.

In Rambodagama only a few vegetables were cultivated but no potato cultivation. Paddy cultivation was done along with upland mixed tree crop farming.

This report does not attempt to make use of all the data, or even much of the information gathered by means of the questionnaire, for two reasons. First, it attempts to address a set of issues related to the sustainability of two farming systems rather than an in-depth analysis of factors affecting land use practices on which the main study is focused. The issue addressed by this report is only one of the aspects, and a major one at that, surfaced by this study. The theme as such and the issues addressed in this report are based mostly on the discussions the author had with people of the two study villages and through non-participant observation.

1.2 Some Theoretical Approaches Useful for the Analysis of Factors Affecting Sustainability of Agricultural Production

Sustainability is a term that has been variously used and understood in the literature. The Brundtland Commission, commonly known as the World Commission on Environment (1987) has defined the term "sustainable development" as meeting the essential needs of the present generation for food, clothing, shelter, employment and health "without compromising the ability of future generations to meet their own needs". This definition emphasizes the need for meeting the needs of the present without jeopardizing the needs of future generations in order to satisfy their requirements or prospects for future development. Sustainable development, according to the views of the World Commission, is not living at a subsistence level which may imply a backward march in terms of modern quality of life indicators that apply to many nations and communities of the world today.

The term "sustainability" for the purpose of this report is defined as the "ability of a living being, a living system or a resource to exist or survive and function in a future date at least at the present level of vitality and efficiency or more favourably at a higher level by employing the technologies and institutional arrangements that are already in existence and functioning or having prospects for evolving such technologies or institutions to improve their functioning".

While defining what is sustainable is difficult, identifying and assessing a sustainable system or the conditions to be met to fulfil such system is an even more formidable task. For instance, in agriculture, sustainable production is seen as a process affected mainly by two types of factors.

(1) The deterioration of the per capita resource base of a population in absolute terms. This type of deterioration reflects the loss of resources to human kind due to the denudation of forest cover, desertification and alkalization.

(2) Deterioration of the per capita resource base of a population in relative terms. The latter occurs either in terms of a relative reduction in quality of environmental resources to support agriculture or a reduction of the per capita resource base in the face of the burgeoning population growth.

Environmental resources supporting agricultural production include land, water, humidity, temperature and sun light in quantities or qualities needed for the growth of a given crop species and a genetic resource base that will serve to sustain its continued reproduction.

In addition, access to inputs such as seeds, externally provided plant nutrients, technology, labour and draught power produced within the system of production itself or outside it with prospects for their continuous supply are necessary. Similarly, an effective demand for the produce either as a subsistence product or as a marketed commodity is another aspect that would guarantee the production of an agricultural commodity on a sustainable basis.

However, sustainable agriculture very often is viewed as the ability of a unit of natural resources or an ecological system to support and maintain its productivity in terms of a given system of farming or technology. For instance, lands and water resources are dealt with as the key elements of nature a substantial degradation of which is seen as the cause of unsustainable agriculture. The perspective adopted in this study is that the sustainability of an agricultural production system is determined by a dynamic interaction between the natural resource system and the human system making use of it for sustenance.

Natural resource degradation is a physical and biological phenomenon caused by a multiplicity of factors. On a surface level, for instance, soil erosion is a phenomenon brought about by rainfall and the erodability of the soils. However, the extent to which lands are exploited, significantly influenced by the very social system within which this takes place. This is because, the very social system will determine the access to land, end uses the lands are put into and the purposes they are brought under, mode of production and the technology adopted in production, and how the benefits are distributed. In this sense, as an external element, the type of land use practices adopted by the people plays an important role in land degradation and is generally referred to as the human factor in land degradation.

The human factor as an explanation for natural resource degradation has been viewed differently in the literature, indicating the different dimensions inherent in the problem. Discussed below are some of the major perspectives in order to clarify the issues involved in sustainable management of a natural agricultural resource.

Deterioration of the per capita resource base of a population in absolute terms may be the result of two distinct factors

(1) Term of denudation like deforestation, soil erosion, salinization and alkalization, siltation and persistent drought resulting in a loss of land and water needed for agriculture.

(2) Population pressure or the human impact on environmental resources takes two forms. First, the growth of the population in absolute numbers results in changes in the per capita resource base in relative terms with the end result that more pressure is brought to bear on a unit of resource. Second, changing life styles such as increased affluence may raise the demand for the products and services based on natural resources.

Population pressure has been one of the major explanations offered for the degradation of environmental resources. As early as 1798 Thomas Malthus argued that population growth is reflective, accelerating at a geometric rate, whenever living standards rise above subsistence levels and is in turn checked by the rate of economic growth which occurs essentially at an arithmetic rate. Similarly, Ricardo argued that burgeoning numbers of people become a problem when an increasing amount of

poorer lands have to be brought under cultivation to feed them. The population-environment debate came to the forefront when millions of people started to perish in the Sahel regions of Africa, South of the Sahara, when there was a prolonged famine resulting from substantial environmental changes that had taken place.

Both Malthus and Ricardo had not taken into account that changing technology would enable the yield per unit of land to be enhanced through increased productivity rather than the need to cultivate greater extent of land and/or the effect of world trade that would result in the transfer of food from surplus regions to deficit regions. On the other hand, it has been shown that the intensity of land use increases along with population growth (Boserup E, 1965) or when the market demand increases. Likewise, population growth rates respond to economic growth rates, by slowing down. Conflicting evidence relating to these arguments has been offered. One argument is that the intensification of land use can result in a reduction of the carrying capacity of the land to support agriculture as for instance a progressively reduced fallow period, could affect the fertility of the said soil.

The idea that technology can deal with problems of depletion has been advanced recently with much more force. For example, Julian Simon (1981) while acknowledging that land in some places become unproductive due to soil erosion and other destructive forces, claims that the amount of arable lands is being increased year by year as technology finds and creates new resources.

One shortcoming in a practical sense with the "possibility of a technological fix" is that poorer countries do not have the necessary technology, capital or appropriate human resources to develop such technologies to deal with the problem. The developing countries also heavily depend on agriculture for food, employment and export incomes. They have learned, from negative experience, the high risks associated with world food surpluses, such as the surplus produced in the North America during the international food crisis of 1972-1974. During this period, the less developed countries could not gain any adequate supply from the global staple food market as the former Soviet Union surprised it by purchasing a bulk of the surplus. The famine that affected the Sahellian Regions in the 1980s further highlights the need for guaranteed food supplies. Therefore, there is more at stake for the poor countries than the rich ones when the ability to produce their own food is affected.

The World Commission on Environment (1987) clearly explained how poverty can result in the degradation of natural resources. They concluded "Those who are poor and hungry will often destroy their immediate environment in order to survive. They will cut down forests; their livestock will overgraze grasslands. They will overuse marginal lands and in growing numbers they will crowd into congested cities" (1987:28). The report also emphasizes that though the environmental stress has often been attributed to the growing demand for scarce resources by the rich and the pollution caused by the rising standards of living amongst the relatively affluent, the poor no less contribute to pollution and stress on the immediate environment in their struggle for survival. The poverty-environment relationship, according to the Bruntland Commission is deemed to be an inverse one, other factors like high population growth, fragmentation of lands and inappropriate tenure arrangements also contribute significantly to environmental degradation. This emphasis on the connection between poverty and environmental degradation underscores the need for economic growth to overcome the problem by improving the living standards of the poor.

Lappe and Collins (1975) argue that much of the current destruction of the ecosystems of the LDCs were begun with colonialism bringing their lands under a double burden through the institution of export-oriented agricultural production systems. They argue that the establishment of plantations for export oriented agricultural production meant not only the expropriation of the best lands for continuous cultivation but also the dispossession of local farmers on to marginal, often hilly land not at all suitable for farming.

Garret Harding's (1968) ideas, presented in "Tragedy of the Commons" have initiated a discussion on a set of issues relating to the management of natural resources to which there is open access. He argued that the problem with natural resource management lies in common property ownership. The system, he thought, could have worked where there was a regular check on the population such as by wars, poaching or diseases. But once such conditions are under control, individual users of common property resources, like grazing lands with open access, will, as rational beings, act to maximize personal gains by increasing their marginal benefit, ensuring that by marginal costs accrue to the community.

It is the understanding now that Harding oversimplified the unrestricted access to common property grazing rights as well as overstating the selfish behaviour of individual headers. However, the effect of communal property arrangements, such as common land tenure systems, on natural resource management cannot be underestimated. It has been pointed out that planting of trees in some regions of Africa may entail the right to the land on which the trees are planted, thus working as a barrier to planting trees on tenanted lands (Bromley, D and Cernea, 1987).

One other major perspective on environmental degradation focuses on the role of the state. Arguments from this perspective can, in general, be summarized into two categories: those arguing a "reluctant state" and the others arguing a "contributory state". Those who advocate these perspectives tend to believe that issues such as population growth are overemphasized, providing a scape- goat to inept or corrupt governments who pass the blame on or show their helplessness (Bromley, 1989). As far as the reluctant state is concerned, the apathy of governments is seen in terms of their reluctance to initiate land reforms and take action to increase redistributive justice and alleviate widespread poverty.

Those subscribing to the contributory state advance arguments which portray a state that is based towards urban and industrial development, making terms of trade for rural products unfavourable through macroeconomic policies, or by introducing cash crops among rural producers, or by inviting agribusiness that will displace peasant producers from both the land and production for subsistence consumption.

Ecological stability is seen as threatened by cash crop agriculture for a number of reasons. It is generally stated that food production under traditional land use practices is more environmentally harmonious than under cash crop farming with modern technologies and chemical inputs. For example, it is argued that cash crops grown on a monocrop basis tend to replace more diverse and stable polycultural systems with an increasing propensity to natural and economic hazards (T.B.Bayliss-Smith, 1987:36). On the other hand, the effects of the introduction of cash crops vary depending on the scale and location (Simon, Maxwell, 1989; Thiesenhusen, 1991).

1.3 Criteria of Assessing Sustainability

From a management point of view, the unsustainability of agricultural land or a production system could be identified as a system while one or more of the following characteristics are evident.

(1) Heavy dependence on external sources for primary factors of production such as imported fertilizers, agro-chemicals, farm power and seedling material. A good example of this are farming systems that depend heavily on petroleum-based sources of energy and nutrients of which the supplies can be affected by complete exhaustion, price increases beyond the affordability of producers in the poorer countries, or that may curtail the production or their availability.

(2) Progressively increasing land extensification for maintaining agricultural production.

(3) The need for sustaining land productivity through the application of increasingly higher levels of plant nutrients such as organic and inorganic fertilizers.

(4) Having to depend on progressively increasing levels of chemicals to control weeds, pests and fungi.

(5) Increasing application of labour as a major input of production to have the same output or to arrest the progressively declining land productivity.

(6) Dependence on inputs that cannot pay off by themselves in terms of productivity or incomes from production. For instance, when labour is used as an important input, the labour by itself may not be attracted to agriculture if its productivity is perceived as inadequate in qualitative or quantitative terms. Heavy emphasis on off-farm income sources by agricultural land operators signify such diminishing returns to agriculture. Furthermore agriculture may be less attractive as a means of livelihood when alternative means of employment are available and which pay higher levels of social and/or economic incentives to labour. Similarly, a system of exchange labour can work in agricultural production only when the labour is relatively abundant and can be devoted for exchange purposes. When employment opportunities become relatively more available or when agriculture cannot provide a minimum living, exchange labour systems will undergo heavy stress in order to attract labour to perform essential tasks associated with agricultural production.

(7) Total biomass produced on the land is more or less equal to the total agricultural produce harvested on it and removed altogether for consumption or sale. Therefore, incremental crop production on a specific land resource has to depend on nutrients that have to be brought from outside thereby increasing the vulnerability of production associated with supply.

(8) Excessive removal, progressive distancing or separating of crop eco-systems from the natural eco-system. Ideally, a crop system with its associated socio-economic system should be reinforcing the natural eco-system including its flora and fauna, hydrological and geo-morphological features of the natural landscape. Agricultural extensification and over exploitation of the natural eco-system by deforestation, changing water courses and by changing the natural landscape to establish mountain crop systems and associated human systems will finally have a detrimental impact on the very basis of an agricultural system by increasing the run-off, earth slips, drying out of water sources etc.

(9) Heavy dependence of agricultural land operators for survival on state welfare, income subsidies and food aid. Such externally provided welfare measures or "political handouts" may have a retarding effect on the release of labour from the agricultural sector to the non-agricultural sector employment. Meanwhile, for the agricultural land operators, there may be little or no incentive to increase farm production efficiency as income or food subsidies greatly relieve their needs for increased income. Furthermore, increased dependence on income subsidies may also reduce the self-reliance of the farming population at a personal or a collective level to support them. This phenomenon may result in agricultural operators relying on statutory apparatuses to help them in the maintenance of village level agricultural infrastructures and conservation measures and declining vitality of the community to exist and participate in production.

CHAPTER TWO

The Context of Small Farmer Agricultural Production in Nuwara-Eliya District

2.1 Macro Eco-environmental Context of Farming

Sri Lanka's land area is about 65,000 sq. k.m. and is surrounded by the Indian Ocean. As an island situated in the Northern half of the Indian Ocean, Sri Lanka is exposed to moisture-laden winds from the South-west and the North-east. Furthermore, its location between 6 and 10 degrees North of the equator with close physical proximity to the Indian sub-continent, gives it a predominantly monsoonal and tropical climate.

In terms of the physical features of the land, Sri Lanka can be divided into two main geographic regions namely, the central highlands and the lowland plains. The central highlands is a land mass characterized by an elevations ranging from 300 meters to over 2000 meters above sea level, and is marked with numerous strike ridges, hills and mountains. Low-lying plains, representing about two thirds of the landmass of the country, are characterized by low-lying coastal plains traversed by rivers that originate in the central highlands. A major part of this land is dry for a substantial part of the year with an annual precipitation of 1250 mm. The geophysical character of the region also results in a radial drainage pattern that carries surface water from the highland watersheds providing a source of water for 103 distinct natural river basins that cover over 90 percent of the Island. The remaining small coastal basins, of which there are about 94, contribute little to the water resources of the country (Natural Resources of Sri Lanka 1991:137-138). This undoubtedly underscores the importance of the central highland region as a provider of water resources.

A major ecological function of the central highland mass is to effect precipitation by intercepting the passage of moisture-laden monsoonal winds. The annual precipitation in the region ranges from 2,540 to over 5,500 mm with only occasional spells of drought.

Contrastingly, the central highland massif also creates relatively dry regions in the East and North that cover over two thirds of the country by working as a barrier against the moisture-laden monsoonal rains. Thus, the average rainfall in different zones varies spatially from 1,250 mm in the dryer areas to over 5,500 mm in the wetter highland regions.

On the basis of the rainfall patterns, Sri Lanka has been divided into three climatic zones viz. Wet, Dry and Intermediate. The Wet Zone is situated in the southwestern quarter of the Island, encompassing a major portion of the hilly region comprising some 23% of the total land area of the country. Since the maximum rainfall occurs on the windward slopes of the central highlands and diminishes significantly in the North-west and South-east part of the Island, nearly two thirds of the country experiences dryer conditions for most of the year. This increases the dependence of the Dry Zone on the water resources of the central highlands for irrigated agriculture.

Agro-climatic characteristics of the different zones influence not only the agricultural practices but also the distribution of the population, which is disproportionately high in the Wet Zone. Historically, the paddy production in lowland Dry Zone areas has been done by small-farmers under irrigation. The Wet Zone regions produce a number of cash crop with tea and rubber plantations occupying a substantial proportion of the cultivated land.

The unique features of the central highlands coupled with indiscriminate human activity make it an ecologically vulnerable area. The landscape of undulating and steep hills, together with high precipitation makes erosion a natural feature of this region. Thus, inappropriate land use practices and mismanagement of natural resources such as the forested areas and water streams located in the region may aggravate its inherent vulnerability. The physical features of this central highlands and its function as the upper catchment area to the country's river system would lead to the irressistable conclusion in that management of the environment in the region is most vital for the irrigated farming systems in the dry zone.

2.2 Historical Context

History of mismanagement and over-exploitation of this ecologically vulnerable region goes back at least one and a half centuries to the time when plantation agriculture was introduced on a large scale into the region by clearing vast tracts of previously untouched virgin forests. Some consequences of this immoderate change in the land use pattern in the region include rapid erosion of top soils and siltation of paddy fields, rivers and other irrigation infrastructures downstream by depositing soils washed away due to the opening up of elevated slopes.

The advent of the plantation agriculture into the region meant not only bringing under cash crops cultivation the previously untouched forested areas, but also the acquisition and the sale of lands used by the peasantry on a customary basis for collection of forest products, as grazing lands or for swidden agriculture. This was accomplished through the mobilization of the legislative powers vested with the state.

The first land legislation that was enacted for this purpose was the Crown Lands Encroachments Ordinance (Ordinance No. 12 of 1880) the fundamental objective of which appeared to have been to remove all obstacles hindering access to land for setting up of coffee plantations. Clause 6 of the Ordinance considered that " all forests, waste, unoccupied lands shall be the property of the Crown until the contrary thereof be proved". As was noted earlier, estimates as to the total extent of land sold for plantation interests vary. Snodgras (1966:22) claimed that during the period 1940-43, the Colonial office, mostly for coffee plantations where Europeans were the main beneficiaries sold some 230.000 acres (92,000 hectares).

Even today, the colonial heritage of Sri Lanka appears to influence not only its economy and society, but also how the ecological environment is managed in a number of ways. In the aftermath of the institution of plantation agriculture, as Shanmugarathnam (1981) shows, "the bulk of the peasantry of the Wet Zone which had nearly 65 percent of the island's population had to be contended with its paddy tracts and the limited highlands". He further notes that although the physical expansion of the plantations was a direct cause of landlessness in the Wet Zone and the process of monetization that started off with the plantations had eventually led to the dispossession and the disintegration of the peasantry.

Shanmugarathnam (1981:75) also shows that "the area under plantation crops increased by 975 percent between 1871 and 1931 while the area under food crops dropped by 20 percent between 1871 and 1891 and increased by a mere 7.7 percent between 1871 and 1946. As a result, the peasant population's per acre of land increased from a mere 2.13 to 4.8 between 1871 and 1946. Since then the population in the country has almost trebled with little change in the rural and urban bases, aggravating the land-population ratio further.

Furthermore, the very institution of plantation agriculture has also defied in a number of ways the very "negotiation space" within which the country should find solutions to its environmental problems. For example, working of the plantation economy necessitated maintaining a large labour force within the estate on a more or less regimented basis. Many people of the area were reluctant, for different rea-

sons, to make their labour available for the estates on a hire basis. Thus the required labour had to be imported from South India, mainly from drought stricken regions at the time. Today, by and large, the labour force of Indian origin comprises the majority of the estate labour force and a substantial proportion of it has become naturalized citizens of Sri Lanka.

The Indian labour force is heavily dependent on the estates for employment. Thus a socially and politically justifiable solution to landlessness problem in the central highland regions and the problems associated with the environmental degradation in the area have to take into account the very existence of a labour force dependent heavily on the estates for their mere survival. Thus the major factors that influence a solution to a number of problems such as ecological, social, economic and political have been already determined. Such a solution would entail reducing the pressure in the region by making available to the estate labour force at least some of the lands that had been grabbed a century ago for plantations and thus enable them to make a decent living..

2.3 Evidence of Continued Land Degradation

The degradation of the environment in the central hill regions has also worsened in the current period by the rapid population growth and the uncontrolled introduction of cash crops into the area. The dwindling land-population ratio, together with an increased incidence of landlessness and poverty in the light of the lack of alternative employment for the peasantry has resulted in heavy pressure on marginal and forestlands including the traditional agroforest gardens.

Climatic factors favor the growing of exotic vegetables, potatoes and tobacco in the region which is undertaken on a cash crop basis to cater to a lucrative market in the urban centers. This factor relieves, to some extent, the burden of low incomes associated with having to operate uneconomic micro-holdings where the scarcity of land presents a serious problem. On the other hand, cash crop cultivation involves clean weeding and leads to heavy soil erosion. Clean weeding is a practice predominant in the temperate zones but is found to be totally unsuitable for alleviated highlands in the tropics.

In addition to the serious problem of soil degradation that has continued from the time the estate plantations were instituted in early part of the 19th century, forestlands in the district too have continuously been under heavy pressure. At present, the state of natural forests in the region has reached a critical point under the impact of urban and agricultural land expansion, selective logging and exploitation for fuelwood. In 1985 the forested area in the low country Wet Zone was 9.1 percent of its land area or less than 2 percent of the total land area of the country. Similarly, forests of the montane zone constituted some 17.8 percent of its land area or 1.54 percent of the entire land area of the country (Gunatilleke, C.V.S. 1985).

2.4 Institutional Context

In spite of the perceived danger of environmental degradation in the central hill regions, and its implications for the country's agricultural production, the state appears to play a contradictory, if not insignificant role in solving the problem. On the one hand, the state shows its concern for the problem by attempting to implement projects aimed at soil conservation, the Agricultural Diversification Project and the Community Forestry Project. The current Forestry Master Plan similarly places heavy emphasis on the reforestation needs of the region.

On other hand, the state itself appears to be aggravating the problem by promoting or protecting cash crop agriculture in the region. Potato cultivation, for instance, was vigorously promoted by the state in the region in the 1960s to reduce the burden of importing this popular food item despite the high levels of soil erosion it caused. Similarly tobacco, another crop associated with heavy soil erosion was grown by the private sector with little control by the state. In spite of the high landlessness that exists

among the hill country peasantry, land acquired in the region under the Land Reform Acts of 1972 and 1975 has been, to a substantial extent, vested in statutory agencies created and managed by them. At present, the private sector companies have been handed over their management under the structural adjustment programme implemented by the Government.

There may be many alternative explanations for this line of action by the state. One was the limitation imposed by the "negotiation space" within which a policy solution to the problem was to be found.

First, as was noted earlier, it inherited a plantation labour force of foreign origin who even today depend largely on plantation agriculture for a living and who have not sufficiently integrated into the macro socio-economic and political processes of the country. They are also deprived in terms of health, education, training and employable skills other than to work in the tea plantations and themselves have the problems of acute landlessness and lack suitable housing for a decent living. Any attempt at relieving the land pressure in the village sector by converting uneconomic tea holdings into village agriculture or forestry would leave a substantial proportion of estate work force bad by off. On the other hand, while there are social and political issues related to the problem, there is also the important consideration of the country's dependence on tea for its foreign exchange earnings.

2.5 Nuwara-Eliya District

Nuwara-Eliya is one of the three districts of the central province of the country. There is no mention of Nuwara-Eliya in the records of the pre-plantation period in the country, but of a number of other locations in the vicinity such as Sita-Eliya and Vijayabahukanda. This fact reveals that the area had been sparsely populated before introduction of plantation agriculture.

The Nuwara-Eliya district covers a total land area of about 1,745 square kilometers including its mountainous landscape. Its altitude varies from 300-2000 meters. Given the phisio-morphological character of the area some 70% of the lands are in slopes of more than 30% while another 15% of lands are located on slopes of more than 60%. The district lies in the Wet Zone and the Intermediate Zone of Sri Lanka. The annual average temperature is about 15.9 celsius (60°F) and it rises up to 21 celsius (80°F) depending on the location. The Wet Zone, where the two study villages are located, receives rainfall during both monsoons and has a climate with generally a long growing period favourable for agriculture. In the Wet Zone, the North-east monsoon spreads from October to January-February and the south-east monsoon from April to July-August. Rainfall in this region is experienced also during the two shorter transitional periods. The Intermediate Zone receives rainfall during the North-east and the two inter-monsoonal periods. The different areas experience also different intensities of rainfall varying from 900 to 3000 mm per annum (Robert van Grootveld 1992:8). Major soil groups in the Wet Zone areas, Kotmale and Ambagamuwa areas are red yellow Podzolic and Mountain Rego soils.

Robert van Grootveld (1992:9) states that

> "The heat and high rainfall in these areas leach most mobile nutrients from the soils and apart from the bio-mass of the great variety of plants , which contain eighty to ninety percent of the available nutrients, the soils themselves are infertile, especially if clear cultivated, leading to insoluble oxides of iron and aluminum as well as erosion".

Tea plantations dominate the agricultural land use pattern in the Nuwara-Eliya district. This district also supplies a substantial proportion of the country's requirements of potatoes and exotic vegetables. The district area constitutes the upper catchment area of the Mahaweli River. Two of the major reservoirs under the Mahaweli Project viz. Kothmale and Randenigala are located within the district.

Woodlands and natural grasslands in the district cover about 70,000 hectares or 40% of the land area. Of this, dense forest cover is about 29,000 hectares while the remaining area (41,000 hectares) is made up of 20,000 hectares of degraded forest land, 8,700 hectares of scrub lands and 13,000 hectares of grasslands. About 95,000 hectares are reckoned to be cultivated while the tea plantations alone account for two thirds (63,000 hectares) of the cultivated area. Approximately one third (about 31,000 hectares) is under village agriculture where various types of farming are carried out..

According to the 1982 census, approximately 603,577 people lived in the district with a density of 346 persons per square kilometer. The plantation sector accounts for 60% of the district's population. The smallholding village sector consisting of 31,000 hectares had to support almost 200,000 people or 6.14 persons per hectares in 1982. The village sector agriculture consists of basically of six types of farming. These different types of farming with the area under cultivation are summarized below.

Table 2.1
Types of Agricultural Practices and Area Under Each of the Practices With the Percentage Distribution

Type	Area	% of land	% of total (ha) under Village of the Agriculture district
1. Paddy	5535	17.64	3.2
2. Mixed gardens	8023	25.56	4.6
3. Shifting (inc.tobacco)	11049	35.21	6.3
4. Coconut small-holdings	216	0.69	2.0
5. Market gardens	3098	9.97	1.8

Source: Zijlstra, P.J 1989

Social economic linkages between the plantations and the peasant sector are minimal while the population on the plantations, also depend to some extent, on the village agricultural sector for food.

According to the 1982 census, within the village sector there are 38,423 smallholdings of varying sizes with a highly skewed distribution. Nearly fifty percent of the villagers do not own any paddy land and the phenomenon of tenancy and various forms of share cropping systems are widespread. About 12.3% of the population are landless while 33 % operate only homegardens. As much as 45% operate on lands averaging less than an acre or 0.4 hectares. Approximately 33 % of the smallholder population own more than 0.8 hectares.

CHAPTER THREE

The Market Garden System and its Sustainability

3.1 Saman Eliya

Saman Eliya is a village located along the Kandy Nuwara Eliya road. The center of the village is reached by a stone laid road alone the undulating landscape. The Grama Niladhari (GN) division, Saman Eliya encompasses a large area including a large tea plantation, the Labukele Estate, about 975 acres. It accommodates 610 families with a population of 3415 persons. The estate workforce is mainly of Indian origin.

Saman Eliya has a population of 507 or 136 families, and about 242 acres are cultivated. In addition to the area under agriculture, the Saman Eliya G.N. division also has about 500 acres of natural forest-lands and 632 acres of land reforested with non-indigenous tree species located on the steep hill slopes.

Some background information that will be useful in understanding the basic issues discussed in relation to the Saman Eliya farming system is provided below briefly.

3.1.1 Agro-climatic Features

Ecological significance: Village constitute a watershed area drained to the Kotmala Oya reservoir located only a few miles down the elevation.
Elevation: 1,000-1500 m **
Slope: 40 - 60%
Average annual precipitation: 3300 mm
Months of high precipitation: June-July (381-387 mm)
Months with low precipitation: February-March (89-126.9 mm)
Number of rainy days: 160-190
Average temperature: 15.9 Celsius (60 F)
Months with high temperature: March-June (16-17 C0)
Months with low temperature: December - January (14-15)

3.1.2. Physical Facilities and Services

Vehicular access to the village: Kandy Nuwara-Eliya Road
Divisional Secretariat Division (DSD): Kothmale
Grama Niladhari Division (GND): Saman Eliya
Agricultural Instructor Division: Maldeniya
Nearest town center: Nuwara Eliya (14Km)
Schools with access to : Three located in the vicinity of the village.
Hospitals or clinics in the vicinity: One maternity home, one government dispensary in close proximity to the village, the Nuwara Eliya district hospital 14 km away from the village.

3.1.3 Socio-Economic Conditions

No. of households in the village sector	: 133
Average size of the family	: 5.6

Literacy rate	:	92 %
Total area under market gardening	:	242 acres
Typical size land cultivated:	:	1 acre
Typical land use pattern	:	potato dominated vegetable farming with 250-300% cropping intensity
Average annual income per family	:	Rs.85,451.53
Per capita money income	:	Rs.15,143/=
Percent of total income from salaries	:	10
Percent income from hired labour work	:	2.7
Percent income from agriculture	:	75
Percent income from potato and other vegetable crops	:	70.3
Percent income from animal husbandry	:	4.6
Percent income from subsidies	:	5.7%

3.1.4 Cropping pattern: No paddy farming. Farmers cultivated potato and vegetable in their highland plots, throughout the year.

3.1.5 Animal rearing families: In 1994 there were 42 cows and 07 bulls in the Saman Eliya GN division. Three families kept five goats.

3.2 Market Garden System of Farming In Saman Eliya and the Rationale Behind its' Working

3.2.1 Historical, Macro Economic and Socio Economic Factors Inducing Market Garden System

The cultivation of exotic vegetables was first introduced by persons of European origin who settled in the region, following the institution of the plantation estates. The non-indigenous varieties of vegetables were introduced into the country to meet their preference.

Certain intrinsic qualities of these crops such as their appearance, keeping quality, the flavour and easy preparation might have contributed to their spread among local population, in particular, amongst the urban dwellers. These vegetables are prepared differently in Sri Lanka to the way they are done in the countries of their origin could have been adapted over generations according to local needs, tastes and conditions. Traditionally, in Sri Lanka the vegetables, including those non-indigenous food varieties, are prepared as curries to accompany the meal of rice. The curries are prepared by cooking these vegetables with chillie, spices, and coconut milk. Potato is also prepared mostly as a vegetable.

Potato and vegetable cultivation in the Nuwara Eliya district is important for a number of reasons. First, much importance has been attached to potato growing as an import substitution food crop. Second, this form of farming has helped to provide an increasing population with an acceptable level of living in an area where land scarcity is high and alternative employment opportunities are low. Saman-Eliya began as a youth farm by the then government in 1968 to relive the excess population in the village sector of the Kothmale region. As it was not successful due to high rate of dropouts, in 1971 the land earmarked for the youth farm was allocated in 1971 to the remainder of the youth, numbering 34, each person getting one and a quarter acres. In 1977, another 40 persons or families, selected of those landless in the region were settled in the village and they were allocated quarter to half an acre reflecting the dwindling land resources in the region. People of the area treat the original youth farm area as the authentic Saman-Eliya proper settlement rather than this newly established one. This study is concerned with the farming system established by the former youth farm settlers.

In the late 1960s potato cultivation was introduced into the country as an import substitution crop, and the import of potatoes was stopped. However, imports were allowed by the Government when produc-

tion was low to curtail escalating prices. For instance, during December 1994, the scarcity of locally produced potatoes resulted in substantial price increases. The retail price going up to as much as Rs: 80.00 Kg. As soon as the Government reintroduced the import of potatoes, the price declined by more than 50%. By March, with the influx of locally produced potatoes into the market, the retail price of potatoes was further reduced to Rs 26. Thus potato producers have enjoyed a good price for their potatoes even with the prevailing high transaction costs, when imports are stopped.

3.2.2 Ecological Factors Affecting the Agricultural Land Use Practices

Temperature and precipitation levels and soil types that prevail in certain locations in the central highland region favor the cultivation of both potatoes and other non-indigenous varieties of vegetables on a cash crop basis. In this respect, the region enjoys a number of features that give a comparative advantage to the growers of non-indigenous food crop varieties, the most important being the cool temperature prevalent in the hill country almost throughout the year. The temperature levels that prevail in different regions of the country are set out below

Table 3.1

Temperature Levels Prevalent in Different Regions in Sri Lanka

Region	Temperature (Celsius)	
	Minimum	Maximum
Low-lying Areas	24.2	31.9
Highland Areas	16.8	25.8
Nuwara Eliya	11.5	20.2

A favourable environment appears to determine to a large extent not only what could be grown in different ecological niches in the district, but also the quality and the yield levels obtained. Potatoes produced in the Nuwara Eliya potato growing areas fetch a higher market price than for instance, those produced in the Jaffna district. Most hill country vegetables have an appealing appearance and keeping quality over both indigenous and non-indigenous vegetables produced elsewhere except in Welimada, another major vegetable producing area situated in the Badulla District. Water spouts and natural water streams that are found throughout Nuwara Eliya too provide a bountiful source of cool natural water for cleaning operations connected with the harvested crops and this is a further natural advantage the highland vegetable producer enjoys.

The major type of soil found in the area is Red Yellow Podsolic and Mountain Regosols located on a mountainous terrain. These soils are considered to be suitable for vegetable cultivation. Thus the model soil type found in the area, as noted earlier too, constitutes a natural resource favourable for growing non-indigenous food crop varieties like potatoes, beans, cabbage, carrot and knohkol as in Saman Eliya.

The market quality of the produce, it should also be noted here, is manipulated by other means too. For instance, the colour and size of vegetables and potatoes are also influenced by the degree to which nutrients used as the rate and timing of the yield is determined by provided inputs such as plant vitamins.

The range of natural advantages the upcountry vegetable producer enjoys has also been enhanced by a number of external factors at the national level. Prior to the outbreak of the ethnic disturbances in the

country in early 1980s, the Jaffna district was a major supplier not only of non-traditional vegetables to the local market but also a substantial proportion of the locally produced potatoes. The civil war situation that has erupted from ethnic rivalries since 1983 in the Northern regions of the country has resulted in disrupting the production and supply of these high value cash crops from the Jaffna district to the market. This has given the central highland vegetable and potato farmers an advantage and at present two central highland districts, Nuwara Eliya and Badulla have a near monopoly of the supply of potatoes to the market.

3.2.3 The Social and Institutional Environmental Factors Influencing the Market Gardening System of Small-Holder Agriculture in Saman-Eliya Village

3.2.3.1.Social and Institutional Factors

Beside micro-economic policies of the Government and the ecological environment that favour the cultivation of non-indigenous food crop varieties in the region, a range of localized social and institutional factors appears to influence the adoption of these agricultural practices in the area. An agricultural holding of one acre (or less in a significant number of cases), operated by the typical farmer in Saman-Eliya, would hardly be adequate to maintain an average family of 5.6 members as in the case in the village. If the land is cultivated with any other subsistence crops such as those grown in other parts of the country or in the district itself, the income generated will be quite insufficient to maintain an average family.

On the other hand, there is little scope, in ecological terms, to cultivate paddy or undertake upland mixed crop gardening or growing of minor export crops in Saman-Eliya as is undertaken in Rambodagama for instance. Saman-Eliya has a climate that suits the growing of potato and exotic vegetable better, than in Rambodagama. The working of the Rambodagama farming system will be discussed in greater detail in chapter four. Also, there is less land available per person or family in the Saman Eliya than in Rambodagama.

Labour is much more intensively used in the market gardening system that prevails in Saman Eliya than in subsistence crop farming practised in Rambodagama. Thus market gardening has resulted in a labour market which is partly supplied by the poorer land operators, landless labour in the area and mostly by the surplus labour of the estate sector. In other words, if not for intensive market gardening, a significant portion of the Saman-Eliya work force would be unemployed, underemployed or forced to migrate. Thus in a sense, the inhabitants of the Saman Eliya village make the fullest use of the ecological environment and adopt an appropriate cropping system which also results in a substantial income.

In discussing the socio-economic factors influencing vegetable cultivation as a market-oriented venture, in Saman-Eliya, aspects of human resource skills applied in this type of farming system also have to be taken into account. Entrepreneurial skills including a working knowledge of how the market system works are important. Also the land operator, whether a traditional subsistence farmer or a cash crop, the farmer should have a thorough working knowledge of the agro-ecological factors affecting farming, such as the climate and the nature of the soil. Most farmers both in Saman Eliya, at Rambodagama seemed to have this knowledge.

However, the advantage the Samna-Eliya farmer has over the Rambodagama farmer appear to be an awareness of how the market works and how to combine cash input to get maximum profits. The observed difference in the levels of knowledge the farmers demonstrated may be due to differences in their ability to articulate what they known. Most Saman-Eliya farmers earn a relatively higher income than that of the Rambodagama farmers by growing crops that have a better demand. It is not argued

here that the Saman-Eliya vegetable farmers allocate the resources available to them most efficiently in economic terms, but that they use the available resources in a highly efficient way given a range of limitations imposed on them. Such limitations include the ecological, social, economic and institutional "context" of farming.

For instance, since land is scarce and rents are high or the opportunity cost of allowing even a small patch of land to remain unused for a few months is economically disadvantageous, maximum use is made of the land intensity, as even the smallest possible earning cannot be forgone as this would affect the very livelihood of the majority of the farming population in the village. Family labour particularly of the housewife is used to an economically optimum degree. This explains the very high levels of land use intensity that prevail in the village.

The strategies adopted and the rationale behind growing radish as an economic crop in the village illustrates this. Radish compared to other exotic crops grown in the country has a less favourable market and fetches a relatively low price. However it is a vegetable involving relatively low costs and a shorter growing period. Labour involved in growing radish is mostly family labour and cultivation is also limited to the preparation of plant beds, planting of seeds and harvesting operations. Generally, no fertilizer or other chemicals are applied and when applied, the application is less intensive in comparison with other crops. Less application of inputs to radish is also rationalized in a real marketing sense. As most farmers follow a similar pattern of cropping, seasonal flooding of the market with radish affects the price. The market is also inundated with produce from non-hill farming areas during the season. This is in a way unavoidable, as the crop is also determined by seasonal agro-climatic conditions. A recent example of a market failure of radish is attributed to the saturation of the market demand experienced by this crop between September and October 1994.

In spite of such experiences most farmers periodically. try to get a radish crop after the harvest of potatoes or other lucrative vegetables, for a number of reasons. Firstly, the nutrients needed by radish compared to other crops grown in Saman Eliya are low and therefore, the residue of nutrients left from the previous vegetable crop would be adequate to raise a radish crop. Thus a lower profit margin from growing radish is still a profit. Radish is also regarded as an interim crop between two major crops. Because its shorter growth period and as it does not interfere with the economic use of land. Third and most important, is that growing of radish is considered by farmers as a form of short term rotation crop to absorb "all types of poisonous" substances like agrochemicals applied to the land or as a strategy for the rehabilitation of heavily exhausted soils. So radish growing is also treated as a form of crop rotation and also as a means for rehabilitating the soil after a crop has exhausted its nutrients or has changed the texture of the soil due to intensive application of chemical inputs.

3.2.3.2. The Role of Animal Husbandry in the Farming System

The enterprise of Saman Eliya farmers can be seen in the way they attempt to in-corporate cattle farming into the cash crop farming system. Cow-dung is useful in potato and vegetable farming as a basal application in order to conserve and maintain soil productivity and to provide essential micronutrients that are lacking in organic fertilizers. Potato is one of the crops that depends most on cow-dung and poultry waste. Saman Eliya farmers were largely dependent on farmyard manure, brought from other districts, and farmers have tended to rear at least one animal. Yet the farming families, which keep cattle, are few and no buffaloes were kept. In the Saman-Eliya GN Division, 42 families had cows one per family. Milk was mainly for home consumption. Only 44% of cattle rearing farmers sold milk while the monthly income from milk constituted only a fraction of the annual average income of a Saman Eliya farming family.

In view of the the importance of cow-dung and poultry manure in growing potato and vegetables almost all farmers were interested in rearing cattle, but they have to contend with a number of prob-

lems. One is the availability of labour . Vegetable and potato growing are cropping systems with highly labour intensive practices and therefore it is very difficult for the farming families to provide labour for activities like cattle rearing. The cutting and collection of grass require 2-3 hours of family labour or a half-day of hired labour.

Grass grown on edges of slopes, and elsewhere to control run off are the main natural sources of food for the cattle. The grass has to be cut, gathered and transported manually. Adequate amounts of grass or fodder cannot be gathered from within the individual farmyards or the adjoining farms. Grass, therefore, has to be collected from within at least half a square kilometer.

Besides, grass, fodder available in the vicinity is limited due to the lack of tree cover. Both the potato and vegetables produce little residue matter, which can be used as animal feed. Grass grows lush during the rainy season nourished by residues of fertilizer applied to cash crops. However, there are two major factors limiting the production of sufficient grass within the farming system: the small size of the land operated; and the drought from January to March, during which period the amount of grass availble is greatly reduced.

However, Saman Eliya farmers attempt to rear cattle whenever possible, which is not always conducive for doing so. This points to the level of entrepreneurship and resourcefullness of the people. It also shows how the market forces can result in maximum utilization of the "ecological niche" not only for economic benefits but also for ecological reasons, as cattle are kept mainly for soil management purposes.

3.2.3.3 Functioning of the Farming System in Relation to the Natural Ecological System

Viewed from an agronomic or ecological resource management perspective it would be difficult to comment on the efficiency of land use and cultural practices of the Saman-Eliya market gardeners or their practices in terms of sustaining the productivity of their limited land resources. For instance the soils are not left to fallow for a period adequate to recover from the heavy exhaustion of nutrients, by having a range of rapidly growing vegetables and root crops. The general technical agricultural advice to the farmer is that a second potato crop should not be grown in one year, especially between the months of August and December in order to avoid the incidence of fungus attacks associated with the heavy rain. And where crop rotation is needed to conserve the soil, farmers attempt to get a crop through the application of heavy dozes of fertilizer and fungicides. As an alternative, the technical advice is to divide the land into four segments and to leave one segment fallow each time the land is brought under cultivation by allowing time for the natural biological and chemical processes to take place and to allow the soils minimum time to recover naturally. There is a lot of sense in this recommendation as this would also help to control the spread of diseases and the need for heavily dozing the soils with fertilizer and the crops with fungicides during the rainy season. However, from the farmers' point of view, this is difficult to put into practice as they do not have lands to spare, and need all the available land to support a family throughout the year.

3.3. The Role Played by Externally Provided Soil Nutrients in Crop Production in the Saman Eliya Farming System

In the face of high land degradation under the Saman-Eliya type of use of agricultural land the productivity of agricultural crops within the system appears to be maintained mainly by two types of agronomic practices. One is through the provision of high-energy nutrients by applying chemical fertilizers, and the other through the application of farmyard manure in large quantities. Thus the fertilizer use, both organic and inorganic, under the market garden system has been usually high. For instance, in a survey of vegetable production undertaken in 1966 by the Department of Census and Statistics it has

been found that the average vegetable farmer in Nuwara Eliya added 27 cwt. of chemical fertilizer and 137 cwt. of organic matter per acre of land. This study further notes that an average vegetable producer spends, compared to other types of agricultural practitioners in the district, well over eight times on chemical fertilizers and organic manure and about four times as much on purchases of insecticides and pesticides. The practice of heavy dependence of farming system on purchased inputs especially in terms of agro-chemicals still continues.

Not only are the levels of inorganic fertilizers used for market garden crops comparatively high when compared to other forms of farming in the area, as much as 450 percent in certain cases for in excess of the recommended levels. According to Wijesundara (1990:84) vegetables in the upcountry are probably the most heavily fertilized among all cultivated crops in the country. Given below are estimated amounts of inorganic and organic fertilizers applied to vegetables over the recommended amount. It appears that application of inorganic fertilizers as against the recommended levels are also very high.

Table 3.2
Quantities of Mineral Fertilizer and Cattle Manure Added to Different Crops in the Upcountry Wet Zone (Mineral Fertilizer (N+ Pz05 + K20) kg/ha)

Crop (+ /ha)*	Recommended	Applied	Cattle manure
Beet	489	1731	20 .5
Cabbage	21	1874	-
Carrot	489	1032	17.5
Leak	421	868	30.7
Potatoes	550	1798	40.3

* Wet basis
Source: Shifaya Marikkar (1992:193)
Source: Wijesundara and Marikkar, Dept. of Agriculture, Sri Lanka Unpublished.

3.3.1 Function of Organic Fertilizer in the Market Garden System of Agriculture.

It is well established that the application of organic fertilizer helps to improve the biological, chemical and physical qualities of soils. They help to adhere fine soil particles together to form soil aggregates and increases the water and nutrient retention capabilities of the soil. Organic fertilizer is heavily applied in potato and vegetable cultivation though against the technical advice of the extension personnel of the Department of Agriculture and in spite of the cost of such applications. Thus, it appears that in market gardening as practiced in Saman Eliya, organic fertilizers fulfils a function, by improving the ability of the soils to resist the impact of rainfall, leaching of soils and stimulating soil microbial activity.

Beside these physical functions performed by the organic matter, some of the micronutrients that are not included in inorganic fertilizers, which are lacking in the soils, too are supplied by the organic manure. Thus the input made by the farmer and the degree to which it is reported to have increased over a few decades shows that soil degradation is occuring significantly. Recent nationwide information also points to reducing levels of potato yields. One should not however overlook the other possible explanations or factors reinforcing the reported reduction in yield levels in Saman Eliya over the last few decades. An important factor may be the changes in seed quality. For instance, in terms of potato seed purchases some farmers indicated that they do not get the correct quality or quantity of seeds resulting in reduced output or even crop failures when immature potato seeds are planted. Under

weighing of seed potato was seen as a common practice by some farmers, resulting in less potato seeds being cultivated per a given extent of land reduced productivity. These factors may also contribute to the recent reduction in the potato yield.

3.4 Sustainability of Market Gardening System

Potato dominant exotic tubers and vegetable gardening in Saman Eliya, as mentioned earlier, is a system of farming involving an intensive use of land, labour and agro-chemicals resulting in a considerable out put for the local market. The competitive advantage however is with the favourable elements in certain ecological niches of a generally ecologically fragile region. Not all the lands that are suitable for growing of exotic vegetables are available for the propose as much of this land is used for other crops like tea.

Neither the existing demand nor the cost of production make the expansion of vegetable cultivation an attractive proposition. The existing demand is influenced by the price factor, which is relatively higher than the prices fetched by non-indigenous vegetable varieties. An increased demand may result in a reduction of the price, but producing at such low price becomes unconomic in terms of the high production costs. Also, significant price fluctuations are a common experience often resulting in with substantial financial losses to the farmer. The return obtained by the farmer is also influenced by the high cost of transportation of the produce to urban centers and the margins of profit made by the wholesale and retail chain. Similarly, neither does the country have modern cold room facilities to store this type of highly perishable produce for use in lean seasons nor has the scope for expanding exports been fully realized.

A number of considerations should be taken into account when assessing the sustainability of this system of farming. These would include the examination of ecological, physical and the socio-economic factors impacting on the system or the advances in the production technique that could determine its viability. For example, one may start with the lands, as one of the fundamental natural resources essential for agricultural production. Likewise, the changing pattern and the intensity of inputs used for crop production, their supply and the possible difficulties in obtaining their supplies are some of the considerations in the assessment of sustainability of this farming system or factors affecting its sustainability. Both input and producer prices, their changes and the possible effects these changes may have, include yet another set of factors that should be considered in such an assessment. Some factors contributing to the vulnerability of this system of farming, especially in terms of its sustainability, will be examined briefly in the remaining section of this chapter.

3.4.1. Vulnerabilities Associated with Degradation of the Natural Resource Base

A major danger facing the Saman Eliya farming system is the degradation of its resource base: as a result of the soil becoming of progressively poor.

There has been no fragmentation of the land so far, the farmer person land ratio still prevails and the economic viability of system remain unaffected. This is because Saman Eliya is a newly established farming community. It was established, as was noted earlier, as a youth colony in the 1960s. Yet the need for sub-division will arise within the next decade or so with the growing up of the second generation.

As the study on which this report is based was to measure the socio-economic factors affecting land use practices rather than the intensity of land degradation in technical terms, no attempt is made at measuring the soil erosion, the fertility of the soils or the absorption of nutrients by crops in any tangible form. However, certain types of farming practices, especially increasing of the intensity of fertilizer application undertaken by Saman Eliya farmers over the last few decades, amply demonstrate the almost imperceptible process of land degradation.

3.4.1.1. Erosion and Leaching Associated with Land Degradation Under The Market Gardening System

The growing of exotic vegetable, particularly potatoes, appears to place a heavy stress on the land and its nutrient system for a number of reasons. Some of the more important factors leading to the degradation of the land under the market gardening system in Saman-Eliya are outlined below.

The way the land is used for potato cultivation in Nuwara Eliya results in heavy soil erosion, estimated at arround 100 tons a hectare a year. This is caused largely through clean weeding and tilling operations under market gardening system of farming in this ecologically fragile region.
An ideal way of preparing the land for farming in this region would be a form of "no till farming". This practice is adopted in the central highland regions, where the mixed crop gardening system prevails. Both forest and grass *(pathana)* land in the region too include other land use systems with effective soil cover. Well matured vegetatively propagated tea (VPP), after about four years of planting, also represent another method of conservation agriculture suitable for the region. Compared to this, the system of exotic food crop cultivation that prevails under the market garden system in the central highland region requires "clean weeding" of the fragile mountain terrain. This is done by turning the soils upside down about nine inches deep and loosening it thereafter before making plant beds each time the land is cultivated. No machine but only a mammoty is used in the whole range of operations connected with land preparation. It appears that this type of land use practice for vegetable growing is relatively new to the region and was introduced with or after the introduction of the plantation agriculture to meet the dietary needs of the colonial planter population that settled in the country. The practice of clean weeding and tillage is obviously unsuitable for tropical mountain regions such as Nuwara Eliya with a highly erosive rainfall pattern and steep slopes.

Thus the tillage and land preparation practices associated with vegetable market gardening is conducive to soil erosion. Under the ecological conditions of Saman Eliya, such as the physical terrain, precipitation and relatively non-existence of tree crop systems around the market garden plots, potato/ vegetable gardening involves heavy soil erosion. However, our observation is that high levels of soil erosion due to rapid run off on most cultivated lands in Saman -Eliya have been significantly arrested over the years. A few farmers have been able to prevent more or less completely, soil erosion with run off water by building up stone walls. On such lands leaching of soil is a bigger problem than soil erosion itself by run off. On some lands, stone wall construction is partly done and the erosion levels are substantial.

The most popular erosion control practice adopted by Saman-Eliya farmers is the construction of drains. Some build plant beds before planting and some construct terraces depending on the landscape. Almost all farmers grow grass *(Savendara or Vetiver)* along the boundaries, and along terraced fields to arrest the rapid run off rainwater in order to prevent soil erosion. Almost every season when the land is brought under cultivation, the soil matter collected along the live hedges are drawn back to the field. Thus land preparation is obviously a labour intensive operation to regain the vitality of the soil by turning and setting back the washed and leached soils. The grass that is being produced as live hedges is cut and fed to the cattle which are raised on a small scale in the village on a stall-fed basis. Live hedges planted with coffee, oranges, pears or ornamental flower are also intended to arrest rapid run off of rain water. The farmers believe that these operations are successful in "revitalizing" the soils after each harvest.

Normally, as stated earlier, the use of both the organic and inorganic fertilizers by Saman Eliya farmers is very high. Also according to farmers, the use of cattle and poultry manure on a per crop and per acre basis has been on the increase during the last two decades. Some farmers thought that this was necessary because of the loss of soil fertility on a regular bases. For instance, a number of farmers informed us that in the 1960s when the land was first brought under potato cultivation, per acre productivity was

much higher than it is today. These productivity levels are still being achieved on lands newly brought under cultivation. An often-quoted example by farmers to show the incidence of land degradation is the drop in seed potato-yields. They indicated to us that in those days when one ton of potato seeds were planted, the yield obtained ranged from 16-22 tons. Today, however most of them indicated that this had fallen to between 6-14 tons.

Considering the overall land degradation experienced, the system of crop production that prevails in Saman-Eliya does not appear to be sustainable due to several reasons. It was also observed early that in addition to soil erosion and leaching of soil nutrients due to continuous tilling of the soil in an environment where both erodability and erosivity levels are high, heavy absorption of soil nutrients by rapidly growing crops like potatoes place a heavy drain on soil nutrients.

3.4.1.2. Extractive Nature of Potato and Vegetable Production

As the vegetable matter produced in market gardens is used for human consumption, this can be treated as a form of "extraction from soils or nature's deposits" than a form of sustainable agricultural production. In contrast to this is the upland mixed crop gardening system that prevails in Rambodagama. When the system of farming contributes to sustain soil productivity by the fallen leaves as it mostly returns the nutrients taken by plants by depositing organic leaf materials. Under the Saman Eliya system, while little crop residues are added back to the soils, no green manure is added from outside the system. This is not because the farmers are not aware of the role played by plant leaves or green manure, but mainly due to the scarcity or lack of such materials within the very system of agriculture or in its environment.

Apart from the information provided by farmers on land degradation, the available technical data also point to the fact that the lands cultivated with non-indigenous food crop varieties, as undertaken under Saman Eliya farming conditions contribute to intensive land degradation. According to Grootveld (1992), the area cultivated with market gardens is estimated to be 3,587 ha or 2.1% of the total land area of the district. The approximate soil losses under this system of farming, according to him is 100 tons/ha a year, contributing to some 7.5% of the estimated soil losses of the district (see annex 1). These facts, for instance, show the high soil losses under the market garden system. The limited area cultivable under the market garden system also points to the fact that this system of farming has a distinctly adverse effect in the natural resource base because the availability of both the lands and the soils is seriously limited.

On the other hand, the average estimates may, perhaps, mask the seriousness of the problems of soil erosion on lands brought under this type of cultivation. For instance, sustained production of a farming system with such heavy soil loss will depend on the intensity of cultivation of the land and how the soils and nutrients returned. The Saman Eliya farmers have not yet started replenishing the exhausted lands with fresh soils in an attempt to upgrade their decreasing productivity. This is already happening in areas such as Kandapola, a few miles away from Saman Eliya. Thus the undermining of the very basis of agriculture is a major source of concern in the matter of sustaining the market garden system of farming.

3.4.2 Heavy Nutrient Intake by Crops as a Source of Land Degradation

The nutrient intake by the range of crops cultivated in Saman-Eliya is seen to be high. Given below is some information relating to the average value of NPK intakes reported by Wijesundara (1990) in relation to some plant samples collected from farmers' fields.

Table 3.3
Intake of NPK by Various Crop Varieties Grown on Market Gardens

Crop	Botanical Name	Duration (days)	Total NPK Intake (kg/ha)
Leek	Allium porrum L.	150-165	337
Beet	Beta vulgaris L.	75-90	392
Lettuce	Lactuca sativa L.	30-45	35
Radish	Raphanus sativus L.	45-60	202
Cabbage	Brassica oleracea	75-105	411
KnolKhol	Brassica oleracea gougylorides L.	45-60	321
Pole bean	Phasaeolus vulgaris L.	100-105	328
Potato	Solanum tuberosum	90-105	728
Carrot	Daucus	90-105	420

Source:- Adapted from Wijesundara S.M.(1990)

It appears that the NPK intake by potatoes is the highest among vegetable crops, with an average NPK intake of 728 kg/ha. Also carrots, cabbage, knolkhol and beet take in substantially higher amounts of nutrients. Wijesundera (1990) also notes that potassium used by potatoes is very high and the quantity applied as fertilizer is not adequate for plant growth. Wijesundera and Amarasiri (1990) studying phosphate sources of growth of vegetables on acid soils report that "... application of P at 100 kg/ha is needed to get high yields from upcountry potato, cabbage, pole bean and tomato". Wijesundera (1990:82) notes that "potassium is the nutrient removed most by almost all vegetable crops." The amounts of K absorbed by most vegetable species are much greater than the amounts applied according to the recommended levels of fertilizer while the opposite is true for P. For example, potato used up three and a half times more K than that is applied as fertilizer.

Thus it appears that under the Saman Eliya type of vegetable gardening system there is continuous intake of plant nutrients, which have to be replenished on a continuing basis in order to support plant growth. Also under this system, lands are cultivated the year round with some plots cultivated with three crops a year amounting to 300 percent land use. Thus cash crop agriculture under such intensive conditions results in immense stress on soils. Such stresses not only emanate from regular disturbances to soils by intensive clean weeding and tilling operations, but also high levels of nutrient absorption by rapidly growing plants and the intensive application of fertilizers and other agro-chemicals toxic to the soils. Soils appear to be so degraded or have been conditioned in such a way that they are not able to support a crop without application of fertilizers at a high level. Thus the lands under Saman-Eliya farming system are also allowed little time to rehabilitate through natural biological processes.

The extractive nature of the agricultural practices, especially in terms of soil nutrients, is one other factor contributing to land degradation in Saman Eliya type farms. Almost all the crops are grown as annuals, the cultivation period lasting between 30-45 days for lettuce and 150-165 days for leeks. Lands cultivated with potatoes and exotic vegetables are capable of generating large quantities of vegetative bio-mass on a rapid succession which is harvested succulent while the crop is still in a physiologically active state. Thus almost nothing is added back to the soils and this shows the "extractive nature of cash crop farming" in this ecologically vulnerable area.

To elaborate this point further, large amount of vegetative material as tubers, stems and leaves are removed as edible materials at harvest time from the lands. Good examples are leeks, cabbage, beets, carrots and knolkhol. Of these vegetables, little is left as residues and much of the nutrients absorbed by them in growing are retained in edible portions. Over 75% of the nutrients absorbed by potatoes are

reported to be found in the aerial parts of the plant and have no economic or consumptive use other than recycling by returning to soils. As Wijesundara (1990) notes "Potato removes the highest quantity of nutrients of all the vegetables studied and a major portion of these is contained in the residue. Yet the return of this residues as fertilizer is not advised due to spread of bacterial wilt".

3.5. Vulnerabilities Associated with the Market Gardening System in Terms of Input Supplies

Sources of input supplies for the Saman Eliya market gardening system of agriculture is summarized below.

Table 3.4
Sources of Input Supplies to Saman Eliya Vegetable Gardening System

Type of Input	Family or own origin	Local origin	Regional origin	National origin	Foreign used per acre
1. Land Rent (acre/year Actual computed value/family	X	X			
2. Water/Irrigation	X	X	X		
3. Capital	X	X	X		
4. Labour	X	X	X		
5. Seed					X
6. Machines & equipments - spray - mammoty - water pumps					X X X
7. Agro chemicals weedicides insecticides fungicides					X X X
8. Fertilizer inorganic - NPK - Postasium				X	X
9. Fertilizer/ organic - cowdung - poultry manure	X X	X X	X X		X

Source: prepared by the author on the basis of village level information and literature review.

As shown in Table 3.2 almost all the non-natural resource inputs used in the potatoes and vegetable cultivation system in Saman Eliya are supplied from sources outside the farming system. Some are heavily import dependent.

3.5.1 Vulnerability Associated with the Supply of Important Inputs and Their Use Patterns over Time

3.5.1.1 Seeds

The majority of the small agricultural producers in the country use their own seeds or get them in exchange from other farmers. Dependence on such informal sources for the supply of seeds is common

in the production of paddy, other subsidiary food grains and a range of indigenous vegetable crops and yams. Seed supplies for non-traditional or exotic vegetable varieties and potatoes however are heavily dependent upon imports.

In terms of the size of the seed market for agricultural crops grown in the country, the market for potato seed appears to have a disproportionate share both in terms of the acreage cultivated and value added production. As far as production costs of potatoes are concerned, the cost of seeds alone varies from 45% to 60%. of the total production costs. According to Pattie and Madawanaarachchi (1993:19) "The total value of the seed market in the country is estimated at nearly 540 million rupees, when the additional amount of vegetable seed is taken into account. However, the bulk of this is potato seed. When potato is excluded, the total market value is reduced to only 240 million rupees, or five million US dollars". They further note that (p. 18) " ... potato seed has a strong market in the country. Potato prices in Sri Lanka are also very high, making potato seed prices high compared to other countries".

It is well established that the production of potatoes is facing a number of problems in Sri Lanka including its susceptibility to viral and bacterial diseases. For instance, bacterial wilt is a hazard endemic to potato production in the country. Therefore, the availability of disease-free, standardized seed potato is essential for the success of this crop. Nevertheless, the demand for seed potato has never been met by formal sources in the country or distributed in a timely manner. Thus, a substantial proportion of the farmers has to produce their own seeds or buy from informal sources.

Unlike in many crops that are produced for subsistence consumption or on a part subsistence basis, production of exotic vegetables and potatoes is highly market-oriented and governed by market forces. Because they are non-indigenous plant varieties, the ability to produce our own seed is limited by ecological factors. There may be also other problems that are not very clear to us at present, affecting seed production in the country. For example, in the proceedings of Sri Lanka's Seed Workshop, Jan 26 - Feb. 6th 1987 (P.81), it was remarked that:

> "The root and tuber crops programme... appears to be on the verge of releasing a group of new varieties. In the case of potatoes, most of the varieties cultivated in Sri Lank date back to the 1960s. In co-operation with the International Potato Center in Peru, new releases have been proposed since 1981, but for various reasons official release has not been granted. An effort is being made to release new potato cultivars having the potential for true seed production within the next five years".

Thus it appears that in addition to truly agro-ecological problems that constrain the production, fully or partly of the seed potato requirements, there are other non-technical and non-ecological problems that affect such efforts. The problem here is that seed potato production in the country is not self-sustained and is heavily import-dependant. This involves vulnerability in terms of the supply of seeds as well as the quality. High dependence on imported potato seeds also increases the probability of importing diseases in terms of pests, viruses and fungi not found in the country. This type of risks will depend greatly on the care taken in selecting the sources of seeds and on following quarantine regulations in the end.

3.5.1.2 Supply of Chemical Fertilizers and Other Agro Chemicals

It has been established that vegetable and potato cultivation in the central highland region is heavily dependant on large does of chemical and organic fertilizers in order to obtain a good crop (see for example, Wijewardena and Amarasiri, 1990; Wijesundara, 1990)

Similarly pest attacks such as the insects, nematode, fungi, bacteria are endemic to both the potato and vegetable cultivation under the Saman Eliya type of market gardening system. Thus it is normal to use

pesticides and fungicides heavily under this farming system compared to most other farming systems prevailing in the country. The factors that apparently influence the high incidence of pest attacks in this farming system are the; widespread genetic uniformity of crops cultivated and their non-native origin. It is well known that there are a number of major limitations attached to the chemical control of pests including the increased possibility of a secondary pest outbreak, pest resurgence, toxicity to non-target organisms and resistance developed by targeted pests.

The market gardens system of farming accounts for a major share of the demand placed on Sri Lanka's chemical and fertilizer market. The country is heavily dependent on the impact of these important inputs except potassium. Thus their importation has become a burden on the country's scarce foreign exchange and has affected their supply from time to time. Thus on two counts the supply of these items can become vulnerable viz. dependence on imports and the availability of foreign exchange. Heavy application of agrochemical also can add to the vulnerability in another sense. For instance, Wijesundara and Amarasiri (1990:58) note that:

> "Unlike the general pattern of low fertilizer use in the low country of Sri Lanka, most farmers in the upcountry use high quantities of chemical and organic fertilizers and consequently the content of residual soil phosphorus is substantially high in the vegetable growing lands in this region".

Beside the effect of residual matter that remain in the soils, the land can become conditioned to the heavy application of nutrients without which growing of crops may become difficult.

3.5.1.3 Supply of Organic Fertilizers

As was mentioned earlier, for its vegetable and potato production, the Saman Eliya market gardening system is becoming increasingly dependant on the supply of farmyard manure to sustain the fertility of the soil. However this important input in the Saman Eliya village is limited due to a number of factors. One is obviously the restricted land available. Almost all the land that could be brought under cultivation, except for the area under homesteads, have been brought under vegetable and potato cultivation. The second limiting factor, as was noted earlier, is the capacity to produce grass and fodder within the system itself as the cattle population in the locality cannot be expanded in order to increase the local cowdung or milk production in the vegetable growing areas due to the limited fodder and agricultural residue produced within the farming systems. Fodder trees cannot be grown due to the lack of land. The existing tree cover within this farming system to obtain adequate fodder as animal feed is substantially limited too. Unlike paddy, potato and vegetable crops produce only a little residual biomass that can be fed to the cattle in the first place. On the other hand, a system based on concentrated food and nutrients alone is an expensive way of rearing cattle in Sri Lanka. Compared to this, under traditional forms of agricultural practices such as under tree crop and paddy farming systems that prevail in Rambodagama, a range of biomass matter in sufficient quantities is produced along with food crops to feed a limited number of cattle. Therefore, animal feed that is being produced within the Saman Eliya locality is limited to grass growing along roads and the boundaries of lands, and other types of lands that are not used for cultivation such as steep slopes. Thus the availability of grass and fodder and other agricultural residues will present, in addition to lack of availability of land, a formidable obstacle to increasing the cattle population within the Saman Eliya area.

It should be noted that producing poultry manure locally presents many more problems than keeping cattle in the area. First, those families who keep some poultry are small in number and keep only a few birds for their consumption. Second, many families are not ready to keep poultry, for religious and social reasons. Third, the lack of land also presents a formidable constraint in rearing poultry.

Beside the factors affecting local supplies, the Nuwara Eliya district itself constitutes a farmyard ma-

nure deficit area. Vegetable and potato cultivation as is practiced in Nuwara Eliya depends largly on imported cowdung from other regions in the country. At the district level, the buffalo and cattle population is comparatively small. According to the 1982 census, the district had 38,832 head of cattle and 7,017 buffaloes representing 2.9 and 1.3 percent of the island's total cattle and buffalo population respectively. For the same year, the district accounted for 2.9 percent (110,087 of 2293571) of the poultry in the island. Here too the estate sector accounted for 78,768 birds.

Both in the estate and villages, which accounts for a substantial proportion of the poultry, within the district, the birds are reared free range for subsistence production. Thus unlike in large scale poultry industries, where the deep litter system is used, village and estate poultry systems do not produce a surplus of manure that could be sold. Also few Saman-Eliya farmers kept poultry.

High dependence on farmyard manure produced outside the system, or for that matter outside the district, could cause supply difficulties, in the form of escalating costs, relative to farm output prices, which may affect the sustainability of production. This could be appreciated when one looks at how the supply of this important input is organized and met. For instance most of the cowdung suppliers are concentrated outside the Nuwara Eliya district in the Dry Zone districts of Anuradhapura, Polonnaruwa and the Wet Zone district of Kandy. Similarly, suppliers of poultry wastes are concentrated in Bingiriya, Negombo, Kandana, Avissawella and Horana in the Colombo and Gampaha districts. Cowdung is purchased, transported, and sold by truckloads by the organized trucker buyers. While cowdung is most of the time disposed in bulk, poultry manure is sold in terms of gunny bags. Potato and vegetable farmers in the Nuwara Eliya and Badulla districts make the heaviest demand for farm manure.

A cattle farmer receives between Rs: 250-350/-, depending on the quality of the product and the location, per lorry load consisting of 50-350 cubic feet of wet bulk. In Nuwara Eliya, 350 cu. feet lorry load of cowdung is sold for a price between Rs: 1300-1400/. Similarly, a trucker supplier will sell a large size polypropylene bag of poultry waste for a price between Rs: 25-40 depending on the size of the bag and the quality. Some of the trucker buyers provide without any charge the rice husks to be used to the poultry farms for deep litters and collect poultry wastes as compensation or otherwise by paying a minimal sum to the producer who wants to dispose of it.

The supply of farmyard manure, as an important input used by market gardeners, can become a source of uncertainly. At present, the farmyard manure producing areas have a surplus because the use of this important input in those areas is limited and even may be treated as a waste rather than a resource. On the other hand, the Nuwara Eliya and Badulla districts where farmyard manure is mostly in demand are deficit-producing areas. This paradox works at present to the advantage of market gardeners in the central highland regions, in particular the Nuwara Eliya vegetable and potato farmers. Yet a slight change in the demand scenario in the supplying areas or non-indigenous vegetable producing areas is bound to negatively affect the supply of farm- yard manure to areas where it is needed most.

Existing circumstances dictate that both the supplier and purchaser of farmyard manure is controlled by the transporter to the disadvantage of the market gardener. For instance, the farmers in Saman-Eliya claimed that those truck loaders in order to make maximum profits, mix the cowdung with rice straw, weeds and leaves. Such practices reduce the quality of cowdung and affect both the costs of production and productivity. The reason for this is probably because cowdung as a raw material itself is in short supply. This also points to the supply problems that Saman Eliya farmers have to face.

Also other changes that may occur on the supply side, for instance a reduction in the cattle population in the cattle manure producing areas or a higher demand for cowdung in producing areas themselves or in areas other than vegetable growing areas, may change the existing supply scenario. A newly emerging market for packet compost and cowdung when fully developed, for instance, could add to the problems of the vegetable growers. A packaging industry can provide dry matter in packet form in

small quantities at a relatively high price because the costs of processing, packeting and storage and transport are involved. Beside the prohibitive costs associated with packet farmyard manure, they would not cater to large-scale users of raw cowdung such as the vegetable and potato growers in the district.

3.6 Other Factors Affecting Sustainability

3.6.1 Possible Impact of the Increasing Incidence of Large Farmers Moving into the Potato Prduction System.

The productivity of new lands brought under production in an area where land scarcity is great points to another ongoing process where small farmers cultivating potatoes and vegetable could be affected. Saman Eliya farmers have informed us that it is very difficult for the farming community currently to pick even twigs from the Government forest reservations adjoining the village due to the strict enforcement of forest laws prohibiting their use by villagers for agri-cultural, fodder, timber or fuelwood products. Yet according to the villagers, forest lands are cleared to cultivate potato and this has been done under political patronage by elite "gentlemen farmers" from outside the area. Such activity even at a minimal level, can affect the Saman Eliya type of farming systems in two ways. One is through the process of natural resource degradation affecting agriculture, especially the degradation of lands and water streams that originate in the forested steep highland areas. The delicate balance between non-natural eco system such as the farming system with the natural eco-system is further aggravated due to this process affecting in turn the agricultural production in Saman Eliya. Second, the higher yields obtained by such land operators have the market advantage of reduced unit costs mainly due to the high productivity rates achieved by cultivation of more or less virgin forest lands with higher levels of natural nutrients and fertility of soils. The large farmers also have relatively a higher level of scale of economies attached not only because of the size of the land operated by them but also due to the manner in which the farming enterprise is run. For instance, one of the large farmers in the area who was importing seed potatoes for both sale and use was running a poultry farm outside the district and had the advantage of this important farm- yard manure. Large farmers also supplied fertilizer and agro-chemicals to other small farmers thereby controlling retail prices. They also managed the transport system catering to both the supply of inputs and the transport of farm produce to markets. When big timers get going this may result in displacing the small scale potato cultivator out of production or even from the land itself due mainly to the advantages associated with the scale of production and the control of services to the rest of the farmers. It appears that, certain small vegetable producers remain in the business of vegetable production as a result of the relatively high profit margin got by import-protected potato growing than through the incomes generated by vegetable production by itself. Thus a reduction in potato prices, perhaps due to the effects of the scale of economies achieved by large land operators once they stabilize themselves, may affect the level of profits accruing to the small-scale cultivator.

CHAPTER FOUR

Rambodagama Subsistence Farming System and Factors Affecting its Sustainability

4.1 Rambodagama Village and Some Key Aspects of Its Agricultural Economy and the Society

Rambodagama is a village located along Kandy-Nuwara-Eliya road accessed by Thawalan Tenna-Pusulpitiya road or off Kandy-Nuwara-Eliya road from Ramboda alone the road to Kothmale new town. Some of the basic information on the socio-economic and agro-ecological conditions in Rambodagama is summarized below: -

4.1.1 Physical Agro-climatic

Elevation of location (approximately):	1000-1450 m
Slope:	30% - 40%
Average annual precipitation:	3300 mm
Months with highest precipitation:	compared well with Saman Eliya
Average temperature:	20 Celsius (75 f)
Nearest city Centre:	Nuwara Eliya (25 km)
Nearest townships:	Kothmale new town (1 km), Rambodagama (1 km)
Vehicular access:	Nuwara Eliya - Kandy Road, Thawalan Tenna Udupussallawa Road

4.1.2 Agro-ecological Significance: The village is located in hydro-catchment to Kothmale Oya reservoir constructed with a 350 feet high rockfill dam at Kadadora by blocking the Kothmale Oya (stream). Kothmale Reservoir is located adjacent to the Rambodagama village. This reservoir has an effective storage capacity of about 300,000 acre feet enabling regulation of about 95 percent of mean annual flow of the 43.3 kilometers long Kothmale Oya at the dam site (H.N.S. Karunatilake, 1985:63). The water released from the dam feeds a number of successive reservoirs constructed along the elevation such as Polgolla and Bowetenna reservoirs.

4.1.3 Administration and Services

Assistant Secretariat Division:	Kothmale
Grama Niladhari Division:	Rambodagama
Agricultural Instructor Division:	Hellbode
Schools with close access:	Kothmale new town high school
Rambodagama Hospital and Clinics:	Nuwara Eliya District Hospital (25 km)

4.1.4 Socio-Economic Conditions

No. of households:	113
Average size of the family:	5.3

Literacy rate:	86 %
Average annual family income:	Rs. 54906
Percentage of total income from	
1. Agriculture (Paddy, agroforestry and animal husbandry):	17
2. Salaries (public service):	43
3. Working as hired labourers:	10

4.1.5 Agriculture

Total area under paddy:	65 acres (approx.)
Paddy acreage held by five 5 largest land holding families:	24
Total area under upland gardens:	173 acres (approx.)
Highland acreage held by largest highland holding families:	34
Percent households self sufficient in paddy:	27
Cropping pattern:	Wet paddy for two seasons per annum on lowland asweddumized to terraced paddy Fields. Some terraced paddy lands are abandoned. Mixed crop farming on up-lands. Neglected tea on about 10% of the upland area.

4.1.6 Animal Husbandry:

About 12 farmers rear 31 neat cattle and 13 buffaloes. Neat cattle are mainly for milk production and buffaloes are kept for draught power. About three families kept about 10 goats at the time of the survey. Goats are kept mainly for selling for meat.

4.1.7 Method of Labour Mobilization:

The village agriculture is oriented mainly for meeting the subsistence needs and little is produced for the market. There is also little dependence on imported inputs; such as fertilizers, agro-chemicals. Similarly, there is no dependence on machinery for land preparation, weeding, harvesting, threshing or transporting. Almost all the preparations are manually done where the peak labour demand is met by a system of exchange (*aththam*) labour.

4.1.8 Main Agricultural Production Problems

The low productivity of the land due to the small parcels of land operated and the complicated land tenure systems are the main problems faced by the agricultural sector in the village. Low productivity is largely due to the fact that as high yielding varieties that is appropriate to the area are not being used, the lack of an appropriate system to produce seeds from the existing varieties and the low application of essential fertilizers. Wild Boar infestation, which is a recent phenomenon, has caused immense damage to the crops that are the main stay of the subsistence economy of Rambodagama.

4.1.9 Sources of Irrigation Water:

Water spouts and streams are the source of water for drinking, bathing and agriculture. Water for drinking is from the unsettled higher elevation areas. The settlement of about 36 families by the Land Reform Commission in an abandoned tea estate above the village has become a matter of serious concern for the original villagers living below. Some arrangements have been made to provide water by connecting watercourses to pipelines. The drinking water is not treated.

4.2 Working of the Agricultural Economy of Rambodagama and its Rationale

There are three systems of agricultural production integrated into the Rambodagama farming system.

(1) Paddy farming on lowlands by using stream water for irrigation
(2) Mixed crop farming on uplands mainly on a home garden basis.
(3) Buffalo and cattle farming, mainly for draught power

4.2.1 Paddy Farming System in Rambodagama

4.2.1.1 Importance and Working of the System

Paddy cultivation is the backbone of the agricultural economy of the Rambodagama. Rice i.e. husked paddy, is the much preferred staple food in the country. Because it can be kept and stored paddy farming is the much-preferred agricultural activity. As such almost all the land that could be cultivated with paddy have been asweddumized The extent of paddy asweddumized and available for cultivation depends on the availability of stream water or other sources of water which determines not only the location of the paddy fields, but also the extent asweddumized. Thus access to water during the growing season will, to a large extent, determine the area cultivated with paddy. In this sense, the lands in the Rambodagama have become a finite resource at least 6-7 decades ago.

Of the sample households of Rambodagama, 37 or 62 percent operated a paddy land in *Maha* 93/94 and in 33 or 55 percent *Yala*. However, the extent cultivated as reported was slightly higher than the total available land in the village suggesting the use of land outside the village or of over reporting or both.

Paddy as cultivated in Rambodagama is labour-intensive and is hardly sold. Labour involvement in paddy cultivation has greatly increased recently due to the widespread damage caused by wild boar. Of the Rambodagama sample population, only one family had sold any paddy in *Yala* while none sold in *Maha*. About 16 (27%) of the households were able to meet all of their annual rice consumption requirements from their own production while 11 (18%) did not cultivate paddy at all. On the other hand, of the total household income, from paddy in this case including imputed incomes accounted for only eight percent of the total annual income of Rambodagama families.

The system of agriculture, its rationale and the pivotal role played by paddy cultivation historically in the economy and culture of the central highland regions can be appreciated by the following account provided by Sarkar and Tambiah (1967). "The basis of rural economy in ancient Ceylon was paddy cultivation. The social beliefs, customs and institutions were closely integrated with the system of paddy production. The Kandyan villages, however, unlike the villages in the other parts of the country, did not depend on artificial irrigation for the vitality of their economy. The terraced paddy fields, which were skillfully constructed by generations of cultivators, obtained their water from natural streams, which rarely failed. The high land which could not be converted into paddy fields because of the lack of water was used by the villager to build his home, to plant fruit trees and to grow vegetables and other crops. The forests at a still higher level and the wastelands played a vital part in the village economy both directly and indirectly. They provided the peasant with pastureland for his cattle, with fuel for his household needs, and with leaf manure for his paddy fields. Indirectly they helped him by ensuring adequate rainfall, preventing soil erosion, and maintaining his cattle which provided him not only with working power but also with manure to increase the productivity of his soil".

4.2.1.2 Human Resource Skills Involved in Paddy Farming: Some Working Aspects of the System

Developing sloping lands into paddy fields involves a great amount of skills, personal discipline, patience, effort both physical and mental, and a fine sense of scale, gradient and principles of gravitational forces of rain water under different phisio-morphological conditions. Thus asweddumizing a

sloping land into a terraced paddy field is an art backed by a traditional system of knowledge, specifically "body knowledge" and skills transferred only through on-the-job training as the work is performed without elaborate technical equipment but by using a simple mammoty. Every season the cultivation of paddy is undertaken which necessitates the application of similar skills in preparation of the land such as in bunding of ridges and on site water management. Terraced *liyaddas*[1] are in rectangular shape and their size depends on the gradient of the land and other obstructions such as rock formations that need to be dealt with in constructing them.

Even in a limited area like Rambodagama, the character of the land resources are varied. Some lands cultivated with paddy are undulating and located just below the settled areas. Such lands enjoy a number of advantages as far as productivity is concerned. These are mostly ecologically determined advantages. For instance, the settled areas in Rambodagama produce a range of agricultural residues, animal waste and other residual matter that flow directly into the paddy fields just below them. The gravitational forces of rain water is first checked by the agro-forest gardens of the settled areas and then released slowly into the paddy fields below them. Thus the effects of run-off after heavy rains are also less on paddy lands just below them making them relatively more productive.

The gravitational force of the rain water, unless checked by forests or the upland tree crop garden system, gathers momentum on reaching the river valley at the bottom of the plain and washes away the top soils and nutrients. Thus the rain water run-off has a harmful effect on paddy lands located away from the settled area or above it. Most of the time, terraced paddy fields, because of the ingenuity of their construction, are capable of controlling the effects of rainwater. The bunds, when constructed very thin to save more land and to increase the actual paddy growing area, are breached by strong run-offs.

Some paddy terraces are large as 10 perches while some are as small as one square meter each. Both the slope and physical character of the land determine the size of the *liyaddas*. Some lands are not only steep but also rocky, where there has been heavy soil erosion.

Some steep slopes too are converted into paddy fields though less steep or flat lands are preferred. Thus, most of the time, small *liyaddas* appear to be attempts at making use of all the land, available along the slopes, and devises adopted for controlling the run-off water. Large *liyaddas* hold more water and may break away with prolonged heavy rains. Varying sizes of *liyaddas* appear to be a devise adopted to overcome the obstacles imposed by the terrain itself enabling more lands to be brought under paddy cultivation. Rocky lands, represent the most marginal lands in the region and have probably been brought under cultivation later to cushion the impact of the population pressure. *Liyaddas* have been constructed encircling the rocks and these involve great skills in construction and demand more labour inputs than normal or large *liyaddas* in land preparation and cultivation. Factors such as the terrain of the land, *liyadda* techniques of water and land management, especially of erosion control, determine the technology adopted in cultivation and cultural practices.

4.2.1.3 Factors Influencing Land Use Practices on Terraced Paddy Lands

Paddy is cultivated in two seasons, *Maha* and *Yala*. In 1994, the land use intensity in Rambodagama was 145%. A shift to two-season cultivation appears to have been initiated in the 1940s and was started later, with the growing numbers to feed. Land preparation is done by using buffaloes raised for the purpose by the household itself or through an exchange system. Occasionally land preparation is also done manually by tilling the land with the mammoty. No machinery or tractors are used either for ploughing or threshing.

[1] Ponds like benches constructed along the contours of lands to control water and plant paddy.

The majority of the lands are cultivated to BG400/1, a new improved variety of rice introduced into the area by the Department of Agriculture in late 1970 s. Some lands are cultivated with old improved varieties of rice like H 4 and other traditional local varieties of rice, "*Hathiyal*" and "*Muthu Manikkam*". For consumption, the villagers prefer old traditional varieties of rice. However, the cultivation of these varieties has been curtailed since the cultivation of two crops a year was attempted. The need for adoption of new paddy varieties instead of the much preferred traditional local varieties of rice is mainly determined by ecological conditions that prevail in the village locality. For instance, a mild cold that prevails in the area between the months of December to March affects the time taken for the paddy plants to mature. The land cultivated with old varieties may take 6-7 months to mature for harvesting while new varieties take a relatively shorter time, about 4-5 months. Thus the spread of new varieties of paddy in the village has been impressive. However, the problem is that the villagers have not received guaranteed seed paddy for quite some time to replenish the degenerating old stock. The quality of locally produced seed varieties is low and tends to mature differently due to their cross-pollination under uncontrolled conditions. Non-availability of quality seed paddy affects, among other things the productivity of paddy lands.

In Rambodagama, most of the acreage under paddy is transplanted. Fertilizer application is minimal, far less than the recommended dosage. It was clear from the observations the author made in the village, that fertilizer application in Rambodagama is far below than that used in the areas outside it. Definitely, the lack of capital and the subsistence nature of production is one of the major constraints to the application of fertilizer. Also the fear of the fertilizer gets washed away is given by farmers as another reason. The technical extension personnel did not consider this to be a good enough reason to discourage the farmer from the application of fertilizer. Further, they thought that the low levels of fertilizer application was because less inputs were applied in the traditional subsistence farming system in the country. Both harvesting and threshing is undertaken manually. Paddy yields differ from farm to farm as well as from season to season.

4.2.2 Upland Mixed Crop Farming System in Rambodagama

One of the typical approaches to upland or highland farming in Sri Lanka is a system of mixed crop farming dominated by crops where perennial, annuals and tubers are intercropped with forest trees. The density of non-associated, unplanned species of crops grown together is high and the per crop productivity under such a gardening system can be low. Except for some of the crops that could be widely grown in almost all-ecological regions in the country, the cultivability of most of the crop species in a system of mixed farming is largely determined by agro-ecological factors. The type and density of crops grown in a system are also determined by technical advice or policies of the Government or are shaped by tenurial arrangements that govern access to the land.

Tree crops such as jak, mango, papaya are widely grown in almost all ecological regions and elevations. For instance, in most of the upland mixed crops farming systems in the dry zone plains, annuals such as vegetables and tubers are also intercropped widely with perennial tree crops during the rainy season. Tree crops grown in the Dry Zone include jak, breadfruit, papaya, drumsticks, coconut and some forest tree species such as teak.

In intercropping annuals in mixed crop gardens, agricultural land operators in most of the Wet Zone areas face a number of constraints. One obviously is the limited one of the land holding operated. A second constraint is the complicated land tenure system. Dry Zone upland mixed crop gardens are also relatively newly established and are, to a large extent, free from complicated land tenure practices adopted in the hill country Wet Zone regions. As the upland mixed crop farmers in the central highland region depend heavily on non-farm employment for income as a major source of livelihood, the availability of their labour devoted to intercropping annuals on upland mixed crop gardens is also restricted. These drawbacks nullify the natural advantages in the region for growing of annuals as intercrops.

Any attempt at understanding the working and the rationale behind upland mixed crop farming system necessitates the examination of various land use and cropping practices and factors influencing such practices. Similarly, there is also a need to understand diverse upland mixed crop gardening systems that exist in other parts of the country and factors influencing their prevalence. Some have referred to this system of farming as tree gardens or homegarden agro-forestry (see for example, Vignarajah, N, 1990:5). Such terms may have been coined by examining the dominance of tree crops in this farming system. For example, in the central highland regions, high canopy fruit trees, fuelwood and timber trees are grown along with papaya, castor, banana and cassava that have a medium canopy. These in turn are intercropped with low canopied arable food crops, spices, wines and herbal plants. Multi-storied cropping systems practiced under such a farming system necessitates a high degree of awareness of the intrinsic qualities of the trees and crops suitable for growing in a given ecological region and their ability to grow under mixed crop farming conditions.

The multi-layer system of crops grown is also suggestive of the extent to which the system is ecologically determined. To perfect such a density of crop growth, which naturally competes for nutrients, water, space and sunlight, is a difficult task if determined and manoevered by humans alone. Thus the association of multi-layers of crop species appears to have, to a large extent, determined also by natural factors such as the natural selection and favourable micro-ecological factors.

Compared to many other forms of upland garden systems in the country, much attention has been focused on the upland mixed garden farming system in the central highlands. It is commonly referred to as "Kandyan Home Garden System" due to the system's widespread, miniature size and its ecological richness in Kandy district. McDonnell and Dharmapala (1973) who studied the Kandy district upland farming system in 1973 coined the term "Kandyan Forest Garden Farms" to describe the system.

4.2.3 Animal Husbandry Practices in Rambodagama

As noted already, economically dominant crop in Rambodagama is paddy. Other important sub-systems of agriculture in Rambodagama are livestock and upland mixed crop farming. There is a high inter- dependence of tree farming systems in the village. Buffaloes and perennial dry cattle apparently are less productive in terms of the income generated by milk, meat and cowdung. They were maintained within the village agricultural system to meet the draught power requirements of paddy farming especially for land preparation. After the harvest, the remainder of paddy straw constituted a major source of food for the cattle. Tree fodder, other agricultural residues, and grass constituted the rest of the feeding matter for the animals kept for draught purposes. Cows raised on a stall-fed basis are provided with concentrated animal food to sustain the productivity.

4.3 Aspects of Sustainability of the Farming Systems in Rambodagama

When viewed from a conservation perspective, many would agree that the upland mix crop farming system in Rambodagama is a sustainable form of agriculture in this ecologically vulnerable region. For instance, the Report on Kothmale Land Slips and Adjoining River Catchments (Sessional Paper XVII 1954: 24) has referred to the system as:

> "The mixed vegetation forms several tiers or stages below the highest palms and Jak trees covering the ground even when dug up is protected from the heaviest rain. There is however, great scope for better stone terracing to improve the retention of manure and soil nutrients".

Similarly, McConnel and Dharmapala (1973) from the hydrological and conservation points of view, consider "the traditional mixed forest farms as an exclusively efficient form of land use system". They also note the high density of tree cover and resultant leaf fall and the minimum amount of weeding required to secure this condition.

In spite of the general agreement on the admirable ecological and conservation aspects of the upland mixed crop farming system, there is little consensus on its advantages as an economically efficient farming system in an area affected by the scarcity of land and lack of opportunities for productive employment. As McConnel and Dharmapala (1973) point out these farms provide essential living levels both by returns from economic cash crops and subsistence produce. Economic cash crops, they refer to include the minor export crops interplanted in a mixed crop gardening system in the Kandy district. Subsistence crops include a number of diverse crop species such as spices, beverage crops, medicinal plants, fruit trees and timber.

As Premaratne (n.d) and De Silva (1985) point out "Although these mixed cropping systems have been carried out over generations, it is now established that these traditional systems are agronomically and economically inefficient. Haphazard planting of tree crops without giving due space considerations, sets limitations agronomically, where the crops compete for light, air space, nutrients and other resources with the end-result of sub-optimum crop productivity". They also note that in economic terms the present system yields insignificantly low incomes, hardly adequate to sustain an average family, as a result of poor crop selection, poor maintenance, improper processing of products etc.

In the light of the preceding discussion, the multi-layer cropping system associated with the upland mixed crop garden system could perhaps be understood as a form of natural vegetation system, for a number of reasons. First, little effort is made by the farmers to select crop varieties that are to be grown or will be accommodated in the garden. The scope for doing this is also fairly limited for two reasons. On the one hand, most gardens are congested if not already over-planted. On the other-hand, most lands are jointly owned and this may work as a disincentive to rationalize production on such lands mainly due to two factors. One is how the output to be distributed. The other is that such action on the part of one or more owners would give a stake in ownership to the remainder of the joint owners.

Lack of motivation to rationalize this type of a cropping system may also be due to the inadequate marketing opportunities for most crop varieties produced on upland gardens. Except for minor export crops and some timber trees grown on upland gardens, almost all other crops are subsistence-oriented. Most food crops aimed at subsistence consumption lack a market demand or organized attempts at sale outside the area. During the season, most local families produce a surplus of subsistence food crops which may be shared, preserved by drying or wasted. Both jak fruits and breadfruits are such crops that are found in abundance during the season.

Fruit bearing of jak and bread fruit trees do not occur with any regularity; they may bear fruits this season, but may not in next season and so on. Therefore, there is little rationale for removing otherwise surplus trees. It is also not a common practice to remove trees that do not serve a purpose such as bearing edible fruit, producing timber, fuelwood or fodder or even shelter. Trees naturally grown will survive until a purpose for felling them has really emerged. Such a purpose could rarely be the need for rationalizing the land use system for increased productivity or biological reasons. For example, land operators rarely undertake pruning to increase efficient penetration of sunlight, economize the use of existing nutrients by the plants to increase productivity or for any other directly productive purpose. If pruning is done at all, it is for animal fodder or for fuel-wood.

Compared to various other land use practices prevalent in the Nuwara Eliya district, agriculture as undertaken in Rambodagama suits the fragile agro-ecological environment of the region. It is also based on an input system the sources of which are of local origin. Approximate soil losses on paddy land is 05 tons per hectare per year while the figure estimated for mixed garden is 10 tons per hectare per year. These figures should be compared with those of soil losses recorded for market gardens and chena lands respectively of 100 and 75 tons per year per hectare (see annex 1).

Regarding inputs, there is little or no cost involved in providing irrigation water as farming is based on

rainwater or natural water streams that run through the village. Seed paddy in most of the cases are produced within the family or exchanged locally. The level of chemical and fertilizer application, especially compared to that of the market gardening system, is very low and has no significant effect on the environment or land resources.

In terms of other inputs the system is also less dependent on external sources for their supply including farm power used in paddy production. Buffaloes kept as draught power are at the bare minimum to fulfil the draught power requirements of the village and they need little forage and grass resources. Buffaloes are also used on an exchange basis. As the labour needed for paddy cultivation is mainly to come from the family itself or on the basis of an exchange system, the supply of this most important factor of production is not governed by market forces. On the other hand, given the current resource use patterns and the level of productivity-which is very low, this farming system could hardly affect inputs at market prices.

Both buffaloes and cattle kept by the villagers make an important contribution to agricultural production in the village, providing draught power. The second function with or without the villagers being mindful of it is the cattle-turning fresh grass and agricultural residues found in the village into useful farmyard manure. As the homestead gardens are located on the higher elevations of the valley, the rain water carries the farmland manure and deposits it at the bottom of the valley where the paddy lands are situated before finally flowing to the streams.

4.4. Major Factors Affecting the Sustainability of the Rambodagama Farming System

However sustainable the paddy farming system is in agro-ecological terms, from the point of view of the significance of subsistence output they produce, the system appears to be under heavy stress. One cannot foresee a total demise of the system, as it has survived more or less under similar conditions, but four crucial factors will determine its very existence.

(1) Spread of modernisation
(2) Burgeoning growth of local population,
(3) Poor performance of farming systems in economic terms or low productivity of land and labour, and
(4) Recent wild boar infestation.

4.4.1 Effects of Modernisation

Modernisation, either in terms of physical, social or institutional structures, appears to infringe on the very basis of agriculture in the village. For instance, it was by the institution of plantation agriculture in the 19th century that the pressure on village land resources began to be felt. Lands in the higher elevations located above the village were brought under plantation agriculture during this period. This does not appear to have limited in any way the lands available for paddy farming. Perhaps it might have affected the lands available for upland mixed crop farming or shifting cultivation as happened in many other localities under plantation agriculture. But it does not mean that village agriculture was not affected under plantation agriculture. Historical evidence is that the institution of tea plantations in the district affected village agriculture in two different ways. Firstly by decreasing the land available for shifting cultivation and the collection of fodder for cattle. Secondly by sedimentation of silt in streams and paddy fields reducing their viability for paddy production.

Starting from the 1940s, small-scale tea estates located in the village have changed ownership from foreign private to a national private ownership. Once the property was reverted, the lands were systematically brought under upland mixed crop gardening. Some badly managed tea lands in the village appear to undergo a process, though slow, of a shift in land use practices from tea to upland mixed crop

gardening. On the other hand, abandoned tea lands in the village constitute a main source of soil erosion. In 1994, for instance, some 10 acres of abandoned tea lands managed by the Land Reform Commission had been alienated for housing purposes amongst the landless in the nearby areas. This land is under heavy soil erosion and thus far no steps have been taken towards its conservation. The silt generated through this process has significant implications for paddy production on lands located in the valleys and of the villages below.

The Kothmale reservoir construction resulted in the inundation of a number of villages including a township by the name of Sangili Palama (Sangili Bridge) which was located by the side of the Kothmale Oya. Similarly, the construction of the reservoir increased the risks of landslides in the area and rendered a number of local families homeless in the Kothmale Divisional Secretariat Division. A great majority of the families who were relocated found land in the newly irrigated Dry Zone areas under the project. No families in Rambodagama were compelled to relocate nor did their lands came under reservoir development. Nor it was not compelled to absorb relocated people.

Sangili Palama township that went under water was replaced by developing a new town including a shopping complex, an administrative complex to house the divisional administrative staff of the Kothmale Division, a police station, a post office and a new high school with a large play ground. The new town is located next to the Rambodagama village.

Modernisation did not come with new buildings and service facilities alone, but also with a tarred road that cut across the village into two physical sections in a semi-circular form along the undulating steep valley. The road concerned is Pundalu Oya-Thawalan Tenna connecting the Kothmale new town to the village. It has also been connected to Nuwara Eliya-Kandy road via Rambodagama village. Not many houses were affected by the construction of this road, but it separated paddy fields stretching from higher elevations to the lower elevations. This had a net negative effect on paddy because of a disruptive effect on the flow of natural water streams by diverting them. The water that runs through paddy fields had been made to run through an anicut across the road to a channel which reached the river. The construction of the road also had disrupted the asweddumized paddy fields, including some of the most fertile lands in the village. This was due to the moving of soils and rock formations to allow for the road construction and for its reservations. The village paddy land lost by the road construction alone is estimated to be about 15 acres.

The more affluent people of the village, especially the salaried employees, constructed their houses close to the road. Some lands that were converted into housing sites were former paddy lands. Under normal circumstances it is prohibitive under the Agrarian Laws to convert paddy lands to other uses such as housing sites. The way it happened, according some villagers, was that the specific land selected for housing was first abandoned supposedly due to shortage of water for irrigated paddy cultivation, which may be only partly true. Then the land was filled before the construction started. Yet another process appears to affect the paddy farming system in the village. This is the slow, yet steady process of paddy lands, considered technically unsuitable for paddy, being brought under vegetable cultivaiton.

The process of converting or abandoning paddy lands for other uses takes place slowly bringing more lands under housing. This is strongly opposed by the poor villagers and other paddy cultivators who are affected most in many ways. First, converting paddy lands to other uses affects paddy cultivation on adjoining lands by changing the landscape, disrupting water springs, thus affecting the collective interest of the cultivators to protect the crops on a given stretch of paddy lands. Also the loss of lands to paddy is a waste to the community as this also affects the lands available for rent, grazing and many other uses. The converting paddy lands into other uses is being opposed by bringing different forms of pressure including seeking legal remedies.

Nevertheless, the process goes on uninterrupted. Those who undertake such activity are wealthy and belong to the influential elite while the rest have little "voice" in the matter. Secondly, they are mostly owner-cultivated lands and located somewhat separately from the main stretches of paddy lands. Perhaps they are not the most fertile land for paddy and sufficiently dry to be for other uses. If not for the persistent wild boar menace working as a major disincentive to farming in the village, much larger extents of paddy lands that are also suitable for growing other food crops might have been brought under cash crop agriculture such as vegetable cultivation. The wild boar menace prevents land operators from growing vegetables like beans and banana for the market or manioc and sweet potato for home consumption.

Be that as it may, the ongoing process has a net negative effect on the paddy farming system in the village. Thus it appears that paddy farming is the most endangered sector of the economy in Rambodagama. In the nearby villages, upland mixed gardens were also inundated under the Kothmale reservoir project. Large stretches of such lands in some villages had also been cleared to facilitate the conveyance of high-tension hydropower lines produced by the project. For instance, the Mallewa village located bordering the Rambodagama lost some of its home garden crops due to the installation of power lines.

The upland mixed crop farms in Rambodagama are not as productive as those in the Kandy district. The economic output of Rambodagama upland mixed crop farming system also has been hampered by the wild boar problem since it started in late 1970s. Nearby forested areas and hill tops provide a hiding place for the wild boar and in the night they roam the village in search of food. They destroy the paddy seeds from the nursery beds, eat the mature paddy at harvesting time, and also eat the manioc, sweet potato and banana roots. The wild boar is a real threat to agricultural production in the village.

The wild boar problem became steadily worse in the late 1970s when police began to acquire villagers' guns for civil security purposes. This was the time when young people with insurrectionary tendencies became interested in guns. Since then, the guns were kept under police custody for the safety and security of officials, members of Parliament and the public. Prior to this the wild boar was hunted for venison by the villagers and their members kept in check. The wild boar has become a disincentive to village agriculture in terms of production of paddy and the growing of other subsistence crops on the upland gardens.

It should be clear by now that in ecological terms, the farming system in Rambodagama is a relatively more sustainable system. The system contributes little to land degradation, especially soil erosion. However, social forces like increasing modernisation and its side effects have a harmful effect on the area under agriculture, particularly on paddy farming.

Though in purely ecological terms, the Rambodagama farming system is a sound one, as a system of agriculture or as an economic system geared to sustain life, it is undergoing a range of stresses that will determine its vitality. Factors unfavorably affecting its existence include the worsening land-population ratio, reduction in productivity levels, lack of appropriate technology that would enhance production without affecting its natural resource base and diminishing economic incentives for those dependent on the system.

4.4.2 Demographic Impact and Coping Strategies

An important way of assessing the viability of the Rambodagama type of farming is to examine the demographic impact on the system. It appears that the deteriorating land - person ratio is one of the most important factors bringing pressure on the system by affecting both economic expansion and the living conditions of those engaged in agriculture in the village.

At the beginning of this century, there were only five families living in the village and in the early 1940s a migrant family joined them. By 1994 there were 113 families in the village with an estimated population of 600 persons. In addition, over twenty families have been added to the village population under the village expansion scheme of the government.
It appears that by the late 1930s the economic limitation of agricultural production in view of the growing population, had set in. By 1930 the population of the district had been growing at an annual rate of 4.1 compared to the island-wide growth rare of 1.7. The high populatlion growth rate experienced was the result of the Indian migrant workers to the district.

This was about the time that the villagers had started migrating to new land settlements located in the Dry Zone regions. These land settlements include Hingurakgoda, Polonnaruwa, Medirigiriya, Kalawewa, Ampara and Minneriya. The process continues to date where some of the villagers have abandoned the region to settle in new irrigated areas such as in Kalawewa and Maduru-Oya under the Accelerated Mahaweli Development Programme.

In addition to the transfer of the excess population to newly settled Dry Zone areas the population pressure in the village also have been reduced by the provision of lands under village expansion schemes in the region itself. Under the village expansion scheme the population movement has been upwards towards the elevated land than downwards. Beside following the same activity, agriculture in a different area, the population has also been migrating to urban centers for off-farm employment and has settled outside the village.

Not all the villagers who want to have better economic openings or better access to land have the opportunity to do so. On the other hand, most of the people, in spite of their hardships do not want to migrate. This reluctance to migrate even within the district is demonstrated by the high dropout rates recorded in youth settlement schemes in the 1960s. Not only do community relations bind the people to the village, but also favourable ecological factors that curb their moving out of the village to areas with unfavourable climate like the Dry Zone areas.

In spite of all the schemes geared at relieving the population pressure on agricultural lands, the population appears to grow steadily though the birth rates have declined throughout the last two decades. This is due to the structural characteristic of the population itself by having a population with a heavy base.

4.4.2.1 Measures Taken by the Community in Coping with the Population Pressure

One means of relieving the population pressure has been migration, which has increased recently in view of the presure of population, and particularly over the past half a decade. One other means of reducing the pressure on lands, especially on paddy lands, has been by attempts at technological changes. One such change adopted in Rambodagama village from the 1940s was to increase the land use intensity by double cropping the paddy lands. This was the time when the country was experiencing a high population growth rate. This practice is continued to date. Another as discussed elsewhere in this report is the adoption of a high yielding variety. (HYV) of rice, namely H4. This was one of the HYVs of rice developed by Sri Lanka rice breeders, though this was not suitable for the area as it was developed to meet the conditions of irrigated farming in the dryer areas of the country. The basic problem it solved in the region was the relatively long time it took for maturing. This fact hindered double cropping the Rambodagama paddy lands. In the 1970s another high yielding variety of rice was introduced into the region by the name of BG 400/1. This was the first time a HYV paddy variety suitable for the area was available and the Rambodagama farmers were quick to grab the opportunity.

Beside, the more recent attempts at coping with the population pressure by migration and technological innovations, there have been a range of traditional customary devices such as systematic and func-

tional arrangements to deal with the person-land ratio or the deteriorating land resource base in the village. These latter devices have been built into both the farming and human institutional systems. Some of these devices are functional in nature and focused on the management of property and would be classified as functional adjustments built into the system of traditional property relations to cope with the pressure for land resources arising out of population growth.

We will discuss first a range of functional devises that had been adopted to cope with the impact of population growth on land resources. According to the inheritance law of the country all the descendants of a married couple inherit the land and property equally though this may vary in practice. For instance, a young female who marries on "*diga* (patrilocal) marriage" may get her portion of inheritance in movable assets at the time of the marriage. These arrangements are normally discussed before the marriage takes place and the woman or her siblings are not expected to revert to her ancestral property for a living. This can be taken as a "social construct" or a "social institutional arrangement" in a male dominant society to remove the excess population from a family's land and property. Yet either customarily or legally, this will not prevent the Diga married woman from reverting to her share of immovable resources of the original family, for housing or lands in times or occasions of distress. Occasions of such distress may include loss of means of living, break up of marriage, being widowed or becoming disabled or sick. Yet everything will depend on how others respond but the conventional practice is to accommodate them.

Another institutional form of systemic adjustment that had been practised in the Kandy regions includes " *Ekagei kema*" (Polyandry) marriage where some seven brothers can marry one woman. Under this system of marriage, a woman married to an elder brother could be co-wifed by his younger brothers. This system of marriage had served two main purposes. One is that the available labour in the family is kept intact for agricultural production purposes in an agriculture-dominated economy. At the same time, both the movable and immovable property were kept intact while the viability of agricultural holdings was to remain undisturbed.

Contrastingly, a woman could undergo a "*binna*" marriage, which according to Obeyesekere (1967:45) in most instances involves uxorilocal residence for males. Under such marriage a husband is expected to join the family of the wife. The main idea behind this practice appears to be to boost the labour supply in an otherwise labour-deficit family in terms of the extent of land operated. In other words such an arrangement had been intended for attracting labour needed for family farming when there are only one or two female children with no male siblings in the family to farm the land. Such social-institutional devises to mitigate the population pressure on lands as well as labour shortages have become negligible at least by the turn of the century due to the advent of "modern civilization".

Another systemic response to cushion effect of population growth has been absolutely 'non sale' of land. All the land available are inherited and not transferred within a market mechanism. This applies especially to paddy land, a very scarce and valued resources in the village. For instance in the 1940s ancestors of the present 'Fernando' family came into the village by purchasing an estate of 9.5 acres. This was from a Malaysian who happened to sell his land at the time. The land, which is also called "Malayalam Wattha" (Malaysian Estate) was later divided among his siblings, sons and daughters who survived him. Today the total number of dependents of the Fernando family consists of about 100 persons, with grand and great-grand children. Yet none of them hold any paddy land in the village. This could not be that they, coming from an urban area, are not interested in paddy farming. Otherwise in most respects they have been well integrated in to the village community and the economy. Then it could be that what prevents them owning or operating paddy lands could be the 'non-availability' of paddy land for sale or transfer' with access to them. Thus it is possible that the community jealously guards village lands, particularly the ownership of paddy lands, and how they are transferred. This could be another systemic device adopted to arrest the deteriorating paddy land population ratio in the village.

Even at present, inter-marriage amongst kinsmen is the most acceptable form of marriage in Rambodagama. Inter-marriage as an institutionalized form of starting a family would function to hold that community intact. It is possible that such marriages facilities not only keeping the landed property together amongst the members of the existing community, but also comprising a couple that would adhere to the property values and norms maintained over centuries by the community. Normally an acceptable male is preferred to a female marrying a man from outside the village and trying to settle down in it. The latter is resisted though agreed to as a final resort.

Thus it appears that the safeguard against population pressure especially as a safeguard against "losing ground" has been built into the human system itself. In terms of physical systems as in terms of land use practices, what historically the villages have been practicing is to bring almost all the suitable land in the village under paddy cultivation.

Sub-division of lands, amongst those inherited have been the main functional devices adopted by the villagers to face the demand on land with the increasing scarcity of land. On the other hand, division of lands on a functional basis such as plot rotation and operator rotation *(Kattimaru and Thattumaru)* appears to be another devise adopted by the Rambodagama inhabitants to overcome the need for further fragmentation of lands in terms of the growing population. Under the plot rotation *(Kattimaru)* system of land tenure, several owners cultivate a number of parcels rotating among themselves so that each can cultivate the same land by his/her turn. This guarantees a fair distribution in quantitative or qualitative terms of the inherited lands amongst the co-owners. Contrastingly, under the *"Thattumaru"* system, one or a group of owners has the use of a plot of land over a specified period. Some *"Thattumaru"* lands, operated on such a time schedule basis, may take from two to seven years to complete its full round.

4.4.3. Poor Productivity Performance of Agriculture as a Major Inhibiting Factor on Rambodagama Farming Systems

It would appear that the basic problem in agriculture in Rambodagama is low productivity of land and labour. This applies not only to paddy farming but also to other two forms of agriculture, the upland mixed crop farming system and animal husbandry. The low productivity observed in the upland farming systems is also applicable to most upland mixed crop gardening systems that prevail in the central highland region. For instance, in discussing bottlenecks in agricultural production in the Nuwara Eliya district in relation to land use practices, Robert van Grootvel (1992:12) remarks that

"Agricultural production levels are low, not only on sloping lands, but can also be seen in the homestead gardens, in milk and meat production and surprisingly nowadays in traditional irrigated paddy civilization also in the paddy lands".

Furthermore as McConnel and Dharmapala (1973:20) state of the upland mixed crop farming system, "Crop management, in a modern- technical sense is poor: except in the case of paddy it can be described as a kind of traditional jungle-gathering of produce rather than systematic agriculture".

Lack of incentives in paddy production has already started in withdrawing lands from paddy cultivation. Some lands are left fallow over long periods until the area is taken up for housing or vegetable farming. Yet the organization of vegetable cultivation as a form of market-oriented farming system in the village is generally limited. This is due to the debilitating factors such as the complexities arising out of the prevailing land tenure practices on both paddy lands and upland mixed crop gardens, lack of capital, unsuitability of certain lands for agriculture like marshy paddy lands.

Lands taken away from paddy farming are those belonging to individuals' who could afford to live without paddy farming. Withdrawing of paddy lands has a net negative effect on the per capita re-

source base of the village both in relative and absolute terms. Those poorer, smallholder operators who are forced to rely on farming are compelled to consume less progressively, are also affected further in the process. The adjustments made by the poorer majority of the villagers consist mainly of cutting back on their basic needs. In other words, instead of getting the most of their natural resources for a living or attempting to migrate to urban areas, they appear to survive with what their limited environment provides them with. For instance, they do not appear make sufficient attempts to modify the technology adopted, change the orientation of production from subsistence to market gardening or change cropping patterns so that maximum returns are got from the available resources.

Neither have they started on social or political agitation on the same scale as seen in other areas of the country. It is not that conditions for social and political agitation do not exist in the area, but they have not surfaced or articulated their grievances on the same scale as the youth from the Southern and North-Eastern regions have. So it is in itself an adjustment process in the main rather than of adjustment in the environment or ecological frontiers. There are a number of reasons for this. An important one is that, given the existing technology and land use practices, ecological resources are exploited to the full, unless the system is diversified itself. In doing so, apparently there are a number of constraints.

Again, one important constraint is the limitations imposed by the ecological elements themselves. It was noted earlier that potatoes couldn't be cultivated in Rambodagama due to unfavourable agro-climatic factors. The economic viability of Saman-Eliya farming system is based on two factors. One is the limitation imposed by ecological factors. Another is the complete protection offered by the government to some of the important import substitution crops such as potatoes. It is not the purpose of this paper to examine the political and social environment underlying this process though this may be an important aspect for further investigation.

Except for potatoes, certain high value vegetable crops can be cultivated in the Rambodagama village though not on all lands. Some paddy lands are suitable for growing of vegetable crops while others are boggy and waterlogged for most of the year and cannot be cultivated with anything else but paddy. Beside the ecological factors that affect the conditions of living of Rambodagama villagers, there are other types of inherent institutional limitations to practising economically productive agriculture in the village, like the size of holding and tenurial complexities. These prevent for example, obtaining credit. The latter is an important input in high value cash crop cultivation. In economic terms, there are little incentives for the agricultural land operators or those who help in agricultural activities in the village to stick to agriculture or remain in the village permanently. A great majority of the people are under-employed for a substantial period of the year. Yet, the system of farming especially, paddy farming is heavily dependent on the surplus labour in the village. For instance, technology applied is labour-intensive and at peak periods demand for labour is met by calling upon the surplus labour of the village through an exchange system. As such absorption of labour into any other sector may jeopardize the very availability of labour on exchange basis. On the other hand, there is no labour market developed in the village for hired labour and at its present subsistence production level, it will be difficult for a cultivator to pay for hired labour. The availability of labour depends on the delicate balance of the 'context in which' it is operating. If its balance for whatever reason becomes disturbed, the system can become heavily vulnerable. On the other hand, the majority of agricultural operators are compelled to depend on an economic system, which cannot support them to meet even their basic needs.

In spite of the sustainability of Rambodagama farming system in ecological terms, its vitality as a socio-economic system supporting the life of those dependent on it, is open to question at present. It is not easy to anticipate the total demise of the system as such, due to the fact that it has survived under similar conditions for ages. The conditions that have contributed to the disintegration of the system appear to have originated with the introduction of the tea plantations. This is due to the encroaching on lands surrounding the village for expanding tea plantations, thus restricting the lands available for

village expansion. As far as people could remember they have continued to survive under similar conditions not by bringing pressure on ecological resources, but heavily relying on off-farm incomes and by restricting their consumption patterns. Initially the villagers did not like to work on plantations as hired labourers. However, in the latter half of the twentieth century they were forced to seek employment on estates due to the inability of the village agricultural sector to support their living by increased production or the lack of other avenues of incomes available to them.

Very often due to the inadequate availability of staple food or insufficient income generated within agriculture, they have been compelled to rely on various non-farm sources. These include salaried employment, working as hired labourers outside the village or sometimes outside the district working as migrant labourers and increased dependence on state-provided welfare measures such as food subsidies.
Beside the disincentives arising from institutional arrangements that make for progressively declining paddy yields, another factor affecting the same process is the lack of time farming families have to devote to the labour- intensive processes of farming. The paradox between not having enough labour for conservation practices and having an excess population is explained by the fact that families have to do off farm work to earn their day to day income. Thus many are part-time farmers. Those not having such off-farm employment opportunities are compelled to devote their labour to unproductive subsistence production and activities such as collecting and processing of food items. This fact is related to the very farming situation as farming families are compelled to make a living in an economic and social environment, which offers little in terms of productive on-farm or off-farm employment. Thus the work performed, despite the drudgery involved, offers little opportunities by way of income even for a modest livelihood.

It is a self-adjustment process that takes place in Rambodagama, in the main, rather than one of making adjustments in the sphere of the living environment of ecological or production opportunities themselves. There are a number of reasons for this. An important one is that given the existing technology and the existing land use practices in the village, it can be said that exploitation of the ecological resources is, in a way, already saturated, and the system needs to be diversified if higher productivity levels are to be achieved. Apparently there are a number of constraints involved in diversifying the system.

4.4.4 The Wild Boar Problem

Villagers find the wild boar threat more menacing than any other problem. The Saman-Eliya farmers had a similar experience. Sources of secondary information also supported the view.

CHAPTER FIVE

Summary and Conclusions

One of the basic findings that emerged in the course of this study is the significant influence certain factors had on agricultural and land use practices adopted by the farmers in the two villages studied, Rambodagama and Saman Eliya. These influence may be considered "contextual factors". The "context" for the purpose of this study are defined to include the physical and socio-economic environment in which the farming is done and includes the ecological, physical, social, economic and institutional setting that influences production decisions, crops and the cropping practices adopted by the individual farmers, as well as the productivity levels they achieve.

Taking this with consideration farming situation differs from season to season, from locality to locality, from farm household to farm household, from plot to plot, and from crop to crop. Thus productivity, either measured in terms of subsistence agriculture or incomes generated by the marketing of crop varies according to the differences and the degree to which the contextual factors exercise an influence in real or perceived terms.

To appreciate how contextual factors affect farming, the influence of ecological factors need to be considered. It was noted that the particular ecological situation strongly influenced the land use practices adopted by the agricultural land operators. The Nuwara Eliya district and the Kothmale Divisional Secretariat area which is a part of the district share a common agro-climatic zone. However, the two villages studied though located in Kothmale have very different ecological environment that determine the crops that could be grown there. For instance, the Saman-Eliya temperature presents near ideal conditions for potato cultivation, yet is highly unfavourable for growing paddy, minor export crops or mixed crop gardening. Similarly, the slightly warmer temperature in Rambodagama preclude the growing of potatoes. Certain marshy lands in Rambodagama could be used only to cultivate paddy or certain tree crops.

Beside the ecology that influences the farming practices undertaken in the two villages, others that conditioned land use and farming practices included social, economic, political and institutional factors. For instance, Saman Eliya demonstrates an attempt at settling a portion of the surplus population on this ecologically fragile environment in order to solve one set of problems but creates another set of problems. The objective in settling people in this Mahaweli upper watershed area was to solve the problem of landlessness, unemployment, underemployment and related social and political stress arising out of these situations. Also envisaged was the increasing of agricultural production. In the case of potato growing, a much wider range of services had been provided to Saman-Eliya farmers by public sector institutions to make sure that the new crop would take hold in the village. The services provided included the extension services, seed potatoes, other production inputs, necessary credit through institutional sources and at times marketing. Most importantly, the government's agricultural and food policy has helped the potato growers to reap substantial profits from a protected market.

Compared to the wider ecological, social and institutional milieu favoring vegetable and potato cultivation in Saman-Eliya, in Rambodagama, it would appear that both the agricultural productivity and the agricultural economy based on it are dwindling, for a number of reasons.

The natural resources available to the Rambodagama community are inadequate to meet even their basic needs. This is specially so due to the changing land-population ratio resulting mainly from the

burgeoning population growth experienced during the last half century. Further, under the existing forms of subsistence agricultural production, extracting a higher surplus from natural resource endowments of the village to meet their basic needs will result in the soil quickly being progressively reduced. Besides the limitations imposed by the type of ecology itself, other constraints such as the prevailing social, economic and institutional conditions also impede the Rambodagama farmers' attempts at diversifying or modernizing their agriculture.

The fact that they possess a clear title acceptable to the formal lending institutions as collateral enables the Saman Eliya farmers to obtain loan for their capital-intensive crop production. On the other hand farmers in Rambodagama although having lands suitable for cash crop cultivation were disqualified from getting institutional loans as the title to their loans were unacceptable. In Rambodagama the lack of clear title deeds stems either from shared ownership of land or lack of any written title to customarily owned, used and transferred lands. Such factors work as major disincentives to any attempts at improvising agricultural production in Rambodagama.

Likewise, any attempts at intensification of production and increasing productivity by adopting high yielding varieties appear to be limited also by the non-availability of paddy varieties suitable for local conditions. This reflects the agricultural policy bias towards specific crop varieties, regions and areas. For instance, crops serving the objectives of the Government such as those that help to save foreign exchange, i.e. import substitution crops, receive priority. Similarly, areas that have high productivity are given high priority over the marginal areas in terms of the supply of inputs. In other words, it appears that the emphasis is more on production, productivity, saving of foreign exchange than on the sustainability of production, conservation and maintenance of agricultural and bio diversity or on assisting the marginal communities to meet basic needs on a self-help basis.

As such ecological, technological or institutional factors inhibit the land operators in Rambodagama in their attempts at diversifying or modernizing agriculture to increase the productivity of the limited resource. Thus in the face of significant limitations placed by the living environment itself, the farmers of Rambodagama appear to look inwards and try to make adjustments in their own life by reducing their own consumption. Such adjustments include changing approaches to production, reproduction and changing of life styles. Rambodagama farmers appear to have been making a journey downhill over the last few decades if not for over a century.

As far as the issue of sustainability is concerned, both farming systems are on the decline or under heavy stress in trying to sustaining themselves. Instead of discussing the possible disappearance of either system faced on the present level of information it would be more appropriate to identify vulnerabilities inherent in the systems. If access was available to longitudinal data of the two villages on the parameters that have been examined in this study, a clear identification of factors affecting sustainability of either system could have been easier.

Stress factors affecting the two systems differ substantially, or affect the system in varying degrees or the factors themselves are in different stages of evolution as they affect the systems. For instance, Saman-Eliya village at present is relatively less affected by the land tenure complications but difficulties are bound to arise in less than a decade if steps are not taken to absorb the second generation of settlers. Stress on the Saman-Eliya farming system is bound to emanate from a rapid deterioration of the natural agricultural environment. Land degradation in Saman Eliya emanates from four sources.

(1) Intense clean weeding and tilling operations intrinsic to the market garden system of agriculture in Saman-Eliya aggravates soil erosion and leaching of soil nutrients in this ecologically vulnerable area characterized by intensive tropical rains and steep terrain.

(2) Rapidly growing species of vegetable that tend to remove most of the natural or externally provided soil nutrients from the market gardens in a matter of few weeks or a few months.

(3) Removal of the bulk of the bio-mass produced from the ground as edible matter with most of the extracted nutrients contained in the parts removed.

(4) Permanent damage done to the soil by way of letting agro-chemical residual matter remain in the soils, and depending on externally provided nutrients for crop growth and thus damaging the totality of the agro-ecological environment or the very eco-system conducive to agriculture by intensive application of synthetic agro-chemicals.

Though land degradation is evident under the Saman-Eliya farming system, but the degree to which this has already taken place cannot be assessed for two reasons. First, land degradation in Saman-Eliya is associated with two processes-qualitative and quantitative. Regarding the qualitative nature of land degradation, it would be difficult to assess the stage it is in, and the extent to which it can continue to support agricultural production. But what is certain is that degradation occurs at a substantial level but its extent has to be studied in greater detail. Second, the impact of land degradation on productivity has been offset by the application of inputs at a significantly higher level and also by adopting many other forms of technical and cultural practices that would conceal the real situation.

The Saman-Eliya type of farming systems also depend heavily on externally provided inputs such as seed material, soil nutrients and other inputs like weedicides. Either the inherent fertility of the soils is low or has been depleted under intensive cropping practices. Under such conditions, the application of nutrients from sources outside the system has become necessary. As Wolf (1986:13) citing various sources has indicated, that productivity potential of internal resources such as the inherent fertility of the soils can be masked or diminished, or it can reduce the vitality or the strength by the rapid introduction of artificial fertilizers or externally provided inputs. On the other hand, the supply of such inputs has to be got from an unpredictable market that could effect the sustainability of the system.

Finally, certain advantages the potato producers in the Nuwara-Eliya district have, such as a range of appropriate ecological elements conducive to the growing of temperamental crop species which most other areas in the country lack give them a competitive edge. The war situation affecting potato supplies from the Jaffna district to the market or the conditions created by the Government by banning imports more or less on a regular basis have also meant relatively high levels of profits accruing to potatoe growers in the district. It is apparent that such levels of mostly artificially accrued profits are unprecedented in the small farmer sector of the country. The indirect result of this profitability were attempts at growing potatoes in the district where they had not being grown before, including hitherto forested areas. Also this phenomenon has captured the interest of the capitalist and of the relatively large land-owning entrepreneurs or others such as Government officials because of its profit levels. All this resulted in various kinds of manipulations and interference with the working of the land, the input supply market and perhaps even into the market and import regulations. When fully in place, such activity can finally lead to a large-scale displacement of small farmers dependent solely on incomes from potatoes for a living.

In Rambodagama, on the other hand, a different set of mechanisms appears to be at work in affecting the sustainability of the subsistence farming system. First, declining of the agricultural resources base in relative terms due to wider ecological or land degradation in the village is limited. In this sense, the farming systems are sustainable. Yet, the village agricultural resource base is on the decline in absolute terms due to the use of existing agricultural lands for alternative uses, as for instance, the asweddumized paddy lands being used for road construction and housing or vegetable production for the city market.

It appeared that modernization has encroached on a substantial proportion of the scarce paddy land resources in the village to the great annoyance of the poorer villagers. A major factor that has led to turning paddy lands to different uses is the lack of profitability of paddy farming itself. Technological changes adopted like double cropping, and adoption of a high yielding variety (HYV) have resulted in

productivity increases only marginally. One reason was that the changes made were highly ineffective in terms of both the suitability of the seed paddy introduced in order to have substantial productivity increases, or their non-availability in the village. For instance, HYV 400/1 that was introduced in the 1970s has degenerated over the years and remains in need of a fresh stocks.

The paddy farming system is dependent for its labour supply on a system of exchange labour. Taking into account the present level of productivity of paddy lands in the village, it will be difficult to cultivate them by hiring labour on a commercial basis. Thus far there is no excessive off-farm demand for labour in the village. However, a substantial increase of off-farm labour, will have a destabilizing effect on the labour supply to the paddy sector in the village.

A paradoxical situation is that the same forces that have a detrimental effect on both paddy and upland mixed crop gardening systems, by precluding any attempt at increasing productivity on such lands, appear to function as a factor maintaining them or their conservation in their present form. For example, there are many share owners for upland home gardens and their property is not divided among them while the produce is divided according to each person's share on the property. Thus while one obtains her/his share of the produce according to the proportion of the share of the property itself, no one is allowed to undertake changes of a permanent nature on the property such as selling, cutting or pruning of the tree crops. Such action will be seen as impinging on the common property by one set of owners detrimental to the rights of others.

A special note has to be made of paddy farming in Rambodagama. Although paddy covers only 27 % of the cultivated land in Rambodagama, it is an important crop in the village for various reasons. First, it reduces the vulnerability of the people who depend on meager incomes for the purchase of their staple food. Second, the region itself, with only 3.2% of the land cultivated with paddy and with about a cropping intensity of about 150 percent is a highly paddy deficit area. According to Robert Van Grootveld's (1992:12), the average yields of paddy in the region ranged from 1,650 to 2050 kg/ha (or 30 to 40 bushels per acre) with Rs: 6,680 to Rs: 8,300 gross return in monetary terms. Though the recorded yield levels are low, given the technology applied and the investments incurred, they are substantially high comparatively. The yield levels recorded for the Matara District in *Maha* and *Yala* were relatively lower than those in Nuwara-Eliya.

Beside its economic importance, other factors contribute to the importance of the paddy farming system in the region. Terraced paddy farming is an important aspect of the cultural heritage of the region and adds to its scenic attraction. If the cultural heritage or the natural scenic beauty is considered to be an important element in tourism development in the country, undoubtedly the terraced paddy fields and the value of cultural heritage associated with it could play a perceptible role in such attempts. Finally, it is also in the highland plains that some of the country's genetic paddy varieties are conserved in situ. Though it is true that such old indigenous genetic varieties are disappearing fast, there are still a few who would cultivate them at least for home consumption.

The major thrust of this study has been to identify and assess the possible damages facing two distinct farming systems in the central highland region of Sri Lanka. One represents a system of subsistence-oriented paddy and mixed crop farming in Rambodagama, and the other a system of market-oriented non-indigenous cash crop cultivation in Saman-Eliya. The latter being a profitable systems of agriculture is able to satify the basic needs of the people of Saman Eliya, provide more employment opportunities and rely on their own incomes for a living. On the other hand the system may collapse due to many weaknesses including the degradation of its resource base, break down of the input supply system, decreasing economies of scale due to population pressure and land fragmentation and the failure of the market itself.

Unlike the subsistence food production system the reliability of which has been tested over centuries,

we do not have much experience of the cash crop farming system as practised in the ecologically fragile region of Saman- Eliya. In the event, if it cannot be maintained over the years, the results on the people dependent on the system can be disastrous, for a number of reasons. The system depends on its ability to convert a range of inputs, both external and internal, applied to the land, into a marketable commodity having a substantial demand. The community, on the other hand, is expected to depend on the market for almost everything for its consumption, including firewood. In a developing country such as Sri Lanka, a breakdown in the market system both in terms of the demand and supply is not a remote possibility. We have already seen how the input supply market can be affected. Even without affecting the producer market represented by Saman Eliya farmers, the supply market for food items needed by the farmers of Saman-Eliya too would break down. The insidious way this can happen and its profound effect on the community could be understood from the following account.

The food shortage, especially the shortage of the staple food rice that was experienced in the country between 1972 and 1974 had profound effects on the import-export economy of the Saman Eliya. The district, as was noted earlier, is a deficit producing area of the staple food rice and the Saman-Eliya villagers had to purchase their entire requirements. With the shortage, rice started to flow from surplus areas to the deficit areas, especially to the cities, attracted by higher prices through thriving private market channels. Yet the distribution became inequitable and was skewed towards cities while among the rural dwellers the poor in the rice deficit areas were affected most, while the affluent people could afford to purchase rice at escalated prices. The Government in order to collect enough rice for a wider and fairer distribution placed a ceiling on private rice and paddy transport between the regions. This process had a net negative effect on the Saman-Eliya villagers, as they could not purchase enough rice for their needs.

As stated earlier, vegetables and potatoes in Sri Lanka are consumed as curries to go with rice and thus they are complementary items as far as rice consumption is concerned. The reduced levels of consuming rice meant a reduced demand for vegetables in the consumer market resulting in having a double burden placed on the Saman-Eliya vegetable cultivator. The cost of vegetable and potato growing, which constituted 90 percent of purchased inputs, meant that vegetable growing became no longer profitable while the farmers had to buy their staple food from a rising market. This had a substantially negative impact on the conditions of living of the people. Thus, some had to migrate temporarily to paddy growing areas in search of both food and work. Hence it appears that this system is highly vulnerable to outside influences.

In conclusion recording of a few personal observations may be in order. In the first place, solutions to Sri Lanka's environmental problem, especially in terms of the degradation of its natural resource base, have to be found by taking into consideration the very context in which it takes place. A part of this very context has already been determined with the institutionalization of tea plantations. The region at present has widespread landlessness and a large work force of Indian origin dependent on tea plantations which brings a meager living. Added to this is the country's dependence on tea for foreign incomes. Thus settling a few individual families on micro-holdings carved out of a degraded tea estate or in forested areas will not solve the problem of landlessness, unemployment or even increases agricultural production, but will aggravate the country's existing environmental problem. It is therefore evident that there cannot be ad hoc approaches to the problem. Any long term solution must involve a holistic approach and take with account the economic, social and political dimensions of the problem.

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